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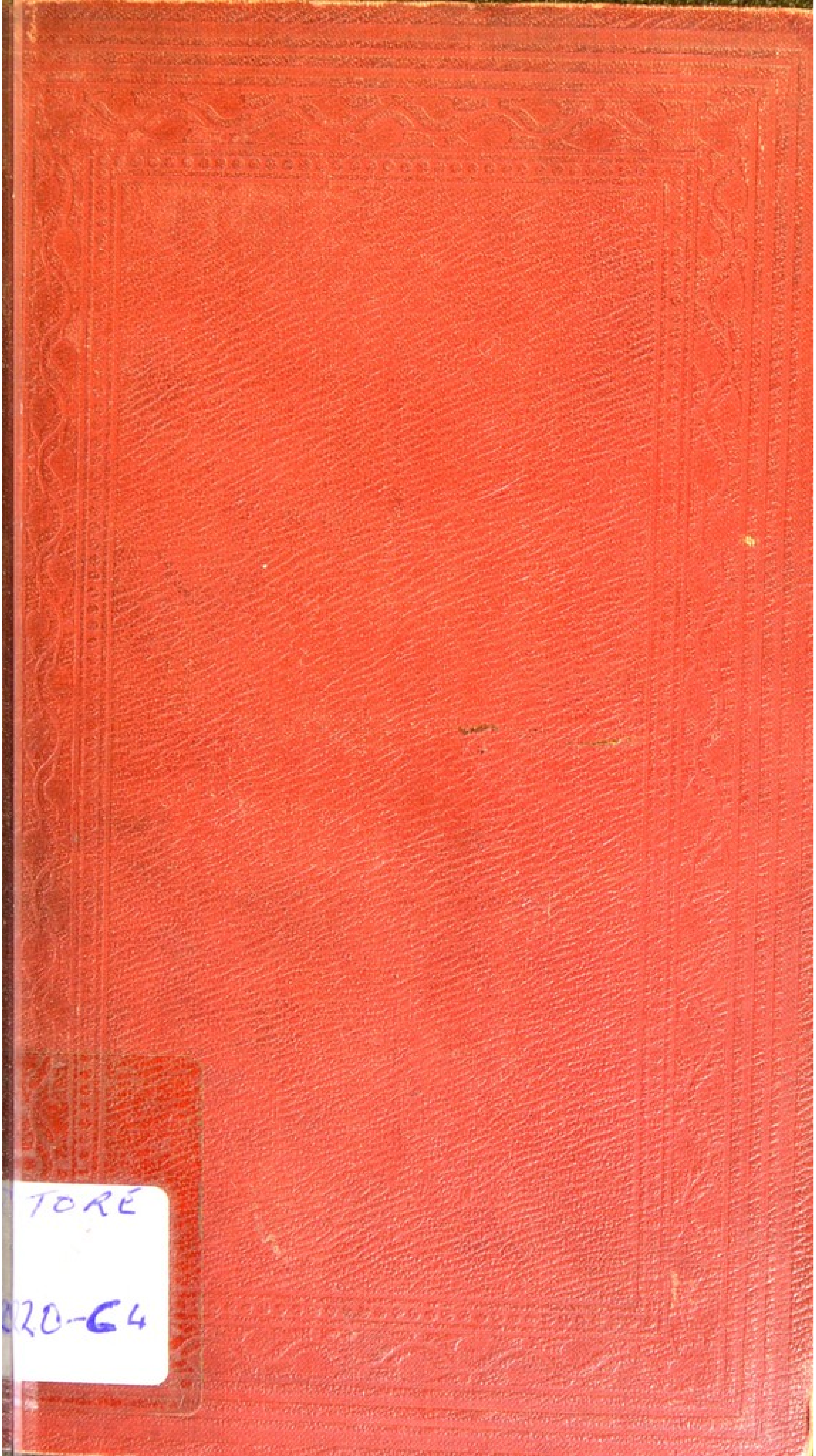

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Henfrey's Masters edition
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TREATISE

ON THE

FALSIFICATIONS OF FOOD.

TREATISE

ON THE

FALSIFICATIONS OF FOOD,

AND THE

CHEMICAL MEANS EMPLOYED TO DETECT THEM.

CONTAINING

WATER, FLOUR, BREAD, MILK, CREAM, BEER, CIDER, WINES, SPIRITUOUS LIQUORS,
COFFEE, TEA, CHOCOLATE, SUGAR, HONEY, LOZENGES, CHEESE,
VINEGAR, PICKLES, ANCHOVY SAUCE AND PASTE, CATSUP, OLIVE (SALAD) OIL,
PEPPER, MUSTARD.

BY JOHN MITCHELL, M.C.S.

AUTHOR OF

"MANUAL OF PRACTICAL ASSAYING."

LONDON:
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PREFACE.

It is the object of the author of the following pages, to point out a few of the adulterations practised by the manufacturers and vendors of various articles employed in domestic economy; as well as to show in what manner such adulterations can be readily and easily detected. Nearly thirty years have now elapsed since the appearance of a work on "Culinary Poisons," by Mr. Accum, in which was exposed the nefarious art of adulterating provisions, &c. Since then, however, as may well be supposed, many new adulterations have been introduced, and the science of chemistry so much extended, as to offer more ready and certain means of detecting the ordinary impurities in articles of food, as well as the extraordinary or newer frauds, so that even if Mr. Accum's work were not out of print, another containing the required information would be necessary, to check in some measure the growing evil.

It is with the view of supplying this want, that the author has been induced to undertake the experiments &c. which are detailed in the following pages.

From that which has already been stated, it will be seen, that this system of fraud is not of recent origin, and if the subject be examined further, it will be found that England is not the only nation suffering under the curse, for in every nation, and in every time, the same mode of procedure has been adopted and has flourished, the only difference being, that science, and the avaricious disposition and misplaced industry of some parties have raised adulteration to the standing of an art, and so clever have those who deal in its mysteries become, that it requires the greatest tact, labour, and circumspection, to bring their iniquitous proceedings to light. For as chemistry advanced, it unfolded new secrets, and opening on the one hand more decided and unequivocal tests for the adulterations, it at the same time gave a larger scope for the adulterators, and pointed out new sources for more effectually disguising any alteration in the article, and rendering the sophistication almost imperceptible to most of the usual chemical tests.

Although Mr. Accum's work appeared at a most opportune time, it is much to be feared that the adulterations of the present day assume a still more frightful character, from the reasons just assigned. It is true that the exertions made by the officers connected with the revenue serve to keep in check many adulterations which would otherwise take place, but the substances which come under their cognizance are so very few in comparison with those which remain unprotected, and which the dealer alone has to overlook, that much fraudulent and even deadly adulteration is constantly practised, and indeed, in those articles under the protection of government, it is found that the avarice or dishonesty (or both combined) of the dealer, is sufficiently strong to induce him to execute frauds and sophistications of such a skilful and novel character, as to escape not only the officers, but the chemists specially employed to assist in the investigation. Many cases of this class are on record.

It must not be supposed, however, that every person convicted and fined for adulterating the substances in which he deals, is guilty, for certain cases are known in which the substances have been supplied to him in a sophisticated state, when it was thought that they were absolutely pure and genuine.

It is not generally known, that nearly all the substances used, either as articles of food or clothing, are adulterated, debased, or badly manufactured, and to an extent that would, at first sight, be deemed almost impossible.

Sophistications are practised either with a view:—

Firstly—Of making the substance more saleable by improving its appearance by the addition of some body, either innocuous or otherwise.

Secondly—Of depreciating its quality, by adding to it some substance, which will diminish its *real,* without altering its *apparent* strength or general appearance. This is generally a very deadly fraud.

Thirdly and lastly—Of depreciating its quality by the addition of some simple substance, as water, or if it be a solid body, as plaster of Paris, sand, &c.

These comprise the quality of frauds, not mentioning, however, short weight and measure, both of which are too well known to need much comment.

It will be now as well to pass in review, the substances generally subject to adulteration. They are Wines, Spirits, Beer, Tea, Coffee, Sugar, Bread, Chocolate, Milk, Cream, Pickles, Oil, Flour, Cheese, Mustard, Pepper, Confectionary, and Vinegar. To these may be added the frauds practised in drugs and substances not articles of food or medicine, as jewellery, silks, cottons and linens, with these, however, the author has not at present to deal.

Some of the frauds practised are innocuous, others deadly; some merely consist in deceiving the purchaser either in measure or weight, others reduce the quality of the article by mixing it with some diluent which is in itself harmless, whilst some go as far as to mingle highly deleterious or even poisonous substances with those articles which are absolutely necessary to life. Such substances are the salts of copper and lead, and some vegetable matters, as Cocculus Indicus, &c. It is true, that but small quantities of these chemical ingredients are employed, their nauseous taste and well known poisonous character prevent that—but what deleterious effects must be produced by a continual introduction of such substances into the system, day after day, month after month, year after year, however small, however trivial, however comparatively unimportant one small dose might be, no substance having an injurious tendency can be taken for any length of time without being the occasion of the most disastrous, and often fatal results.

Leaving the subject of intentional and systematic falsification, it is necessary to advert to those admixtures which are accidental, and oftentimes the result of carelessness and inexperience. Many articles of food derive poisonous constituents from the vessels employed in their manufacture; being acted on by vegetable juices, fatty matters, &c. This portion of the subject is fully discussed in the First Section, and it is hoped that a perusal of that and the following Section will cause every person to discard such poisonous vessels and poisonous methods of cooking, and employ only those means and substances which are not injurious to health.

At the present time, when every precaution is being taken to preserve the Public Health by effective drainage and ventilation, the author thinks that little apology is needed for the introduction of the present work, inasmuch as without wishing to be an alarmist, he is fully convinced that much disease is induced by the use of damaged or adulterated provisions, and that it is the duty of every one who has it in his power, to add something, however little, to the means of best carrying out any plan of rendering the Health of the Publicmore secure.

The following extracts from the preface to Dr. Ure's Supplement to his Dictionary of Arts, will show that England is about the only nation that has no laws, or no effective laws, for the protection of the public against the adulteration of food.

" In every well governed state of continental Europe there exists a Board of Health, or Conseil de Salubrité, composed of eminent physicians, chemists and engineers, appointed to watch over whatever may affect injuriously the public health and comfort. In France, this commission consists for the capital, of seven members, who have the surveillance, in this respect, of markets, factories, places of public amusement, bakeries, shambles, meat, medicines, &c. This tribunal has discharged its functions to the entire satisfaction of their fellow citizens, as appears from the following authentic report. ‘Non seulement une ‘foule de causes d’insalubrité disparurent, mais ‘beaucoup de moyens, de procédés nouveaux furent ‘proposés pour assainir les Arts et les Métiers qui ‘jusque là avaient paru inséparable de ces causes ‘d’insalubrité; la plûpart de ces moyens eurent un ‘plein succès. Il n’y a pas d’exemple que les ‘membres du Conseil appelés à donner leur avis ‘sur des plaintes formées contre des fabriques, aient ‘jamais répondu qu’il fallait les supprimer sans avoir ‘cherché eux-mêmes à aplanir les difficultés que ‘présentait aux fabricants l’assainissement de leur art ‘et presque toujours ils sont parvenu à resoudre le ‘problème. Le Conseil de Salubrité que l’on ne ‘saurait trop signaler à la reconnaissance du publique ‘est une institution que les nations étrangères ‘admirent et s’enforceront d’imiter sans doute.’*

“The Prussian municipal law (*Allgemeine Landrecht*) contains the following enactments with regard to the sale of spoiled or adulterated victuals. Th. ii. Tit. 20: Abschnitt 11, sec. 722 to 725. ‘No person shall knowingly sell or communicate to others for their use, articles of food or drink, which possess

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* Dictionnaire Technologique, Tome 2, p. 293.

properties prejudicial to health, under a penalty of fine or bodily punishment. Whosoever adulterates any such victuals in any manner prejudicial to health, or mixes them with unwholesome materials, especially by adding any preparation of lead to liquors, shall, according to the circumstances of the case, and the degree of danger to health, be liable to imprisonment in a correction house, or in a fortress, during a period varying from one to three years. Besides this punishment, those who are found guilty of knowingly selling victuals which are damaged or spoiled, (*verdorbener*), or mixed with deleterious additions, shall be rendered incapable for ever of carrying on the same branch of business. The articles in question shall be destroyed, if incorrigibly bad, but if otherwise, they are to be improved as far as possible, at the cost of the culprit, and then confiscated for the benefit of the poor. Further, whoever mixes victuals or other goods with foreign materials, for the purpose of increasing their weight or bulk, or their seeming good qualities, in a deceitful manner, shall be punished as a swindler.' "

The author having now shown that in England the adulteration of articles of food is carried on to a very great extent, accompanied by all the evil consequences resulting from the consumption of such adulterated articles, and that in most other countries attention is most successfully paid to this subject by government, he has laid before his readers an extract of a law which seems to him, with some little alterations, to be exceedingly just and necessary for the safety of the Public Health, and begs in conclusion, he may respectfully be allowed to call the attention of government, and those parties interested in the present system of Sanitory Reform, to appoint a well constituted and organized body of scientific men, for the purpose of examining the many commodities in daily use, giving them full power to inspect the manufactories from which any adulterated article has been procured, and if any substance of a deleterious nature, similar to that discovered in the article which first led to the search, be found, then let the party so offending be fined or imprisoned, according to the enormity of the offence. The author feels confident that no honest and well-meaning manufacturer would offer the least opposition to such a mode of procedure; indeed, it would tend to enhance the fair fame of the honest, and to denounce as criminal, the misdoings of the dishonest.

Finally, the author much wishes that some one more capable than himself had undertaken the present task, but with all the imperfections to which such a work is, and must be liable, he trusts that no one will accuse him of having written in an unkind or unfair spirit, but give him the credit of having attempted some little, towards benefitting the health of his fellow creatures.

23, Hawley Road, Kentish Town.
May, 1848.

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TREATISE

ON

THE ADULTERATION OF FOOD.

SECTION I.

ON THE VESSELS IN GENERAL USE FOR THE PREPARATION AND PRESERVATION OF ARTICLES OF FOOD.

There can be no doubt whatever that the substance, or substances, of which the vessels employed in culinary purposes are manufactured, has much to do with the purity, and consequently with the aptness as articles of food of the various aliments in daily consumption.

The nature of the vessels which ought to be employed, has long since engaged the attention of chemists, and many even of much celebrity have not considered this subject unworthy of investigation.

Count Rumford, Proust, and Sir Humphrey Davy are amongst the number, who, by their researches, on this subject, have doubtless contributed much to the present comparatively sanitary state of society.

The metals entering into the composition of the general routine of kitchen utensils, as saucepans, boilers, &c., are iron, tin-plate, copper, and brass.

The ordinary saucepan is made either of plate-iron, tinned (tin-plate), or cast iron, tinned. Stew-pans, and vessels of that class, are constructed of copper or brass, more generally the latter compound metal. In some cases, vessels of copper receive an internal coating of tin.

Now as tin is the metal which most ordinarily comes in contact with our food, it is but right to examine its properties as regards the animal economy.

Tin, in its metallic state, seems to have no injurious effect on the animal system, for it is given medicinally, in certain cases, in considerable doses. As it is generally in the metallic state, we must look for it in the food, as prepared for the table, (that is as it has fused off in globules from the sides of the saucepan or other vessel—a very common occurrence), it will be seen that this metal alone can do no very considerable, if any, harm.

It is true, that tin may be present in food in a soluble state, that is as a salt of tin when vegetable acids, as lemon-juice, vinegar, &c. are boiled in vessels, coated with this metal; but even in such a case no apprehension of harm need be entertained, for the amount dissolved is so very minute that it can scarcely be detected by the most delicate test. Indeed, when we consider the length of time the tinning of a saucepan lasts, and that the greatest wear and tear it undergoes is in its cleansing, with whiting, sand or other sharp substance, we need be under very little apprehension, even if tin were a poisonous metal, (which is far from probable), of contracting any deadly complaint by its continual passage into the system in such infinitessimal doses. Indeed, it has been proved that a tin-platter has been in constant use for two years without losing more than four grains of its original weight, and the greater part of this abraded during cleansing.* If we admit that as much as half had been taken into the system in a soluble state (a state in which, perhaps, none of it could possibly enter) we should only have two grains for the two years, so that only about .0026 of a grain of tin introduced daily into the system, an amount which, even if the metal were exceedingly poisonous, would do very little or no harm. Indeed, it seems to me that metallic tin is one of the most wholesome coatings that can possibly be provided for vessels employed in domestic economy.

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* Proust.

The noble metals, as silver and gold, would indeed be preferable, but then their expense utterly precludes their general use for this purpose.

Thus far for pure tin. The tin of commerce, which is employed in general tinning, is not pure, but contains traces of arsenic, copper, lead, and iron—the first three of which are very poisonous metals. We have now to consider whether the alloy of these metals with tin, as in ordinary tinning, can have any injurious effect. It is certainly a startling proposition, that the vessels in which the greater part of our food is cooked contains three of, perhaps, the most poisonous metals we are acquainted with ; yet nevertheless such is the fact.

We will now proceed to consider the influence these metals can have on food cooked in contact with them.

The ordinary class of food, as potatoes, meat, &c. have no influence on such an alloy as just cited ; but more is to be feared from acids and vegetables containing sulphur, as onions, greens, &c., because nearly all metals are more or less attacked by such substances.

If moderately strong vinegar, or common pickling vinegar, be boiled in vessels containing an alloy of lead, tin, copper and arsenic, only the most minute portions of tin, &c. will be removed, even if the boiling be continued a very great length of time, so that no fear need be entertained on this account, provided the liquid (and this applies to broth, soups, &c.) be not allowed to cool in the vessel; if it be, a considerably larger proportion will be taken up, and occasionally so much as to render the liquid aliment poisonous.

A considerable proportion also of these metals may be taken up, if the vessel in which any of the just-named substances are boiled, be not cleansed very soon after the liquid contents has been removed; for in such a case, the metals have a great tendency to oxidate, and it is the oxides alone that are to be feared, for they alone are soluble in such menstrua, and insoluble in water; moreover they adhere so closely to the vessel, that they cannot be detached by the mere process of washing as practised in the kitchen; and they, therefore, remain until the next time the vessel is required for cooking, and then if any substance capable of dissolving them be used, then and then only are they removed, and that solvent substance is generally some article of food.

From these remarks it will be evident that the greatest cleanliness, as regards cooking utensils, ought to be insisted upon, and that the instant, or as soon as practicable, after their contents are removed, they ought to be well washed with an abundance of hot water, and wiped dry with a cloth; and not left to drain as some persons allow, because in that case there is a great liability to oxidation so that the washing may be nearly as well dispensed with, if the drying be omitted.

If pewter vessels be employed, acid liquids must not be allowed to cool in them; and in cases where pewter platters are in use, they ought to be washed immediately after the meal is finished, more especially if any preparation of vinegar has been used as a condiment, for if it be allowed to remain in contact with them, the crevices formed by the action of the knife upon their surface are apt to get filled with oxide, which the next quantity of vinegar, or other such substance, may dissolve, and thus carry into the system an insidious poison; for lead is, perhaps, of all the metals the most dangerous, for when taken in small doses, no effect may be shown for years, perhaps, yet, during that time, the foundation of most painful and direful diseases is being laid, and paralysis is generally the result.

We now come to the consideration of the use of copper and brass vessels, tinned, and otherwise.

Although copper is such an extremely deleterious metal, (with certain precautions to be hereafter pointed out), vessels made of it may be used with nearly the same impunity as those of tin plate. Certain substances have a very singular and marked action upon it: such are all fatty matters, vegetable acids, and even, under certain circumstances, common salt. From this, it will be seen that nearly all our aliments are liable to be contaminated and rendered poisonous by contact with copper vessels, for but very few articles of food lack fatty matter, a vegetable acid, or salt.

If broth, or any other fatty matter, be boiled for a short time in a copper vessel, it will take a greenish tinge, owing to a portion of the copper of the vessel having entered into solution (indeed butter is an excellent test for copper, as we shall hereafter have occasion to point out); and if the liquid be allowed to cool in the vessel, it will become very deeply green, on account of a greater oxidation of the copper having gone on at the line of contact with the liquid and the air, and the oxide, so formed, has been taken in solution. There is no need here to mention any other test to recognise the presence of the dissolved copper than the green tinge of the solution —that alone being sufficient.

Vinegar has also an extremely great solvent and oxidising power on copper, so that either copper or brass pans should never have any preparation containing vinegar made in them. If a little vinegar be poured into a copper or brass pan, and the latter rinsed with it and allowed to remain at rest for a few minutes only, and then rinsed again, and the vinegar poured into a glass, it will generally leave a greenish tinge, and always a very disagreeable styptic metallic taste, which is owing to the presence of diacetate of copper, or verdigris. This can be proved by the addition of a few drops of liquid ammonia to the vinegar which has been in contact with the brass or copper pot, an azure blue tinge will be given to it. This test can be further confirmed, by testing another portion of it with a few drops of a solution of ferrocyanide of potassium, a brownish red precipitate will result, if a considerable amount of copper be present; but if only a trace exists, a rose red colour will be given to the solution.

Not only vinegar, but nearly all vegetable matter has the power of acting upon copper or brass when hot. Salt is also decomposed by contact with metallic copper during oxidation; in this case, chloride of copper is formed, which may be detected in the same manner as the verdigris.

Now, as both these compounds are deadly poison, as, indeed, is the compound of fatty matter with oxide of copper (this compound is a metallic soap), how much ought we to deprecate the employment of copper or brass vessels for culinary purposes (excepting when employed with the protection to be presently described); and how much more ought we to deprecate those parties, who, in the preparation of pickles, recommend that the vinegar they are made with should be boiled in a brass or copper vessel, because by such a mode of procedure, gherkins,

&c., may be pickled of a most beautiful green colour. It is, also, recommended to boil greens and peas with a penny piece for the same purpose.

It is doubtless in this manner that many complaints which baffle medical skill (because their origin cannot be discovered) are engendered; and many persons have fallen victims to this most baneful practice. Under the head of pickles this will be more particularly adverted to.

In the preparation of confectionary, brass pans are very often employed, and no danger can result from their use, provided they are kept perfectly clean and bright; but the syrup, or other preparation, ought never to be allowed to cool in them. If, however, a dirty, or in other terms, an oxidated vessel be employed, then the saccharine matter will become poisonous, for sugar has the property of dissolving a large quantity of oxide of copper; and, in such a case, the copper is more difficult of detection, for organic matter prevents the ordinary reaction of tests in solutions of copper. Ferrocyanide of potassium, however, imparts to such solutions the characteristic rose red tint before mentioned. It is better, however, in such cases to evaporate the solution to dryness, ignite the residue in a porcelain crucible, and act on the ignited mass by dilute nitric acid, aided by heat. If the solution be then filtered, and a solution of ammonia added to it, the azure blue tinge of the ammoniuret of copper will be produced. The best method, however, of detecting extremely minute traces of copper in solution, is to plunge into the suspected liquid a plate of polished iron (a knife-blade for instance); in a short time, it will become covered with a coating of metallic copper, which is readily distinguished by its peculiar colour and metallic lustre. The solution in such a case ought to be only very slightly acid, and the iron ought to remain in it for a time, varying from five minutes to as many hours, according to the quantity of copper held in solution.

We now come to the cases where copper or brass vessels may be employed without much risk: they are protected by a coating of tin. Of late years, however, too great confidence has been placed in such protection, it having been stated that as long as a particle of tin remained on the surface of the copper, that no ill effect could accrue; this is a mistake, as I have abundantly proved by experiment. It is pretended that no copper can be dissolved by any of the ordinary substances employed as food, whilst any portion of tin, however small, remains in the vessel; and hence it, according to this, would be as well, and save much expense, if, instead of having our copper vessels tinned throughout, to have affixed a small patch of tin as big as a sixpence. It is true, that less copper is dissolved when tin is present; but it is not true, that tin will entirely protect copper from the action of any ordinary solvent.

I have exposed pieces of copper, covered with a coating of tin of various sizes, to the action of fatty matters, vegetable acids, and salt, and I have invariably found copper in the liquids which had been in contact with the metallic copper, even when it had been protected by a tin covering over $\frac{9}{10}$ths of its surface. So that the assertion, that a small quantity of tin will effectually protect a copper surface is not a fact; it is evidently based more upon theoretical than practical knowledge. I will now give another instance of the fallacy of this opinion. It has been before mentioned, that it has been recommended in the boiling of greens, peas, &c., to introduce a piece of copper (as a penny piece,) for the purpose of communicating to the vegetables a fine green colour. How is it possible that the copper, in this case, could have any effect on the vegetables in question, when it is in contact with the tin coating of the saucepan during the whole time, and yet the vegetable subjected to such a course of treatment invariably becomes coloured green, and hence contains copper as experiment will show.

Thus, we can deduce from this simple, and, unfortunately, nearly every day practice, the inutility of a coating of tin to copper vessels, where any portion of the copper remains uncovered, even however small that portion may be.

A perfect coating of tin is then the only safeguard in the use of copper or brass vessels, and then such vessels are the most applicable to all culinary purposes for several reasons. In the first place, copper or brass is a better conductor of heat than cast iron or tin plate; hence, less fuel must be used in heating a certain amount of water to the boiling point; secondly, they are less subject to oxidation; and, consequently, do not scale, become thin, and finally fall into holes as other metallic vessels do; and thirdly, and lastly, from the saving in fuel they effect, and the length of time they wear, they are infinitely preferable to other metallic culinary apparatus. It is true, they cost more in the first outlay, but the increased time of wear, and the fact that old copper or brass is a saleable article, and bears a comparatively high value, renders them, in the long run, the cheapest vessel in use.

From all that has been said on this subject, it can be readily seen, the only precautions in the use of copper or brass saucepans, &c., is to see that the tin coating is perfect, and that they be scrupulously clean.*

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* In an excellent cookery book (*Apicius Redivivus*, p. 91) there are mentioned concerning copper vessels, facts which bear out all that has just been stated, viz., "stew-pans and

We now come to another class of metallic vessels, viz., those coated internally with a kind of enamel; we will now consider whether this enamel is likely to be less prejudicial to health than a metallic surface of any kind whatever, as some of its advocates have mentioned.

In writing on these matters, I have no desire to raise up an especial material in the public estimation to the injury of another; I merely wish to give the result of an impartial examination—an examination I thought was much required, inasmuch as this subject—however important it may be to the community at large—has not been of late years considered worthy the attention of careful experiment; the author has thought otherwise, and whether he has thought rightly or not, the public will doubtless decide.

About the year 1795, a M. Rinman, of Stockholm, made many experiments on the bettering the condition of our culinary apparatus, shewing even

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soup-kettles should be examined every time they are used; these and their covers must be kept clean and *well tinned*, not only on the inside, but about a couple of inches on the outside. So much mischief arises from their getting out of repair, and, if not kept nicely tinned, all your work will be in vain, the broths and soups will look dirty and green, and taste bitter and poisonous." All this, as before stated, can only happen from copper having been taken into solution.

then, that it was a known fact that such an investigation was a subject of considerable importance; indeed, he says, "that all those vessels made of improper materials may not only communicate taste and colour to the substances cooked in them, but they may also seriously affect the health of those who use them."

M. Rinman considered the value of various metals, as bodies fit for making vessels for culinary purposes, but he did not see any that would perfectly answer, so he endeavoured to combine the good properties of an earthen, with those of a metallic vessel, leaving the earthenware portion in contact with the food; and the most plausible manner of accomplishing this, seemed to consist in enamelling or coating, with some vitreous substance, the inner surface of the saucepan, or other vessel.

Rinman tried various compositions for the purpose above named, in some the oxide of lead or litharge entered, in others no such poisonous ingredient. If only a small quantity of litharge be present, no bad effects can result, because with much silicious matter, it is not soluble in ordinary acids; as is well shewn in the glass apparatus of the chemist; but where a very large quantity of litharge is present, it may be acted upon, and serious results ensue. This method was the basis of a patent taken out, in 1799, by Dr. Samuel Sandy Hickling. This was objectionable on account of the lead the enamel contained. But Rinman did not stop at the enamels produced by lead, for he went so far as to prepare a very excellent and cheap substance without lead. For this purpose, he employed equal parts of fluor-spar and gypsum. From such a mixture as this, no bad effect could ensue.

In 1839, Thomas and Charles Clarke, patented a process for enamelling metallic vessels; these enamels contain no lead, and are, therefore, wholesome in use.

Dr. Ure states in the Supplement to his Dictionary, that he has examined the enamelled saucepans, manufactured by Messrs. Kenrick, of West Bromwich, and has found them free from lead, and his opinion on such saucepans entirely tallies with my own, and no doubt with that of all parties who have thought or experimented on the matter. He says "I consider such a manufacture to be one of the greatest improvements recently introduced into domestic economy, such vessels being remarkably clean, salubrious, and adapted to the delicate culinary operations of boiling, stewing, making of jellies, preserves, &c. They are also admirably fitted for preparing pharmaceutical decoctions and ordinary extracts."

In saying thus much for the enamelled vessels of the present day, it ought not to be forgotten that the present patentees are not the first parties who introduced an enamel without lead for this purpose, and from that which I can hear on the subject, to Rinman all the credit in this matter is due.

Not only are small saucepans and stew-pans covered with this enamel, but large iron boilers of twenty-one to twenty-five gallons (and perhaps larger —I have not seen any however), as well as frying-pans and gridirons, In fact, the use of this material cannot be too strongly recommended.

It is now our province to examine the vessels of pottery-ware, and consider what kinds of them may be employed for the preservation of jams, pickles, &c., with impunity.

It must be understood, that it is not the vessel itself which is deleterious, but the glaze which is applied to it; and that only one kind of glazed vessel ought to be employed.

Earthenware jars, &c., are glazed by two distinct methods; in the one, oxide of lead (litharge) or some other lead preparation is employed; and in the other, common salt. It scarcely need be added, that the latter alone ought to be employed in domestic economy.

The lead glazing can be readily detected, it is characterized by a very smooth lustrous surface, exactly as if the vessel it coats had been well varnished. The salt glaze, on the contrary, has very little lustre, and all the asperities of the clay beneath are perfectly visible.

Pickles, jams, and all other substances having any acid re-action, or any tendency to such a re-action, ought never to be placed in contact with a lead glaze, for so surely as they are, so surely will they become contaminated (pickles especially) with soluble salts of lead, and then the well-known effects of poisoning by lead, ensue.

The ordinary dishes known by the name of baking dishes, ought not to be employed; for their glaze contains a very large quantity of oxide of lead, and fatty matters have a decided solvent action on it. Fruit pies ought not to be baked in such dishes, for the acids the fruits naturally contain, have a very energetic action on such glazes, especially where they are exposed to them, for a considerable time, at the boiling temperature.

Hence, all parties ought to discard such vessels from their household economy, more especially when, at the present time, salt-glazed vessels are to be obtained in such abundance. It is true, that they are a little more expensive; but what person, who thought not only of the preservation of his own health, but that of his family, would hesitate in expending only a few more shillings in the purchase of wholesome crockery-ware; and it must be considered, that, although a single dose of lead or copper, in the small quantities we find it taken off from cooking vessels, is not by itself mortal, yet the daily continuance of such a system of poisoning would tend ultimately to the most serious consequences.

I will, in the next section, proceed to consider the various kinds of water generally met with, and in constant use for domestic purposes, together with the means of detecting their impurities, and also giving methods of regulating their purity, to a certain extent, by the removal of some substances with which they may be impregnated.

SECTION II.

WATER AND ITS IMPURITIES.

As water is so extensively employed in every operation relative to the preparation of articles of food, the following pages would be incomplete, were its impurities and the methods of detecting them not discussed.

The varieties of water in common use are the following:—rain-water, river-water, and spring-water. There is, indeed, another variety in common use, but only in the laboratory of the chemist—that is, distilled water; and it must be borne in mind, that any delicate test pointed out in the following pages, as involving the use of distilled water, must only be employed with it, otherwise fallacious results will be obtained; and, in many cases, serious consequences ensue. This will be the more readily understood when the detection of the impurities of water is pointed out.

Rain-water is the purest natural form of water, excepting that obtained by the melting of ice, snow, &c.; the water obtained from such sources being equivalent, in purity, to rain-water. Rain-water is insipid, as indeed is all pure water; its only impurities being carbonic acid in small quantity, together with ammonia, as discovered a short time since by Liebig. This variety of water is best adapted for extracting all soluble matter from tea, coffee, &c., more especially when it has been collected, not from a house-top in the usual manner, but caught in a tub, or pan, placed in the garden, or otherwise, away from the house. It is only when collected, as just mentioned, that it occurs pure; for where it has to pass over slates, tiles, and the metal piping found on roof tops, it is likely to contain much lime, which it takes up from the mortar with which it comes in contact. This is, indeed, the least obnoxious of the impurities it may contain; for where it comes in contact with lead, or other metallic substances, it may take up a portion of them, and become, more especially with lead, highly injurious to health.

Not only is rain-water the best for making tea, &c.; but it is, also, most proper for washing, as much less soap is required than when hard water is employed. This is well known, and all careful housewives use it when procurable.

There is, on the part of many persons, a great objection to the use of rain-water in culinary operations, founded on a belief that it is unwholesome: this is an error, and it cannot be too strongly impressed on the minds of all, that the *softer* water is, the more adapted it is to all domestic uses—if we except that one which has been so much insisted on of late—its use as an habitual potation; this is not an exception, so much on account of its unwholesomeness, as on account of its insipidity, which is such as to render it almost nauseous.

River-water stands next in purity to rain-water, but is far from being pure; by pure is not meant a bright, sparkling aspect, and agreeable taste, (the generally received indications of purity), but an absence of all foreign matters, as lime, magnesia, &c.; these substances being generally found in river-water.

This must be very evident when its source is considered. All the water found in rivers, ponds, and even in the ocean itself, has existed at one time or other, in the state of vapour (steam so to speak), in the atmosphere; from whence it has descended as rain, hail, snow, or dew, which, in the liquid state, after refreshing the whole surface of the earth, has percolated through the different strata composing its crust, and has there taken up all matters soluble in it. This can be readily conceived; for we know that if water be poured over a lump of sugar, or salt, the latter substances will become gradually less, and at last totally disappear; so water, in passing over any stratum which contains soluble matters, will take them up: for instance, if it pass over a stratum of chalk, it will dissolve a portion, and become essentially a hard water; if it pass over a magnesian limestone, it will become impregnated with magnesia and lime, in the state of carbonates; if it pass over decomposing iron pyrites, it will dissolve salts of iron, and become chalybeate-water and so forth. Now, when all this is taken into consideration, it can readily be supposed, that water derived from such sources must necessarily contain many impurities; indeed, to so great an extent does water take up many substances, that it becomes medicinal:—it is then termed a mineral water.

In ordinary river-water, however, the impurity existing in the largest amount, and the one which gives the character of hardness, is carbonate of lime or chalk. It does not exist, indeed, as carbonate of lime in the water, because that substance is insoluble; but it exists as a bicarbonate of lime which is a soluble compound.

The manner in which chalk becomes soluble in water, is much as follows:

It has been already stated that rain-water contains carbonic acid; and, moreover, it is well known that there are many natural springs of that remarkable gas, and which gas is soluble in water; now water containing, in solution, carbonic acid has acquired the property of dissolving many earthly carbonates, especially that of lime, forming with it a soluble bicarbonate, so that when water impregnated with carbonic acid gas passes over, or percolates through a bed of chalk, it carries away a portion of it, and becomes much charged with lime.

Water, when in this state, readily parts with its acquired lime under certain circumstances. It is well known that when ordinary water is boiled, there is, on cooling, deposited from it a considerable amount of a granular, whitish yellow, or even brown matter, this is chalk, more or less contaminated by the oxide of iron which the water had acquired by the same agency, viz :—carbonic acid. This deposit, inconsiderable as it may appear, is a source of great inconvenience and expense in many cases in domestic enonomy; this deposit is that which is generally known under the name of *fur*, and occasions the ultimate destruction of all kettles, boilers, &c., in which water, furnishing such a deposit, is continually boiled. In this point of view, however, it is the least important, as it only involves an occasional moderate outlay, it is where the lives of sometimes hundreds of persons are endangered, and in many cases dreadful accidents have happened by its formation that the evil becomes of any magnitude. It will not be out of place here to give a slight outline of the action of such a fur, and as it is termed when a steam boiler is mentioned, an *incrustation,* and well does it deserve the name, for it occasionally occurs from two to three inches in thickness.

When water is boiled in a clean metallic vessel, the latter never gets hotter than the contained water, for as fast as the heat, generated in the fire arrives at the boiler, it is transferred by it to the water, and the excess over that necessary to the boiling temperature passes off as latent heat in the steam. When only this goes on, the vessel cannot get injured, but when a deposit is formed within it, the fire, the vessel and the water have different relations to each other. There is now interposed between the water and the vessel containing it, a crust of carbonate of lime, (which is a very bad conductor of heat), so that there is no actual contact between the metal and the liquid. When things are thus, the heat of the fire is as before communicated to the vessel; but instead of passing directly to the water, it is obstructed by the non-conducting crust and there lingers—increasing the temperature of the metal, to a great extent, without a corresponding transfer of heat to the water, so that a waste of fuel ensues,—but this is not the worst, when the metal of the boiler becomes very highly heated, it oxidises and begins to scale, and this process goes on uninterruptedly until either the crust withinside be removed, or the vessel get so thin as not to be enabled to withstand the pressure of the steam within, when the disastrous consequences, which generally follow the explosion of a steam-boiler, ensue.

Dr. Clark, of Marischal College, Aberdeen, a short time since, patented a method for removing the carbonate of lime, river or spring-water contained, and which process is eminently successful, although I do not know whether it is generally in use. The following extracts, from a pamphlet published by him, will fully point out his method.

"To understand the nature of the process, it will be necessary to advert, in a general way, to a few well long-known chemical properties of the familiar substance—chalk; for chalk at once forms the bulk, as already mentioned, of the chemical impurity that the process will separate from water, and is the material whence the ingredient for effecting the separation will be obtained.

"In water, chalk is altogether, or almost, insoluble; but it may be rendered soluble by either of two processes of a very opposite kind. When burned, as in a kiln, chalk loses weight. If dry and pure, only nine ounces will remain out of a pound of sixteen ounces. These nine ounces will be soluble in water, but they will require not less than forty gallons for entire solution. Burnt chalk is called caustic lime, and water holding caustic lime, in solution, is called lime-water. The solution, thus named, is perfectly clear and colourless.

"The other mode of rendering chalk soluble in water is nearly the reverse. It consists, as before explained, by adding it to water containing carbonic acid, when a bicarbonate of lime is formed.

"A pound of chalk dissolved in five hundred gallons of water, by seven ounces of carbonic acid, would form a solution not sensibly different in ordinary use from the filtered water of the Thames in the average state of that river.

"Any lime water may be mixed with another, and any solution of bicarbonate of lime with another, without any change being produced; the clearness of the mixed solutions would be undisturbed. Not so, however, if lime water be mixed with a solution of bicarbonate of lime; very soon a haziness appears, this deepens into a whiteness, and the mixture soon acquires the appearance of a well mixed whitewash. When the white matter ceases to be produced, it subsides, and, in process of time, leaves the water above perfectly clear. The subsided matter is nothing but chalk.

"What occurs in this operation will be understood, if we suppose that one pound of chalk, after being burned to nine ounces of caustic lime, is dissolved, so as to form forty gallons of lime water, and that another pound is dissolved by extra-carbonic acid, so as to form five hundred gallons of a solution of bicarbonate of lime, and that the two solutions are mixed, making together five hundred and forty gallons. The nine ounces of caustic lime, from the one pound of chalk, unite with the seven extra ounces of carbonic acid that hold the other pound of chalk in solution. These nine ounces of caustic lime, and seven ounces of carbonic acid, form sixteen ounces—that is, one pound of chalk, at the same time that the other pound of chalk, being deprived of the extra seven ounces of carbonic acid that kept it in solution, reappears. Both pounds of chalk will be found at the bottom after subsidence. The five hundred and forty gallons of water will remain above, clear and colourless, without holding in solution any sensible quantity, either of caustic lime, or of bicarbonate of lime."

This is the theory of Professor Clark's process; some of the details of working will be more fully described in the Appendix. If more be required, it may be found in his published specification.

Spring-Water.—This variety of water, as ordinarily obtained, holds in solution more impurity—that is lime, magnesia, &c.—than river water, it also contains much more carbonic acid; and it is owing mainly to the presence of this gas, that it forms such a delicious and agreeable drink. It is from the amount of impurity it contains, that it is not so well fitted for any other domestic use than that of the table, because it is so *hard* that it is next to impossible to wash with it without an addition of soda (which acts in the same way as the lime in Professor Clark's process, by throwing down the excess of carbonate of lime); neither can it be advantageously employed in making tea or coffee, or boiling vegetables, and more especially dry peas. It is, however, best adapted for boiling greens, &c., as they always come to table a much better colour than when boiled with soft water.

The impurities we have just treated of, are only of minor importance in domestic economy; it is to the manufacturer that they do almost incalculable injury.

Brewers often go to an enormous expense in boring deep wells, in order to obtain a supply of soft water for extracting all soluble matter from the malt and hops they employ. Dyers also bore wells, in order that they may have an unfailing supply of pure water, as certain colours cannot be dyed where water, containing the ordinary impurities, comes in contact with the dye stuffs. Bleachers again require pure water, and many other branches of manufacture might be mentioned, where pure water is absolutely indispensable.

So far with ordinary water and its ordinary impurities. There is still another, and the most grievous of all, that is the presence of lead in water, and it occurs more generally than is suspected, since leaden piping, leaden cisterns, and leaden pumps are in such common use.

The poisonous nature of lead is well known; but persons are apt to suppose, when they have not considered the subject, as it is generally known, that metallic lead is not soluble in water, no danger could accrue from drinking water kept in leaden vessels, or passed through leaden pipes.

Upwards of two thousand years ago, it was known that lead had a most injurious effect on the animal economy, and that it could be conveyed into it by means of water kept in leaden vessels; indeed the ancients were very scrupulous as to the use of such water; but the moderns, on the other hand, have a misplaced confidence, and drink water which has been in contact for some time with lead in a fearless manner, although, it is to be dreaded, that many have, by such means, arrived at an untimely end, or at least have been afflicted with that disease termed the Devonshire or painter's cholic, and in many instances paralysis has been the final result.

Indeed, Dr. Percival, Dr. Johnstone, Sir G. Baker, Dr. Lambe, and many other physicians, have related many deplorable instances of individuals taken off by this deleterious agent, and in many cases where direful diseases have been induced.

Dr. Lambe* states an instance where the proprietor of a well, ordered his plumber to make the lead of a pump double the thickness of the metal usually employed for pumps, to save the charge of repairs, because he had observed that the water was so hard, as he termed it, that it corroded the lead very soon.

Sir George Baker relates the following case: †

"A gentleman, was the father of a numerous offspring, having had one-and-twenty children, of whom eight died young, and thirteen survived their parents. During their infancy, and, indeed *until they had quitted the place of their usual, residence, they were all remarkably unhealthy,* being particularly subject to disorders of the stomach and bowels. The father, during many years, was paralytic; and the mother, for a long time, was subject to colics and bilious obstructions.

"After the death of the parents, the family sold the house they had so long inhabited. The purchaser found it necessary to repair the pump. This was made of lead, which, on examination, was found to be so corroded, that several perforations were

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* Lambe on Spring Water.

† Medical Transactions, Vol. I. p. 420.

found in the cylinder in which the bucket plays, and the cistern, in the upper part was reduced to the thickness of brown paper, and was full of hole like a sieve."

One instance occurred some time since of a like kind. It was at the Royal kennel, at Windsor, when many of the men employed on the premises, as well as the hounds, were much affected. The men were attacked with colic, and the hounds with the disease termed "kennel lameness," both of which effects are attributable to the amount of lead contained in the water. I have not the minutes of the examination of the water by me, but I found, on examining it in the laboratory of the Royal Polytechnic Institution, that a very considerable amount of lead was present.

It is only a month or two since I had to examine a water which had caused serious inconvenience to a a whole family, inducing colics and other dangerous complaints; it also contained a very notable amount of lead.

It has been proved, by direct experiment, that water containing much atmospheric air, carbonic acid and some other heterogeneous substances, has the power of taking up lead; and the longer water, thus impure, remains in contact with lead, more especially if the atmosphere have free access, the more lead will be dissolved, and the water, of course, become more deleterious.

Leaves and other vegetable matters, in a state of decay, seem to induce the solution of lead in water as, indeed, does all organic matter; and as ordinary water always contains a small quantity, the cistern (if of lead) should be carefully cleansed out very often, and indeed, whenever a white line appears on the lead in contact with the surface of the water.

Recently Mr. Osborn, of Southampton, in a letter to the Editor of the "Pharmaceutical Times," points out the danger of the use of lead in contact with water employed in domestic economy; he states: "Since the publication of the paper which I read before the British Association last September, some of the most distressing cases of paralysis, and other diseases occasioned by lead in water, and which were before supposed to proceed from natural causes, have been brought to light. Some of these are of a most fearful kind; there are also many individuals in this neighbourhood (Southampton) afflicted in a minor degree, and if some step is not taken by Government to compel the removal of lead, where the disease prevails, the sacrifice of health must continue to take place. I have watched the spread of the evil for the last five years, and have chemically investigated the cause, I am, therefore, able to speak with confidence on the subject, and there are many who can bear testimony of the truth."

Mr. Osborn, strange and discreditable as it may appear, found some parties holding up the subject to ridicule and obloquy, on the ground of injury being likely to be occasioned to property by giving publicity to the facts above mentioned.

The Editor of the "Pharmaceutical Times" justly remarks. "This, truly, is a remarkable state of things. Certain waters are known to be poisoned, the poison is daily imbibed—colic, paralysis, and other terrible diseases follow, and, ultimately, premature death; yet no steps are to be taken to check this wholesale poisoning, because, forsooth, a change would be expensive—property would suffer."

Mr. Osborn further states. "I have examined some of the pipes after they have been removed from the wells, and found the inside completely covered with a floury white powder* (carbonate of lead.) Some of the other pipes were covered with a very fine soft brown powder, or peroxide of lead; underneath this oxide a coating of carbonate was found.

"I find the oxide perfectly insoluble after it has become quite dry; but existing in solution in the water, previous to the pipe being removed."

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[*] This coating, the author has also very frequently observed.

This communication by Mr. Osborn comprises all that has been before stated, proving the lead, thus taken up, to be a most insidious and dangerous poison, which ought to rank among the chief impurities of water.

In this, as in all other impurities, it may be taken for a considerable length of time without feeling any inconvenience; but it must, at length, produce its deleterious effect, as the poison keeps continually accumulating in the system. Sometimes, indeed, persons of peculiar constitutions may take poisons for almost any time without experiencing any inconvenience; this is only applicable to a few, however, who have a peculiar idiosyncracy, and not to the general mass; hence, it is to be strongly recommended that any parties who may by any chance suspect the presence of lead in the water they are accustomed to drink, to examine it most carefully in the manner to be hereafter pointed out, and not to run the risk of poisoning, or the certain advance of painful disease, for the small amount of trouble bestowed in the examination, which takes up but little time.

The usual impurities* of water are the following:

Sulphuric acid.

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* By impurities, it is not meant absolutely deleterious substances in all cases, but merely substances foreign to pure water.

Chlorine.
Carbonic acid.
Sulphuretted hydrogen.
Oxide of iron.
Lime.
Magnesia.
Potash.
Soda.
Lead.

The method to be pursued in ascertaining the presence of any of the above substances, is the following: Sulphuretted hydrogen may be detected by its disgusting odour, which reminds us of putrid eggs, and is familiar in the Harrowgate water. If it be not present in sufficient quantity to smell distinctly, its presence may be indicated by adding to a wine-glassful of the suspected water a few drops of a solution of acetate of lead, which will immediately cause it to assume a black or brownish colour, in proportion to the quantity of contained sulphuretted hydrogen.

If the water sparkle much on being poured from one vessel to another, carbonic acid may be present. This can be further tested by immersing in the liquid a slip of blue litmus paper, which, after a short time, will take a wine-red hue, which will disappear on drying. The best test, however, is to add to the water a drop or two of lime-water, which will cause a precipitate of carbonate of lime, which, on stirring the liquid containing it, will immediately disappear if the water contain free carbonic acid, or will disappear on the addition of a larger amount of the water under examination.

For the remainder of the substances, it is better to concentrate the water, by boiling, to about $\frac{1}{8}$th its original volume. During the evaporation, there may be a precipitate, which may be either carbonate of lime, magnesia, or oxide of iron, or a mixture of all three. These are to be separated by subsidence, or, still better, by filtration. A little pure hydrochloric acid (spirits of salts) is to be poured upon the deposited matter, when it will dissolve with effervesence, indicative of the presence of carbonic acid.

The solution of the deposited matter is now to be filtered, if necessary, and divided into two unequal portions; to the smaller of which, ferrocyanide of potassium is to be added. The production of a blue precipitate, or even coloration, indicates the presence of iron.

To the other, or larger portion, is to be added an excess of ammonia, and the precipitate, if any, separated by filtration—the brownish colour of this precipitate, also indicates the presence of iron. To the filtered liquid, a solution of oxalate of ammonia is to be added as long as any precipitation takes place. If no precipitate forms on the addition of the oxalate, no lime is present. In case of a precipitate forming, lime is present, and the liquid must be rendered clear by filtration. To the filtered liquid, solution of phosphate of soda is added, and the whole violently agitated. If a white granular precipitate form, magnesia is present.

The liquid filtered from the matter deposited by boiling, has now to be examined.

If it tinge reddened litmus-paper blue, it contains an alkaline carbonate, or possibly sulphuret, in which case the water will occasion a brown discolouration, or a black precipitate in solution of acetate of lead, as before mentioned in the detection of sulphuretted hydrogen.

One portion of the water is to be acidified by a few drops of hydrochloric acid, and solution of chloride of barium added. A white precipitate, or turbidity, indicates the presence of sulphuric acid.

Another portion is to be acidified by nitric acid, and nitrate of silver added. A white curdy precipitate, soluble in ammonia, denotes the presence of chlorine or hydrochloric acid (spirit of salts).

A third portion is to be mixed with solution of chloride of ammonium (sal ammoniac), after which oxalate of ammonia is added in excess. A white precipitate indicates the presence of lime.

The whole is now to be poured upon a filter, and a small portion of the clear filtered liquid is treated with phosphate of soda and ammonia. A white granular precipitate indicates the presence of magnesia.

The remaining portion of the clear liquid, filtered from the precipitate occasioned by oxalate of ammonia, is evaporated to dryness and ignited. It is then to be dissolved in water, and solution of caustic baryta added, until the whole becomes alkaline to test paper. It is filtered, and to the filtrate is added carbonate of ammonia. The liquid is again filtered, evaporated to dryness, and ignited. By these means every substance in the water is separated, except the potash and soda. A small portion of the ignited residue is heated on platinum foil before the blow-pipe. If the flame is tinged yellow, soda is present.

The remainder of the dry residue is dissolved in a very small quantity of water, and solution of chloride of platinum added. A yellow granular precipitate indicates the presence of potash. In case, however, only a very small quantity of potash is present, no precipitate will form. The whole must then be evaporated to dryness, and alcohol added.

If potash be present, a substance of a yellow colour will remain undissolved.

There are several other substances occurring in waters, as lithia, strontia, iodine, &c.; but it is not compatible with the limits of this work to enter into means for their detection.

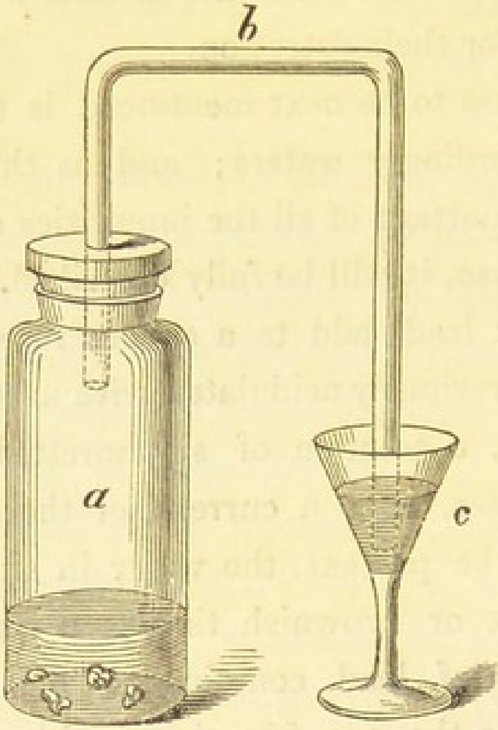
The process to be next mentioned is the detection of lead in ordinary waters; and as this is by far the most important of all the impurities of water in a domestic sense, it will be fully described.

To detect lead, add to a concentrated portion of the water, previously acidulated with acetic or hydrochloric acid, a solution of sulphuretted hydrogen; or, still better, pass a current of the gas through it. If lead be present, the water in either case will take a black or brownish tinge, in proportion to the amount of lead contained. This test is so delicate, that the one fifty thousandth of lead may be detected in solution by it.

The sulphuretted hydrogen gas, is readily prepared in the following manner:—

Place in a common medicine bottle (or other bottle with a wide mouth if possible), a few lumps of sulphuret of iron, and pour a little diluted sulphuric acid over them; then adapt to the mouth of the bottle a cork fitted with a tube bent twice at right angles, *b*. When things are in this state, the gas will pass over at the open end of the tube, which, if dipped into the suspected liquid in the glass *c*, will determine the presence or absence of lead in the manner before stated.

FIG. 1.



This experiment had better be made, either in the open air, or under a chimney having a good draught, as the smell of the gas is most offensive.

SECTION III.

FLOUR AND ITS ADULTERATIONS.

Flour is made up of several proximate principles, which can, with a little practice, be readily separated from each other.

Dumas* gives the following simple directions for the performance of this analysis—an analysis which is comparatively simple and exceedingly useful, for it is often a matter of considerable import to know the value of any particular kind of grain, and the knowledge can only be arrived at, in a correct way, by such a process as the one to be presently described.

This process, as just now stated, is by Dumas, but with some little modification.

Take a given weight, say one hundred grains, of the flour to be examined, make it into a stiff paste with a small quantity of water, and place it in a

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* Traité de Chemie, vol. vi. pp. 385—386.

piece of fine muslin. The whole is then to be placed in a small evaporating basin (or in lieu, an ordinary kitchen basin) of water, and carefully kneaded; a fresh quantity of water is now to be poured into the basin, previously placing that in which the paste had been kneaded into a tall glass. The washing and kneading are to be repeated until the water ceases to be milky. On examining the piece of muslin, it will be found to contain a whitish-grey, elastic, tenacious substance, which is *gluten.*

The liquid in which the dough was kneaded must be allowed to repose until all has deposited that will, and the supernatent liquid become clear. It is then to be poured off, and the *starch* remaining at the bottom of the vessel carefully dried and weighed.

The clear liquid, separated in the last operation, is to be boiled, when a pellicle will form upon its surface, which will contract into greyish flocks, and have the most perfect analogy with coagulated albumen. This is *vegetable albumen.*

The whole is now to be poured upon a filter; the albumen will remain on the filter; the liquid is to be evaporated by a water bath heat until perfectly dry. This residue contains *sugar,* and a gummy matter analogous to *dextrin.*

The rough gluten obtained by the first process may be examined as follows, when it will be found to break up into four distinct substances—

The gluten is to be boiled first with concentrated, and then with weak spirit of wine; a greyish residue remains, which is *vegetable fibrine.*

The alcoholic solutions are to be allowed to cool, during which process a flocculent substance falls, possessing a great number of the properties which characterize *caseine.*

Lastly, the alcoholic liquids are to be evaporated to a syrupy consistence; if water be now added, a pasty substance falls, which is *glutine.*

A *fat matter* precipitates with the glutine, which is readily separable from it by means of ether.

Here we see that flour contains—

1. Albumen.
2. Fibrine.
3. Caseine.
4. Glutine.
5. Starch.
6. Glucose (sugar of grapes) and dextrine.
7. Fatty matter.

The analysis just described is, however, more particular than need be; it is sufficient for all practical purposes to estimate the rough gluten, the starch, the sugar and dextrine, water and bran.

The course is then as follows :—

One hundred grains of the flour, to be examined is a sufficient quantity to operate upon.

Operation 1. Pass the flour through a fine sieve, to separate bran, and weigh it.

2. Place one hundred grains in an evaporating basin in a water bath, allow it to remain about two hours; weigh it, the loss is water.

3. Knead one hundred grains in a piece of muslin; dry the gluten so obtained, and weigh it.

4. Collect the starch, as just described; dry, and weigh it.

5. Evaporate the liquid poured off the deposit of starch to dryness; weigh the residue—it is a mixture of sugar and dextrine; it is not worth while to separate them, but if it be wished to do so, add alcohol, which will dissolve the sugar and leave the dextrine. The sugar may be obtained by the evaporation of the alcoholic solution.

The following analyses were performed in the above manner by Dumas:

WHEAT FLOUR.

Water	10.00
Gluten	10.96
Starch	71.49
Sugar	4.72
Dextrine	3.32
	100.49

WHEAT AND RYE FLOUR (Mastlin).

Water	6.00
Gluten	9.80
Starch	75.50
Sugar	4.22
Dextrine	3.28
Bran	1.20
	100.00

ODESSA FLOUR (Flinty).

Water	12.00
Gluten	14.55
Starch	56.50
Sugar	8.48
Dextrine	4.90
Bran	2.30
	98.73

ODESSA FLOUR (Soft).

Water	10.00
Gluten	12.00
Starch	62.00
Sugar	7.36
Dextrine	5.81
Bran	1.29
	98.46

The following analyses are of London flours: made by the author. The three first analyses are of the flour termed "whites," or best flour, and is the quality employed by pastrycooks; the two last are "seconds," or wheaten flour, used by bakers in the manufacture of bread,—

FINE FLOUR, No. 1.

Water	16.5
Gluten	9.5
Sugar and Gum	5.0
Starch	69.0
	100.0

FINE FLOUR, No. 2.

Water	14.1
Gluten	11.4
Sugar and Gum	4.8
Starch	69.7
	100.0

FINE FLOUR, No. 3.

Water	15.0
Gluten	9.5
Dextrine and Sugar	5.5
Starch	70.0
	100.0

SECOND FLOUR, No. 1.

Water	16.5
Gluten	8.5
Dextrine and Sugar	4.5
Starch	70.5
	100.0

SECOND FLOUR, No. 2.

Water	17.4
Gluten	7.7
Dextrine and Sugar	5.1
Starch	69.8
	100.0

The substances employed in the adulteration of flour are the following:—potato-starch (much employed in France), bean, pea, and rye flour, chalk, bone earth (burnt bones), powdered flints, and plaster of Paris.

In ascertaining the value of a flour, the chief things to be observed are the quantities of gluten and of water. The greater the quantity of gluten, the better the flour; and *vice versâ*, according to the preponderance of water. All this can be very readily accomplished by the means just pointed out; it may be as well, however, to describe an ingenious instrument invented by M. Boland, and termed an *aleurometer* (measurer of flours), it is intended for the purpose of ascertaining the amount and quality of the gluten contained in any sample of flour.

It consists of a hollow copper cylinder, about 6 inches long, and from ¾ of an inch to 1 inch in diameter. It has two principal parts; the one, about 2 inches long, is closed at one end, forming a kind of cup capable of containing about 210 grains of fresh gluten; it screws into the remainder of the cylinder. The cylinder being charged with gluten, is heated to about 420° in an oil bath. The gluten by this treatment swells, and according to its rise in the tube (which may be measured by a graduated stem) so is its quality. Good flours furnish a gluten which augments to four or five times its original bulk, but bad flours give a gluten which does not swell, becomes viscous and nearly fluid, adhering to the sides of the tube, and giving off occasionally a disagreeable odour, whilst that of good flour merely suggests the smell of hot bread.

On the detection of potato-flour.—One method is by specific gravity—thus, a vessel which can contain one pound of wheat-flour will contain a pound and a half of potato-starch; hence the amount of adulteration can be estimated to a certain extent.

An attentive examination of the suspected flour with a good microscope affords, occasionally, satisfactory results. The grains of wheat-starch are very small, and have a flattened or disc-like shape, whilst the grains of potato-starch are very much larger, have rounded forms, constituting more or less irregular spheroids or ellipsoids.

The following method of detecting potato-starch in wheat-flour, was pointed out by M. Gay Lussac.

Take of the suspected flour about 350 grains, the same quantity of fine sand, and 2½ fluid ounces of water.

Triturate, in a mortar, the sand and flour for about five minutes; then gradually add a little of the water, so as to dilute it evenly, and form a homogeneous paste; throw the whole upon a filter, and take about one ounce of the clear liquid, place it in a test glass (wine-glass) and add the same quantity of an aqueous solution of iodine, (prepared at the same time by adding a small quantity of iodine to some water).

If a comparative experiment be made on pure flour, and a flour adulterated with only ten per cent of starch, it will be seen that, firstly, the water filtered from the pure flour will have a rose tint, approaching to a red; secondly, the solution proceeding from the adulterated flour will have a deep violet tint, which will disappear much more slowly than the rose tinge of the pure flour.

If these liquids be examined from time to time, it will be perceived—that the tint taken by the water from the pure flour, becomes lighter at first at the bottom of the vessel, and disappears altogether in about eight or ten minutes; and that a similar effect is produced by the tinge of the water from the adulterated flour; but its disappearance is much less rapid, and that the violet colour remains a long time at the surface of the water, and it is, so to speak, divided into two distinct portions—the one white, and the other coloured.

Detection of Bean and Pea Flour.—The two above-named flours are occasionally employed in the adulteration of wheat flour, and may be detected by the peculiar smell evolved, when a small quantity of boiling water is poured upon the flour to be examined. If pea flour be present, the odour of peas will be evolved; if bean flour, that of beans. Bean flour also communicates a rose coloured tinge to bread adulterated with it.

Rye flour, added to wheaten flour, gives it such a decided specific taste, that the fraud is easily detected.

Detection of carbonate of lime (chalk), and phosphate of lime (bone-ash.)

Add to a mixture of the suspected flour with water, a little strong acetic acid, and allow the whole to digest for some time; if a brisk effervescence ensue, chalk is present, and its presence may be verified by filtering the solution, and —adding to the clear liquid some oxalate of ammonia—a white precipitate will form. No similar result is obtained with pure flour. If little or no effervescence ensue, the flour may be adulterated with phosphate of lime; in which case, another sample must be taken, and treated with hydrochloric acid and water. To the filtered solution must be added some acetate of potash and a few drops of perchloride of iron,—a yellowish white, gelatinous precipitate of perphosphate of iron will fall. If only a very small quantity of bone-ash be present, the mixture must be allowed to stand for some hours before the precipitate will make its appearance. When, however, this substance has been added with a fraudulent intent, the precipitate appears immediately. Distilled water must be used in all these experiments.

Another method, which is equally adapted for bone-ash, is to incinerate, in a crucible, a given weight of the suspected flour; if more than one to 1¼ per cent of ash be left, the flour is adulterated with some foreign matter.

Detection of Powdered Flints.—Incinerate a given weight of the flour, act on the residual ash with hydrochloric acid; all but the flinty particles will dissolve, which may then be dried, weighed, and the per centage determined. It must be borne in mind, however, that flour naturally contains a notable, but small amount of siliceous matter.

The Detection of Plaster of Paris.—Take a quantity of the flour, act on in the same manner as in the estimation of gluten, and pour the liquid containing the starch (as well as the plaster) into a conical glass. In course of time, all will be deposited, leaving a clear liquid; but the plaster, being heavier than the starch, will be deposited first. When the deposition is complete, pour off the water, and place the glass with the deposited starch and plaster in a warm place. The precipitate will dry, and, in a short time, fall out of the glass, all the plaster will be found at the point of the cone, which is to be separated, and boiled in a solution of carbonate of soda. During the ebullition, the sulphate of lime present will be decomposed, with the formation of an insoluble carbonate of lime and a soluble sulphate of soda.

If the whole be now thrown on a filter, and solution of chloride of barium added to the filtered solution, a white precipitate of sulphate of barytes will fall, (if plaster of Paris be present,) which is insoluble in excess of nitric acid. Wash the insoluble residue of carbonate of lime on the filter, and dissolve in a little nitric acid; an effervescence will take place, and lime may be detected in the solution by means of oxalate of ammonia, which will produce a white precipitate, soluble in excess of nitric acid.

As arrow-root and tapioca are so analogous, in a certain degree, to flour, it may be as well to speak of their adulteration at this, the concluding part of the section on flour.

The analogy arrow-root has to potato-starch, has induced many persons to adulterate the former substance with it; and not only has this been done, but the author has known instances in which potato-starch alone has been sold for the genuine foreign article.

There is no harm in this, to a certain extent; that is to say, that potato-starch has the same nutritive powers as arrow-root; but it certainly is a very great fraud upon the public, (and one for which the perpetrators ought to be most severely punished,) to sell so cheap an article at the same price as one which is comparatively costly. There is, moreover, in potato-starch, a peculiar taste, bringing to mind that of raw potatoes, from which the genuine arrow-root is entirely free.

This fraud, however, can be readily detected, arrow-root is not quite so white as potato-starch, and its grains are smaller, and have a pearly and very brilliant lustre, and further, it always contains peculiar clotted masses, more or less large, which have been formed by the adhesion of a multitude of grains during the drying. These masses crush very readily when pressed between the fingers, and as before stated, arrow-root is free from that peculiar odour due to potato-starch. This may be most readily developed by mixing the suspected sample with hot water, if it be genuine arrow-root, the mixture is inodorous; if potato-starch, the smell of raw potatoes is immediately developed.

If a mixture of arrow-root and potato-starch be minutely observed by means of a good microscope, the grains of arrow-root may be readily detected; they are very small and exceedingly regular in shape, whilst those of potato-starch are much larger, and very irregular in shape.

Again, arrow-root when triturated with about two parts of concentrated hydrochloric acid, furnishes a mucilaginous mass, which has an opaque white appearance; whilst potato-starch, treated in the same manner, furnishes a transparent mucilage.

But the most convenient and delicate test of all, is that proposed by Dr. Scharling, of Copenhagen. After mentioning the test by the microscope, he goes on to state that he has obtained more favourable results by employing dilute nitric acid; and that, if arrow-root,* or potato-starch be

* Dr. Scharling's experiments were made upon rice flour,

mixed with about two parts of concentrated nitric acid, both will immediately assume a tough gelatinous state. This mass, when potato-starch is employed, is almost transparent, and when arrow-root is used, is nearly opaque, as in the case above-mentioned, in which hydrochloric acid is substituted. A mixture of nitric acid and water, however, operates very differently on these two kinds of starch. The glutinous mass, yielded by the potato-starch, becomes in a very brief period so tough, that the pestle employed for stirring the mixture is sufficiently agglutinated to the mortar, that the latter may be lifted from the table by its means. Arrow-root, on the other hand, requires from twenty-five to thirty minutes to acquire a like tenacity.

Dr. Scharling further says, "that being satisfied with these results, I undertook a series of experiments on various mixtures of these substances, which led to the following conclusion. That if arrow-root contains but 4 to 6 per cent of potato-starch, the admixture may be detected in the following manner :—

"Take two samples of equal weight, for instance,

arrow-root, and potato-starch: the rice flour and arrow-root behaved in the same manner. Rice flour can, however, be very readily detected in arrow-root, if used for the purposes of adulteration, by the aid of a microscope, as rice flour is in irregular fragments, and arrow-root in perfect grains.

one drachm of each, put either of them into a small porcelain mortar, and add, continually stirring, double the quantity (two drachms), of a mixture of equal parts of commercial nitric acid and water. The stirring is to be continued so as only to thoroughly mix the flour with the acid, two or three minutes after which the quantity of potato flour will have changed into a jelly, so that on taking out the pestle, the mass remains adherent to the sides of the mortar. To effect a similar change in the arrow-root, it will require from twenty to twenty-five minutes, sometimes considerably more, depending on the fineness of the flour; but never during the first fifteen minutes, if the acid employed for the purpose be not too strong. On the other hand, if the arrow-root contain from 20 to 25 per cent of potato-starch, the mixture is usually converted in forty or fifty seconds to the state of a solid jelly, supposing the acid to have a specific gravity = 1.104."

As, however, in all experiments suggested for the unpracticed, it is important that they should be as easy as possible, or, at least, sufficiently certain. Scharling instituted several experiments with different mixtures of acid and water, in order to ascertain if it be requisite to employ acid of a certain strength. Instead of ascertaining the strength of these mixtures by their specific gravity, (which is a very troublesome process to those unaccustomed), he directed his attention to the time required for the purpose of changing pure potato-starch into a perfectly coherent jelly. If the acidulous mixture be strong enough to immediately change the starch into a clear jelly, as soon as in contact, it must be diluted with water. If, on the other hand, the mixture requires more than two minutes to form a jelly with the starch, it is too weak to obtain a speedy result.

Tapioca is also manufactured from potato-starch, it is made by drying potato flour on metal plates, heated to about 212°. The paste immediately forms hard unequal lumps when stirred; after it is pretty well dried, it is sifted; the finer portions form factitious sago, whilst the larger constitute tapioca.

When these factitious articles are heated with water, the peculiarly disagreeable odour of raw potatoes, before spoken of, is given off. Alcohol also extracts from these substances the same flavouring matter, so that these frauds may be readily determined.

SECTION IV.

ON BREAD AND ITS ADULTERATIONS.

As flour is adulterated by the substances enumerated in the last chapter, so we have to look for the same in bread, and they are in general more difficult to detect than in simple flour, more especially when bread is made from flour contaminated with starch from the potato, bean flour, pea flour, &c.; indeed the fraud can hardly be discovered, excepting by persons practised in the characters of such breads. In England, the practice of adulterating flour with potato-starch is not common, but the practice of introducing boiled potatoes into bread is almost universal amongst bakers.

In it there is nothing unwholesome; in fact, the bread is more palatable; but it is a decided fraud, for the bread made with potatoes is not so nourishing as wheaten bread, and is made far cheaper than if flour alone were used; hence it ought not to sell for the price it does. The ordinary run of bread made with potatoes is not so nourishing, by at least 20 per cent., as that made with good wheaten flour.

The most common adulterations in England are, *alum, carbonate of ammonia* (*volatile salts*), *carbonate of magnesia,* and *chalk.* Bread is also adulterated with *sulphate of copper* (*blue vitriol*), *sulphate of zinc* (both highly poisonous salts), *bicarbonate and carbonate of potash, plaster of Paris, and pipe-clay.*

Alum and its detection.—Alum is employed for the purpose of working up inferior flours into, so called, best bread ; the more inferior the quality of the flour, so a corresponding increase of alum is introduced. Its employment also permits the addition of pea and bean flour, in much larger quantity than otherwise could be used.

The use of alum is not so injurious as some of the materials to be hereafter treated of; but its daily use is apt to disorder the proper functions of the stomach, and produce costiveness and other inconveniences, more especially with persons having weak constitutions: its use is, therefore, much to be condemned, more especially as it is only made use of to disguise the bad quality of the flour employed in the manufacture of the bread it is found in.

Mr. Accum says: "Without this salt (alum) it is impossible to make bread, from the kind of flour usually employed by the London bakers, so white as that which is commonly sold in the metropolis.

"If the alum be omitted, the bread has a slight yellowish grey hue, as may be seen in what is called the *home-made bread* of private families. Such bread remains longer moist than bread made with alum, yet it is not so light and full of eyes, or porous, and it has also a different taste.

"The quantity of alum necessary to produce the required whiteness and porosity, depends entirely on the genuineness of the flour and the quality of the grain from which the flour is obtained. The mealman makes different sorts of flour from the same grain. The best flour is generally used by biscuit-bakers and pastry-cooks, and the inferior sorts in the making of bread. The bakers' flour is very often made of the worst kinds of damaged foreign wheat, and other cereal grains mixed with them in grinding the wheat into flour."

It is stated that the smallest quantity of alum that can be employed in producing a seemingly good bread from a bad flour, is about 4 ounces to the sack of flour 240 lb. = to about 6 grains of alum to the 1 lb. of flour. This quantity is indeed very small; it is in general much more.

The following is the result of the author's experiments on the quantity of alum contained in ten varieties of bread he has examined.* Each was a 4 lb. or quartern loaf, and contained: No. 1, 116 grs. of alum; No. 2, 114 grs. of alum; No. 3, 109 grs. alum; No. 4, 108 grs. of alum; No. 5, 105 grs. of alum; No. 6, 94 grs. of alum; No. 7, 58 grs. of alum; No. 8, 41 grs. of alum; No. 9, 40 grs. of alum; and No. 10, 34½ grs. of alum.

The writer has not, as yet, examined a sample of bread which does not contain alum.

Dr. Ure states, however, that he has examined bread made at Glasgow, that has been perfectly free from alum.

The following is the process, recommended by Mr. Kuhlmann, for the detection and estimation of alum in bread:

"Incinerate about half-a-pound of bread in a crucible, and after having pulverized the ash, treat it with nitric acid. Evaporate the mixture nearly to dryness, dilute with about half-an-ounce of water (distilled), and add to the whole an excess of caustic potash solution; boil and filter; neutralize the filtered liquid with hydrochloric acid, and add a slight excess of ammonia. Collect the alumina thus precipitated, in a filter, wash, dry, ignite, and weigh it. Every

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* Dr. Ure mentions in his Dictionary, that as much as 197 grains of alum have been found in a quartern loaf, but does not state that he has found that amount.

100 grains of alumina correspond to about 467 grains of alum."

The best and most simple method, and that which the author employs, is to very finely divide half-a-pound of bread, place it in a glass vessel, and cover it with distilled water, allow the whole to digest for an hour or two, then strain through a linen rag, and wash the residual bread with a little more distilled water; mix the washings with the first strained liquid, and filter through paper, to obtain a bright solution, which evaporate nearly to dryness, re-dissolve in a little water, and filter; add to the solution caustic ammonia; alumina will fall, which collect and weigh, with the precautions already pointed out.

Carbonate of ammonia, its detection.—This substance is employed by fraudulent bakers to produce light and porous bread from unwholesome and bad flour, technically termed *sour*. Hence, a material, which in itself is perfectly harmless, is made by the baker a mask for the worst kind of fraud.

It has been stated by many authors who have written on this subject, that bread prepared with carbonate of ammonia loses it entirely when exposed to the heat of the oven; it does, in fact, lose part, but a portion of its ammonia remains, and cannot be driven off by the usual temperature of a baker's oven. This is fortunate in one respect, as it enables us to detect the addition of ammonia in the form of carbonate; and, when it has been added, we may safely conclude that it has been employed as a mask for an inferior flour.

To detect ammonia, take about an ounce of the suspected bread, and cover it with caustic-potash solution, and gently warm it; if ammonia be present, in considerable quantities, it can be detected by its odour; in small quantities, however, it cannot —hence, other tests than the sense of smell must be brought into action. Dip a glass rod into strong acetic acid, and hold it close to, but not touching the surface of the mixture of potash and bread; if only a very small quantity of ammonia be present, it will be indicated by the appearance of white cloudy vapours.

This process, however, is not applicable to the detection of a mere trace of ammonia, on account of the smallness of the quantity of bread operated upon; so that the following process must be employed. Macerate half-a-pound of bread in water, as in the detection of alum, strain, add a few drops of hydrochloric acid to the strained solution, and evaporate nearly to dryness; add, to the residue, excess of solution of caustic potash, and apply the test of acetic acid, by means of a rod as before; if any ammonia be present, it is determined by the appearance of a white cloud.

Carbonate of Magnesia, its detection.—It was first pointed out by Mr. C. Davy, of Cork, that carbonate of magnesia, mixed with inferior flours, would produce bread of a good quality; that is, in appearance. Mr. Davy says:—

"The carbonate of magnesia of the shops, when well mixed with flour, in the proportion of from twenty to forty grains to a pound of flour, materially improves it for the purposes of making bread.

"Loaves made with the addition of carbonate of magnesia rise well in the oven, and, after being baked, the bread is light, spongy, and keeps well. In cases where the new flour is of an indifferent quality, from twenty to thirty grains of carbonate of magnesia to a pound of flour will considerably improve the bread. When the flour is of the worst quality, forty grains to a pound of flour seems necessary to produce the same effect.

"As the improvement in bread from new flour depends upon the carbonate of magnesia, it is necessary that care should be taken to mix it intimately with the flour previous to the making of the dough.

"Mr. Davy made a great number of comparative experiments with other substances mixed in different proportions with new flour. The fixed alkalis, both in their pure and carbonated state, when used in small quantity, were found, to a certain extent, to improve bread made from new flour; but no substance was so efficacious, in this respect, as the carbonate of magnesia."

Mr. Davy conceives that not the slightest danger can be apprehended from the use of such an innocent substance as the carbonate of magnesia.

In this, however, he is mistaken, for it is an ascertained fact, that the daily use of magnesia induces the formation of the most dangerous and painful calculi. So that this species of admixture is to be most energetically condemned, not only on account of the specific action of the substance employed, but also because, by its means, an inferior flour can be employed.

The following is the best process for determining the presence and the quantity of carbonate of magnesia in any sample of bread:

Ignite, in a crucible, half-a-pound of the suspected bread, pulverize the remaining ash, add acetic acid, and evaporate nearly to dryness to expel excess of acid; act on the residue with alcohol and filter. Evaporate the filtered liquid very nearly to dryness, and dissolve in water; add, an excess of ammonia and phosphate of soda, collect the precipitate in a filter, wash, dry, ignite, and weigh; every 100 parts of the dry residue indicate about 76 parts of carbonate of magnesia.

Carbonate of lime (*chalk*), *plaster*, *pipe-clay*, *and* *their detection.*—The presence of these non-volatile bodies may be detected by incinerating a given weight of the bread; if the ash left be more than one or 1½ per cent of the weight of the bread employed, then it may be concluded the bread is mingled with some such substances as those just mentioned.

The process of determining silica, carbonate of lime (chalk), and plaster of Paris, has already been been pointed out, under Section 3.

Sulphate of copper, its detection.—M. Kuhlmann, Professor of Chemistry at Lille, having been called upon to make some enquiries as to bread suspected to contain substances deleterious to health, studied this subject with particular care, and the following are some of the results he has obtained.

It was he who first pointed the public attention to a deadly fraud practised by some Belgian bakers, consisting in the introduction of sulphate of copper into bread. When flour, used in bread making, was procured from bad grain, this addition was continually made. When the bread does not rise well, a little sulphate of copper obviates the inconvenience; it also makes it retain much more water. The quantity generally employed is very small—about an ounce of the sulphate being dissolved in a quart of water, a wine-glass of the solution is employed for about fifty quartern loaves.

Copper being one of those bodies whose presence is readily recognised by chemical tests, the examination of bread contaminated with it presents no difficulty; either ammonia, sulphuretted hydrogen, or ferrocyanide of potassium, would solve the matter. Of all these, ferrocyanide of potassium seems to be the most delicate test; bread containing only $\frac{1}{9000}$th of sulphate of copper, immediately takes a red tinge when moistened with the ferrocyanide.

M. Kuhlmann has, indeed, detected, by means of this test, $\frac{1}{70000}$th of sulphate of copper in bread: a quantity which is equal to $\frac{1}{300000}$th of metallic copper.

The following is his method:—

"Completely incinerate, in a platinum capsule, half-a-pound of the suspected bread: pulverize the residual ash, and mix it in a porcelain capsule with about a quarter of an ounce of strong nitric acid; it must then be exposed to heat to evaporate the excess of acid, and treated with about half-an-ounce of water. The solution must be aided by heat, the resulting liquid filtered, and a slight excess of ammonia, with a few drops of carbonate of ammonia, added. After cooling, the liquid must be filtered, to separate it from the abundant white precipitate formed by the ammonia; the filtered liquid heated, to expel all excess of ammonia, and evaporated to about a fourth its volume. It must then be slightly acidified by one drop of nitric acid, and divided into two parts, the one tested with solution of ferrocyanide of potassium, and the other with sulphuret of ammonium. If the liquid contained copper, the ferrocyanide would produce immediately a rose tint, and, after a few hours' repose, a crimson precipitate; the sulphuret of ammonium gives a brownish yellow tinge, with the formation of a brown precipitate, after a few hours' rest.

M. Kuhlmann[*] deduces, from a series of experiments in baking, with various small quantities of sulphate of copper, that this salt exercises an extremely energetic action upon the fermentation and rising of the dough, even when not above $\frac{1}{70000}$th part of the weight of the bread is employed, or one grain of sulphate for ten pounds of bread. The proportion of salt which makes the bread rise best, is $\frac{1}{30000}$th, or one grain to three pounds of bread. If more of the sulphate be added, the bread becomes moist, less white, and acquires a peculiarly disagreeable smell, like that of leaven.

The increase of weight by increased moisture, may amount to $\frac{1}{10}$th without the bread appearing softer in consequence of the solidifying quality of the copper, for the acid does not seem to have any influence, as neither sulphate of soda, sulphate of iron, or sulphuric acid, have any analagous power.

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[*] Ures' Dictionary.

Sulphate of zinc, its detection.—This salt is employed for the same purpose as the last-mentioned adulteration; but it does not act in so energetic a manner. It is equally poisonous, however, and is as much to be dreaded.

It may be detected in the following manner:—About half-a-pound of the bread is to be soaked in water, as directed for alum, and the solution pressed and filtered in the same manner. It must then be evaporated nearly to dryness, and, when cold, acted on by water. The solution is filtered, and divided into two portions. In one of which potash is poured very gently, occasioning a white precipitate, which an excess of potash re-dissolves; into the other, red prussiate of potash solution is poured, which occasions a yellow precipitate. Or, still better, the aqueous solution, as above described, is evaporated nearly to dryness, an excess of ammonia added, and allowed to digest for some little time, after which it is filtered, If, now, sulphuret of ammonium be added, a white precipitate of sulphuret of zinc will form. As a conclusive test, this sulphuret may be collected on a filter and washed with water; after which, it is to be dissolved in hydrochloric acid, and the solution thus obtained, acted on by excess of carbonate of soda. A mixture of the carbonate and oxide of zinc will now be precipitated; the precipitate must be washed and dried, after which, it is to be placed on a piece of charcoal, moistened with a drop of solution of nitrate of cobalt, and exposed to an intense blow-pipe flame. The mass, after being allowed to cool, will have assumed a bright green hue.

Carbonate of potash, its detection.—This salt is doubtlessly employed for the purpose of bringing the bread into such a condition that it will retain moisture for a considerable time, which is to the baker a great advantage.

The employment of this salt has no injurious effect, but as it is added with a fraudulent intention, its means of detection should be pointed out.

The following method is employed by MM. Robine and Parisot :—

Half-a-pound of bread is treated with water, as in the detection of alum, and the expressed and filtered liquid evaporated to dryness, alcohol is added to the dry residue, and the solution so obtained filtered, evaporated almost to dryness, re-dissolved in a very small quantity of water, and again filtered. If a granular yellow precipitate be produced on addition of chloride of platinum, carbonate of potash has been employed in the manufacture of the bread examined.

Before concluding this section on bread, it may be as well to make a few observations on the manner in which it is made, as regards kneading by mechanical means instead of by hand, and on the action of the various adulterating substances already discussed.

Not only is the bread better kneaded, but more cleanliness is observed, and a much better, and in some cases, a more wholesome article the result, as the following case will show:

M. Coulier,* inspector of police, having purchased some bread, submitted it to chemical analysis, and, to his astonishment and horror, found that it contained traces of mercury. At first, he thought he was deceived, made a second and third analysis, and with the same result. M. Coulier on this made the strictest inquiries at the baker's, and found that one of the workmen employed was labouring under a frightful disease, requiring the exhibition of mercury, and the mercury existing in the bread had proceeded from the arms of the man in question.

Although the author has never met with bread thus contaminated, it is very probable indeed that much of the same kind is distributed from the same cause in London.

The author has also examined buns and other pastry obtained from various shops in the metropolis, and in many of them, more especially, he has found

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* Des Falsifications des Substances alimentaires, par Jules Garnier et Ch. Harel, pp. 22 and 33.

alum, plaster of Paris, chalk, and sand in very large proportions, far greater than in bread. The danger of this must be particularly noted, as by far the greater part of the articles alluded to above are consumed by children, and doubtless many very dreadful diseases are engendered by partaking of pastry thus falsified. In one bun alone the author found as much as three grains of alum and ten grains of chalk.

The following considerations on the probable action of the adulterations just discussed are due to M. Dumas, and it is thought that their introduction at the conclusion of this section would be useful.

If the nature of the substances employed for the purposes of manufacturing the inferior flour to advantage be taken into consideration, it is a difficult matter to form an idea of the part each plays in the formation of bread.

A great number of them seem to have a greater tendency to check than to excite fermentation, and that which appears especially incomprehensible, is the small quantity of sulphate of copper necessary to produce the marked effect which follows its use.

In order to set this question at rest, Mr. Kuhlmann has made a number of experiments to prove the specific action of sulphate of copper, alum, carbonate of ammonia, carbonate of magnesia, and many other substances.

He has proved in all his experiments that the presence of the smallest quantity of the sulphate of copper strengthens the dough, and makes it rise better.

Sulphate of copper exercises a very energetic action in the fermentation and rising of bread. This action is shewn in a forcible manner, even when the bread contains no more than $\frac{1}{70000}$th, which is scarcely equal to one part of metallic copper in 300.000 of bread. The proportion capable of producing the greatest action is $\frac{1}{30000}$th to $\frac{1}{15000}$th; but if this quantity be exceeded, the bread attracts moisture, is not so white, and has a peculiarly disagreeable odour.

SECTION V.

MILK AND ITS ADULTERATIONS.

THIS liquid, in such general use, has not escaped the cupidity of its vendors. Even, when pure, it varies considerably: containing much more water naturally at one time than another; and, consequently, less cream. Hence, its different specific gravities at different times; thus preventing the use of the hydrometer, or specific gravity bottle, as a measurer of its purity.

The constituents of cow's milk in a normal state, according to MM. O. Henrie and Chevalier, are as follows:—

Casein (cheesy matter)	4.48
Butter	3.13
Sugar of milk	4.77
Salts (various)	60
Water	87.02
	100.00

These proportions of constituents vary with the food.

When the cows were fed on carrots :

Casein	4.20
Butter	3.08
Sugar of milk	5.30
Salts	.75
Water	86.67
	100.00

When the cows were fed on beet :

Casein	3.75
Butter	2.75
Sugar of milk	5.95
Salts	.68
Water	86.87
	100.00

The constituents of skimmed milk, according to Berzelius, are as follows :—

Water	92.875
Curd (not free from butter)	2.800
Sugar of milk	3.500
Lactic acid and lactate of potash	0,600
Chloride of potassium	0.170
Phosphate of potash	0.025
Phosphate of lime and magnesia, with a trace of iron	0.030
	100.000

The climate and season of the year have also much to do with the amount of milk rendered by each animal. In hot countries and dry seasons, the quantity is less, but the average quality is richer. Cold weather favours the production of sugar and cheese in the milk, while hot weather increases the yield of butter.*

The time and frequency of milking have a great influence on the amount of butter yielded by milk. If the cow be milked only once a day, the milk will yield a seventh part more butter than an equal quantity of that which is obtained by two milkings in the day. When the milk is drawn three times a day, it is more abundant, but still less rich. It has been remarked, that the morning's milk is of better quality than that obtained in the evening.†

From these observations it may readily be seen that, independent of any adulteration practised towards milk, it is a difficult matter to ascertain its purity by ordinary means.

The rough analysis of the milk may be of the greatest service, and it is performed as follows :—‡

1. If a weighed quantity of milk be allowed to stand for a sufficient length of time, the cream will rise to the top, and may be easily skimmed off. If this cream be gently heated, the butter, in an oily

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* Sprengel, Chemie für Landwirthe, Vol. II. p. 620.

† Lectures on Agricultural Chemistry (Johnstone), p. 785.

‡ Ibid, p. 792.

form, will collect upon the surface, and when cold, may be separated from the water beneath, and its weight determined.

2. If the skimmed milk be gently warmed, and a little vinegar or rennet added to it, the curd will separate, and may be collected in a cloth, pressed, dried, and weighed.

3. If a second equal portion of the milk be weighed, and then evaporated to dryness by a gentle heat and again weighed, the loss will be the quantity of water which the milk contained.

4. If now the dried milk be burned in the air till all the combustible matter disappears, and the residue be weighed, the quantity of inorganic saline matter will be determined.

5. Supposing these processes to be performed with tolerable accuracy, the difference between the sum of the weight of the water, butter, curd, and ash, and the weight of the milk employed, will nearly represent that of the sugar contained in the given quantity of milk.

For many purposes, a rude examination of milk, after this manner, may be sufficient; but where anything like an accurate analysis is required, more refined methods must be adopted. In such cases, the following appears to be the best hitherto recommended.*

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* Haidlen, Annalen der Chemie und Pharmacie, XLV., p. 263.

a. The butter.—The weighed quantity of milk is mixed with $\frac{1}{6}$th of its weight of common unburnt gypsum, previously reduced to a very fine powder. The whole is then evaporated to dryness, with frequent stirring, at the heat of boiling water; a brittle mass is obtained, which is reduced to fine powder. By digesting this powder in ether, the whole of the butter is dissolved out, and by evaporating off the ether, may be obtained in a pure state and weighed; or the powder itself, after being treated with ether, may be dried and weighed. The butter is then estimated by the loss.

b. The sugar.—After the removal of the butter, alcohol is poured upon the powder and digested with it. This takes up the sugar with a little saline matter, soluble in alcohol. By evaporating this solution, and weighing the dry residue, the quantity of sugar is determined; or, as before, the powder itself may be dried and weighed, and the sugar estimated by the loss. If we wish to estimate the small quantity of inorganic saline matter which has been taken up along with the sugar, it may be done by burning the latter in the air, and weighing the residue.

c. Saline matter.—A second weighed portion of milk is now evaporated carefully to dryness, and again weighed. The loss is the water. The dried milk is then burned in the air. The weight of the incombustible ash indicates the proportion of inorganic saline matter contained in the milk.

d. The casein.—The weight of the butter, sugar, saline matter, and water being thus known and added together, the deficiency is the weight of the casein.

The general substances employed in the adulteration of milk are the following, viz. :—water, flour, milk of almonds, gum, chalk, turmeric or saffron.

Water.—This is the substance that is employed most generally in the adulteration of milk. This fraud is difficult of detection, more especially when the quantity employed is very small.

The following comparative experiments have been made :—*

The general density of pure milk is about	1.038
A mixture of 75 parts milk and 25 of water, have a density =	1.021
A mixture of 66 parts milk and 33 of water, have a density =	1.020

The density of pure milk being variable, it may be readily seen that is impossible to arrive exactly at the truth, by the density of milk examined, as to the quantity of extra-contained water.

The truth can only be comparatively arrived at,

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* Dictionnaire des Réactifs Chimiques, par M. J. S. Lassaigne. Article, milk.

by ascertaining the *minimum* density of pure milk, and seeing whether the density of the examined sample be above or below that.

Not only is water added to the milk, but cream is at the same time, abstracted. These two operations cause, in the appearance of the milk, a very considerable difference, for merely by the abstraction of the cream, the residual milk takes a flimsy look, so to speak, together with a bluish tinge. These appearances increase when water has been added, and, in order to mask the two previous impositions, a third, fourth, or even fifth, must be practised.

In order to ascertain whether a partially skimmed milk has been supplied, we must either ascertain the amount of butter, by one of the processes already pointed out, or have recourse to an instrument termed a *lactometer* (measurer of milk). It consists of a tube of glass, 8 or 10 inches in height, and about an inch in diameter. It is graduated into 100 parts, zero commencing from the top, and, consequently, the scale increases towards the bottom.

In order to use this instrument, the milk to be examined is poured in up to the mark 0, or zero, and left to itself for about 24 hours, more or less, until the stratum of cream on the top does not increase in quantity. The number of degrees which this stratum occupies, indicates, in per cents, the cream value of the milk in question. When the temperature is low, the cream can be made to rise more readily by immersing the lactometer in water, or placing it in temperature of from 86° to 96° F.

In comparative experiments, it is readily proved that the thickness of the stratum of cream greatly depends upon the quantity abstracted as cream, or upon the amount of water added to genuine milk. There may, however, happen cases in which the quantity of cream thrown up by any particular sample of milk does not depend for its amount on that abstracted, or the water added, but upon natural causes; some milks, not throwing up three-fourths the quantity of cream other samples would, when submitted to the same treatment for experiment, has proved that the same cow will not yield as rich milk at one time as at another, so that these experiments are, at best, comparative.

Flour, or starch.[*]—The simplest indication of the existence of flour or starch in milk is that of small diaphanous clots, which may be seen on the sides of the vessel containing it, if it be transparent. Milk containing starch burns more readily on the bottom of the vessel in which it is boiled than pure milk. This, however, is an equivocal test.

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[*] Des Falsifications des Substances Alimentaires, par Garnier et Harel, pp. 278.

The best test is to add to a portion of the whey of the suspected milk a small quantity of tincture of iodine; if starch be present, a blue colour will become apparent.

Milk of almonds.—This is very little used, on account of its expense, but where it is employed, it may be thus detected. To about a quarter of an ounce of the milk, add a few grains of amygdaline, and stir well; if it contain milk of almonds, the odour of *bitter* almonds will be developed in a few minutes; if the milk be pure, no peculiar smell will be produced.

Gum.—This is seldom employed like the last named substance, on account of its expense. The following is the method of discovering it:—coagulate the milk, by ebullition, with a little acetic acid, filter off the whey, and pour into it a small quantity of alcohol; a dull opaque and abundant white precipitate will fall, which, if collected, may be proved to be gum by its properties.

If the same course of treatment be pursued with pure milk, a very light bluish white precipitate falls, somewhat diaphanous, and in very small quantity.

Chalk.—The presence of this body may be determined by evaporating and igniting a portion of the milk, treating the residue with a small quantity of hydrochloric acid, and filtering. If, on the addition of a few drops of oxalate of ammonia solution, a tolerably abundant precipitate is found, chalk has existed in the milk. A very slight precipitate always takes place, under these circumstances, with milk.

Turmeric may be detected by evaporating a portion of the milk to about $\frac{1}{8}$th its bulk, and then adding caustic potash in small quantity. If the yellow colour of the milk be rendered brownish, turmeric has been added. A solution of this substance is added for the purpose of producing in milk a richness of colour, serving to prevent dilution with water and abstraction of cream being apparent.

SECTION VI.

ON BEER AND ITS ADULTERATIONS.

BEER is, perhaps, one of the fluids in most general use as a beverage, and is unfortunately the one which is most adulterated; indeed, to such an extent has this fraudulent practice extended, that many stringent Acts of Parliament have been introduced to check it, and many heavy fines imposed upon the parties who have been detected in mixing deleterious ingredients with it.

The statute prohibits the brewer from using any other substances in the manufacture of beer than malt, hops, and water;* but, in general, many others are introduced, and, as before stated, many of them are deleterious, and some absolutely poisonous.

The author of a Practical Treatise on Brewing,† (which has run through many editions), after having stated the various ingredients used in brewing porter,

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* Sugar, however, is now allowed.

† Child, on Porter Brewing, p. 7.

observes, "that however much they may surprise, however pernicious or disagreeable they appear, he has always found them requisite in the brewing of porter, and he thinks they must invariably be used by those who wish to continue the taste, flavour and appearance of the beer." And yet, as before stated, although many Acts of Parliament have been framed for the purpose of preventing porter brewers from using such materials, yet Mr. Child affirms, from experience, that he could never produce the present flavoured porter without them. The intoxicating qualities of porter are to be ascribed to the various drugs intermixed with it. It is evident some porter is more heady than other, and that arises from the greater or less quantity of stupifying ingredients. Malt, to produce intoxication, must be used in such large quantities as would very much diminish, if not totally exclude, the brewers profit.

The practice of adulterating beer appears to be of very early date; Mr. Accum observes, "that by an Act, so long ago as Queen Anne, the brewers are prohibited from mixing *cocculus indicus*, or any unwholesome ingredients in their beer under some penalties."

Mr. Child, in his Work on Brewing, not only states that *cocculus indicus*, *grains of paradise*, *quassia*, &c., are necessary to produce beer of the desired flavour, but absolutely gives the necessary quantities as proved to be best, by his own experience.

Mr. Accum states, "that it was at the time of the late French war, that a preparation of *cocculus indicus* first appeared as a new saleable commodity in the price currents of *brewers' druggists.* It was at the same time, also, that a Mr. Jackson, of notorious memory, fell upon the idea of brewing beer from various drugs, without any malt and hops. This chemist did not turn brewer himself, but struck out the more profitable trade of teaching his mystery to the brewers for a handsome fee. From that time forward, written directions and receipt books for using the chemical preparations to be substituted for malt and hops were respectively sold, and many adepts soon afterwards appeared everywhere, to instruct brewers in the nefarious practice first pointed out by Mr. Jackson. From that time, also, the fraternity of brewers' chemists took its rise: they made it their chief business to send travellers all over the country with lists and samples, exhibiting the price and qualities of the articles manufactured by them for the use of brewers only. Their trade spread far and wide, but it was amongst the country brewers chiefly that they found the most customers, and it is amongst them up to the present day, as I am assured by some of these operators, in whose veracity I can rely, that the greatest quantity of unlawful ingredients are sold."

The Act of Parliament prohibits chemists, grocers and druggists from supplying illegal ingredients to brewers, under a heavy penalty, as is obvious from the following abstract of the Act:—

"No druggist, vendor, or dealer in drugs, or chemists, or other persons, shall sell or deliver to any licensed brewer, dealer in or retailer of beer, knowing him to be such, or shall sell or deliver to any person on account of, or in trust for such brewer, dealer, or retailer, any liquor called by the name of, or sold as colouring from whatever material the same may be made, or any material or preparation, other than unground brown malt, for darkening the colour of worts or beer, or any liquor or preparation made use of for darkening the colour of worts, or beer, or any molasses, honey, vitriol, quassia, cocculus indicus, grains of paradise, Guinea pepper, or opium, or any extract or preparation of molasses, or any article or preparation to be used in worts or beer for, or as a substitute for, malt or hops; and if any druggist shall offend in any of these particulars, such liquor preparations, molasses, &c., shall be forfeited, and may be seized by any officer of excise, and the person so offending, shall, for each offence, forfeit £500."

Unfortunately, there are only a very few of the ingredients employed in the sophistication of beer that can be detected by chemical tests, and they are only the least baneful. At present we cannot detect cocculus indicus, grains of paradise quassia, &c.,

excepting, perhaps, by a difference in taste of the suspected from the genuine beer, this is only, however, to be acquired, if at all, by practised parties, brewers indeed.

Not only are the above substances added to beer by the brewers, but others also by the publican; such as sulphuric acid, alum, salt, aloes, and sulphate of iron (copperas).

It is well known that publicans keep two distinct classes of beer, *old* and *mild*. These are requisite to suit the taste of their various customers. Now old beer, that is, genuine old beer, is much more expensive than new, inasmuch as it is requisite to store such beer for many months, to bring it up to the necessary standard, thus involving a great outlay of capital; but the publicans of the present day have a ready way of converting new or mild beer into old beer (beer of any age) in a few minutes. This is effected by the addition of a small quantity, according to the taste of the publican, of sulphuric acid (oil of vitriol); and the beer, however new, acquires instantaneously the hard or old flavour, or rather the acidity of the old flavour without its aroma; for genuine old beer possesses a peculiar aroma, and is not essentially acid to the taste, as is that which has been treated with sulphuric acid.

Mr. Accum observes,—"The practice is a bad one. The genuine old beer of the honest brewer is quite a different compound: it has a rich generous full-bodied taste, without being acid, and a vinous odour; but it may perhaps not be generally known, that this kind of beer always affords a less proportion of alcohol than is produced from mild beer."

If, however, the brewer or publican happens to have a quantity of stale beer on his hands, the half spoiled and sour beer can be immediately converted into a new or mild beer, by the simple addition of chalk, carbonate of potash, or of soda. The beer, however, thus prepared, never keeps long, and always has a thick muddy appearance, and disagreeable, flat, maukish taste.

The conversion of mild into old beer, and *vice versa*, are comparatively minor offences; very many parties, however, as I have before stated, are not content with this kind of deterioration, but resort to the employment of substances absolutely deleterious, or even poisonous. Mr. Child, in his Treatise on Brewing,* gives the following recipe for porter:—

1 quarter of Malt.
8 lbs. of Hops.
9 lbs. of Treacle.
8 lbs. of Liquorice Root.
8 lbs. of Essentia Bina.

8 lbs. of Colour.
Capsicum, $\frac{1}{2}$ oz.
Spanish Liquorice, 2 oz.
Cocculus Indicus, $\frac{1}{4}$ oz.
Salt of Tartar, 2 drachms.
Heading.
Ginger, 3 oz.
Lime, 4 oz.
Linseed, 1 oz.
Cinnamon, 2 drachms.

Moreover, Mr. Child says,—"It must naturally happen, that the foregoing statement will surprise many unacquainted with the mysteries of porter brewing; but some articles demand particular attention.

"First, the essentia bina, which is compounded of 8 lbs. of moist sugar, boiled in an iron vessel, for no copper one could withstand the heat sufficiently, till it comes to a thick syrupy consistence, perfectly black, and extremely bitter.

"Secondly, colour, composed of 8 lbs. of moist sugar, boiled till it obtains a middle state between bitter and sweet, and which gives to porter that fine mellow colour, usually so much admired.

"The heading is a mixture of half alum and half copperas, ground to a fine powder, and is so called from giving to porter the beautiful head of froth, which constitutes one of its peculiar properties, and which landlords are so anxious to raise, to gratify their customers."

Mr. Child, after giving the above recipe for the manufacture of porter, besides others for ale, of equally poisonous characters, very modestly closes his work with the following remarks, which seem to me worthy of being made known, inasmuch as they show that, after having given forth to the world methods, which, if followed, would inevitably cause serious maladies, and even death, the author positively states that his work was written merely for the public good.

For Mr. Child says,—" And now having finished the task, he had imposed upon himself, and having seen his work run rapidly through several editions, in answer to the many inquiries which have been made, the questions which have been put, and the letters which have been sent to him, he solemnly declares that he published this work solely for the public good; that he was neither influenced by envy at those who have made fortunes by the secrets here exposed, nor by any private wish of particular gain to himself; but by a desire to soften the hardships of the industrious poor; and in this point of view, he trusts the candid and impartial will consider his book as one step attempted to ameliorate the condition of the labouring part of mankind."

The author will now examine the methods which can be employed in the detection of the substances which are used in the adulteration of beer.

It is much to be regretted that the presence of cocculus indicus, and substances of that class, cannot be discovered by chemical means; it is only the inorganic adulterations that can be detected by the aid of the chemist. As science, however, progresses, we shall doubtless be enabled to detect the presence of cocculus indicus with as great certainty as we can at present detect that of sulphate of iron.

The only means by which the presence of cocculus indicus, and adulteration of its class, may be detected, is by the effect the beer (into whose constitution such ingredients enter) has on the animal economy.

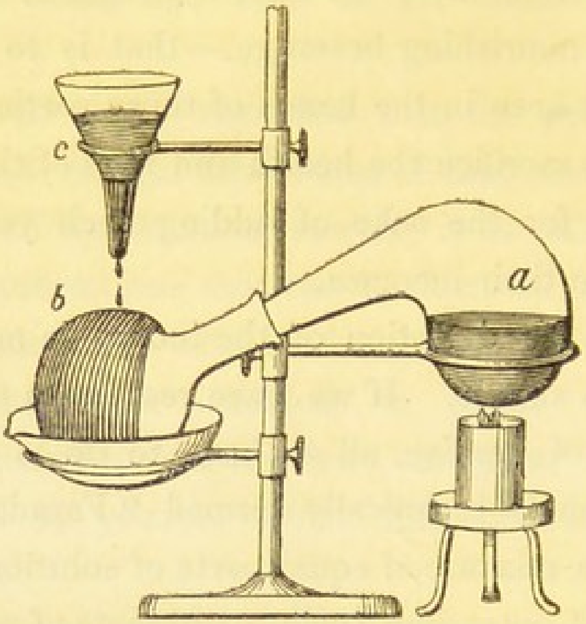
If the party drinking the beer feel in an hour or so a very great lassitude, accompanied by a head-ache, which is very difficult to be described, inasmuch as it differs somewhat in various persons, but all agree that the sensation is as if, not only bodily, but mental powers were completely prostrated, which prostration of energy is correspondent to the amount of the deleterious fluid imbibed, or to the amount of the poisonous drugs contained in it. Beer, which is entirely free from this class of adulteration, merely invigorates and bestows a generous tone to the constitution, when taken in moderate quantities; indeed, beer, as Dumas expresses himself, is at once a healthful, refreshing, and even nourishing beverage,—that is to say, when it has not been in the hands of those parties who are willing to sacrifice the health and lives of their fellow-creatures for the sake of adding each year a small amount to their incomes.

As to the detection of the inorganic matters, the process is simple. If we have reason to suspect the presence of *heading*, all we have to do is to employ that which is technically termed "Faraday's Test," which is a mixture of equal parts of solutions of ferrocyanide of potassium (yellow prussiate of potash) and ferrocyanide of potassium (red prussiate of potash). If to any beer containing sulphate of iron (copperas), a few drops of the test liquid, just described, be added, the whole will immediately become of a greenish hue, more or less deep, in proportion to the quantity of heading employed.

The analysis of beer.—It is sometimes important in comparative examinations of beer, to determine the relative amounts of alcohol, extractive matter, water, &c.; the method of procedure is the following:

Alcohol.—Place ten fluid ounces of the beer (after its per centage of acetic acid has been determined) to be examined, in a stoppered retort, and adapt to it, a Liebig's condenser, or, in lieu of that, a flask, which must be so arranged (Fig. 2) that a

FIG. 2.



stream of cold water can continually flow over it, so as to effect the condensation of the alcohol, which will distil over. When the apparatus is thus prepared, heat the contents of the retort to ebullition by means of a spirit lamp, or charcoal chauffer. Great care must, however, be taken in this part of the operation, for the beer in the retort, on the application of heat, has a great tendency to pass into the receiver, on account of the carbonic acid gas it contains being expelled as the temperature is increased; that is, provided beer is placed in the retort which has not had its carbonic acid previously removed: for this reason, the heat must be applied very gently, and if the contents have a disposition to pass from the retort, the lamp, or source of heat, must be removed until the effervescence has subsided. If due attention be paid to this point, the operation is comparatively easy; and after ebullition has once commenced, no accident of the kind alluded to need be apprehended. After seven fluid ounces of liquid have been collected in the receiver, the operation must be stopped, and when the distilled liquid has cooled to 60° Fahrenheit, its specific gravity must be taken.

If, however, the temperature of the atmosphere, at the time of making the experiment, be more than 60°, the contents of the flask must be cooled artificially. The specific gravity is taken as follows:—into a bottle known as a "specific gravity bottle,"* capable of containing, at 60°, 500 grains of distilled water, pour as much of the distilled alcoholic liquid as will completely fill it, then place in the stopper; the excess of liquid will pass through a little perforation in it, made for that purpose. When this is accomplished, carefully wipe the bottle, and place it in one pan of an ordinary balance, putting in the other pan the counterpoise which accompanies the bottle, and which exactly balances it when filled with distilled water. It will now be found that the bottle and its contents weigh less than the counter-

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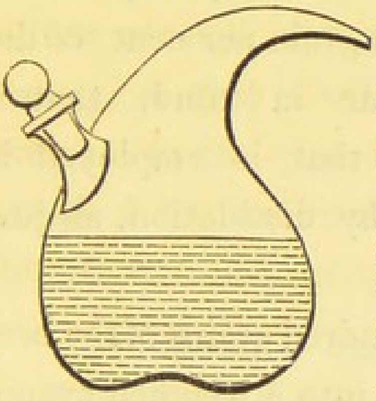
* Such a bottle can be obtained at any place where chemical apparatus is sold.

poise, the alcoholic liquid having less specific gravity, than distilled water. Weights must now be placed in the pan containing the bottle, until it perfectly balances the pan containing the counterpoise. Having ascertained the number of grains necessary to produce this effect, the specific gravity of the distilled liquid can be ascertained. Thus, supposing 25 grains were found to be necessary, it would show that a bulk of the weak alcohol obtained in the experiment, weighed 25 grains less than the same bulk of distilled water, or that 500 grains of distilled water occupied the same space, or, in other words, possessed the same bulk as 475 grains of the liquid employed. Now, as the specific gravity of water is always taken as 1000, it will be quite evident that the specific gravity of the spirit in this case will be 950, for $500 \times 2 = 1000$, and $475 \times 2 = 950$. Now, by reference to the table in the appendix, it will be found that spirit of wine of 950 specific gravity, contains 41·1 per cent. of alcohol at ·825 sp. gr.; so that by weighing the seven fluid ounces of spirit, distilled over, the per centage in the beer can be readily determined. Of course the weight of the fluid ounces of beer must have been accurately taken in grains previous to the distillation.

Acetic Acid.—Ten fluid ounces of beer are to be poured into an evaporating basin, and a test solution of carbonate of soda added until the beer is slightly alkaline, which can be determined by dipping into it a slip of reddened litmus paper, which will become blue if an excess of alkali be present. The quantity of solution of carbonate of soda added, indicates the per centage of acetic acid present. The test solution is made in the following manner:—Take 54 grains of pure fused carbonate of soda, and dissolve them in 1,000 grains of distilled water; every 100 grains of this liquid correspond to 4.83 grs. of dry acetic acid. Having thus prepared the test solution, the operation is conducted as below. An instrument termed a Schuster's Alkalimeter is the most convenient form of apparatus for this purpose. Any quantity of solution of carbonate of soda may be placed in it, (it is better to fill it to almost three-fourths its contents); this accomplished, the instrument must be weighed, and its weight accurately noted. The solution may then be poured, drop by drop, into the beer, whose acidity is to be determined, carefully stirring after each addition; and also examining whether the beer be alkaline or not, by means of reddened litmus paper. As soon as the last drop added, after vigorous stirring, converts the red tinge of litmus paper to blue, the

FIG. 3.



alkalimeter must be again weighed, and the loss of weight noted; then, as it is known how much acetic acid is neutralized by 100 grains of the test-solution, so can the amount of acid present in the beer be readily determined by simple calculation. Perhaps an example will make this clearer. Supposing the ten fluid ounces of beer employed weigh 4,400 grains, and that 184 grains of carbonate of soda test-solution be used in the neutralization; then, if 100 grains neutralize 4·83 acetic acid, 184 grains will neutralize 8·88 grains; therefore, the 4,400 grains of beer contain 8·88 grains of acetic acid, and 100 must consequently contain ·2 of a grain, as nearly as possible; so that the beer contains ·2 of a grain per cent. of dry acetic acid. It must be borne in mind, that it is the beer thus neutralized that is employed in the estimation of the alcohol by distillation, as just described.

Extractive Matter.—Four hundred grains of the beer are to be weighed, and poured into a weighed evaporating basin, which is to be exposed to a steam heat until all the water and spirit in the beer has disappeared, and nothing but a dry mass remains. The basin is then again to be weighed, and the increase in weight corresponds to the amount of extractive matter in 400 grains, which, if divided by 4, of course gives the per centage.

A steam heat, as employed in this experiment, may readily be obtained by placing the basin and contents on the top of a small saucepan in lieu of its lid.

Water.—The amount of water contained in the beer can now be determined. If the weights of the alcohol, acetic acid and extractive matter be added together, that number which, with the sum so obtained, makes up 100 parts, will express the per centage of water in the beer.

Specific Gravity of the Beer.—If it be wished to determine its specific gravity, the sample must be exposed to the atmosphere until all carbonic acid has been given off. The process is then to be conducted in exactly the same manner as described for the dilute alcohol obtained by distillation, with this exception, that it will be found necessary to add the weights to the pan containing the counterpoise, instead of to that containing the bottle, as beer has a higher specific gravity than water.

The following analyses were performed by the author, in the manner just described :—

WHITBREAD'S PORTER (from Publican).

Specific Gravity 1014.

Alcohol	4·20
Extractive	5·40
Acetic Acid	·19
Water	90·21
	100·00

WHITBREAD'S STOUT (from Publican).

Specific Gravity 1022.

Alcohol	6·00
Extractive	6·38
Acetic Acid	·18
Water	87.44
	100·00

ALE (from Publican).

Specific Gravity 1022.

Alcohol	5·60
Extractive	6·98
Acetic Acid	·27
Water	87·15
	100·00

HOLT'S STOUT (from Brewery).

Specific Gravity 1018.

Alcohol	6·30
Extractive	5·60
Acetic Acid	·14
Water	87·96
	100·00

HOLT'S PORTER (from Brewery).

Specific Gravity 1015.

Alcohol	6·00
Extractive	4·50
Acetic Acid	·11
Water	89·39
	100.00

HOLT'S TABLE BEER (from Brewery).

Specific Gravity 1007·4.

Alcohol	4·760
Extractive	4·000
Acetic Acid	·126
Water.	91·114
	100.000

HOLT'S PALE ALE (from Brewery).

Specific Gravity 1005.

Alcohol	6·916
Extractive	3·350
Acetic Acid	·052
Water	89·682
	100·000

HOLT'S STRONG ALE (from Brewery).

Specific Gravity 1018.

Alcohol	8·65
Extractive	6·60
Acetic Acid	·12
Water	84·63
	100·00

BASS'S PALE ALE.

Specific Gravity 1007.

Alcohol	6.91
Extractive	4·79
Acetic Acid	·15
Water	88·15
	100·00

The two following analyses are by Dr. Ure, and are copied from his Supplement to the Dictionary of Arts, Mines, and Manufactures :—

ALLSOP'S ALE.

Specific Gravity 1010.

Alcohol	6·00
Extractive	5·00
Acetic Acid	·20
Water	88·80
	100·00

BASS'S ALE.

Specific Gravity 1006.

Alcohol	7·00
Extractive	4·80
Acetic Acid	·18
Water	88·02
	100·00

It will be seen, on reference to the analysis of Bass's ale, made by myself, that the result is nearly identical with that obtained by Dr. Ure. The following analyses of German beer, by Dr. Ure, may also be interesting :—

BAVARIAN BEER.

Specific Gravity 1004.

Alcohol	4·00
Extractive	4.50
Acetic Acid	·20
Water	91·30
	100·00

BOCK BEER.

Specific Gravity 1013.

Alcohol	4·50
Extractive	6·40
Acetic Acid	·20
Water	88·90
	100·00

The following are analyses of some German beers, by Professor Leo, of Munich :—

BOCK BEER.

Specific Gravity 1020.

Alcohol	4·000
Extractive	8·200
Carbonic Acid	·085
Water	87·393
	100·000*

HEILIGER VATER.

Specific Gravity 1030.

Alcohol	5·000
Extractive	13·500
Carbonic Acid	·077
Water	81·923
	100·000*

LICHTENHEIM.

Alcohol	3·168
Albumen	·048
Extractive	4·485
Water	92·299
	100·000

UPPER WEIMAR.

Alcohol	2·567
Albumen	0·20
Extractive	7·316
Water	90·097
	100·000

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* These numbers are as copied from the analyses.—J. M.

ILMENAU.

Alcohol	3·096
Albumen	·079
Extractive	70·72
Water	89·753
	100·000

JENA.

Alcohol	3·018
Albumen	·045
Extractive	6·144
Water	90·793
	100·000

DOUBLE JENA.

Alcohol	2·080
Albumen	·028
Extractive	7·153
Water	90·739
	100·000

The following table exhibits the per centage of alcohol by measure in some varieties of beer, as determined by Professor Brande and Mr. Accum :—

100 parts of measure contained	Parts of Alcohol by measure.
Ale, home brewed (B)*	8·30
Ale, Burton, 3 scruples, (B)	6·25
Ale, Edinburgh (B)	6·20
Ale, Dorchester (B)	5·50
Ale, common London brewed, six samples (B)	5·82
Ale, Scotch (B)	5·75
Porter, London (B)	4·00
Ditto ditto (A)†	4·20
Ditto ditto (A)	4·45
Ditto ditto, bottled (A)	4·75
Brown Stout, 4 samples (A)	5·00
Small beer, 6 samples (A)	·75
Ditto (B)	1·28

The quantity of carbonic acid contained in beer is very variable, but the following table will give an idea of the appearance beer presents according to the proportions of the above gas it contains.‡

	Gas by measure in 100 parts of beer.
Not sparkling	2
Beading, but not sparkling	3
Giving a little bead, but not sparkling	4

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* Brande's Analysis.

† Accum's Analysis.

‡ Dumas, Traité de Chimie, vol. vi. p. 438.

	Gas by measure in 100 parts of beer.
Sparkling very feebly	8
Small sparkling	11
Ordinary sparkling	15
Tolerably strong sparkling . . .	20 to 22
Strong sparkling, much froth . .	25 to 28

SECTION VII.

CIDER AND ITS ADULTERATIONS.

Cider is frequently mixed with various colouring matters, but as these are perfectly innocuous, it is not considered of sufficient importance to notice them further.

Cider, after being kept some time, or when it has been badly fermented, often contains such a quantity of acetic acid, that it cannot be consumed, unless some means be taken to get rid of the excess of acid. This is done in much the same manner as old beer is rendered new, viz., by the addition of lime, chalk, or pearlashes. The presence of lime or chalk is readily discovered; if to the suspected cider some oxalate of ammonia be added, an immediate precipitation of oxalate of lime will take place. It, however, always happens that a faint turbidity is produced on the addition of solution of oxalate of ammonia to cider, because it naturally contains salts of lime, yet, in such small quantities that, as just stated, only a faint turbidity is produced; whilst in the cider which has had chalk or lime added to it, an immediate and distinct precipitation takes place.

Pearlash or carbonate of potash is also added for the same purpose. It may be detected by adding to the cider a few drops of solution of bichloride of platinum, evaporating to dryness, and acting on the dry residue with alcohol. If a yellow insoluble precipitate remain, potash is present, but it must be also noted as in the case of lime, that cider naturally contains salts of potash, and will invariably give a yellow insoluble residue when treated as above, yet the residue in genuine cider is very small in comparison to that produced by the adulterated article.

Lead in the state of oxide or carbonate (litharge or ceruse), is added to cider, for the purpose of correcting acidity.

In the section on Water, the dangers resulting from the passage of lead into the system, as well as the methods to be pursued in the detection of that metal have been pointed out.

SECTION VIII.

WINES AND THEIR ADULTERATIONS.

It is not surprising that an article bearing such a high price as wine generally does in England should have been selected as a fit substance for adulteration, indeed its falsification has been, and is now, carried on to an amazing extent, and it is exceedingly unfortunate that the state of science, however advanced it may be at the present day, cannot point out the method of detecting by far the greater part of the substances so employed, yet the presence of many of them, and fortunately the most dangerous, may be pointed out. I shall enumerate the substances which are known to be used for the purpose of adulteration, together with the object for which they are added, and then give the means of detecting such of them as we are at present enabled to discover.

Alum is added to new and poor red wines for the purpose of brightening their colour; and to pale faint coloured Port, Brazil and logwood is employed, together with elderberries or bilberries. In cases where an additional astringence is required, oak-wood sawdust is used, and it is by means of the above substances that wretchedly bad foreign and home-made wines are converted into genuine Old Port, which is sold at the public-houses at a high price, thus yielding to both the wholesale and retail dealer a handsome profit, and disordering the whole system of those parties, who are unfortunate enough to have partaken of the compound.

In cases where the bouquet of the lighter wines is required, flavouring substances, such as bitter almonds, orris-root, elder-flowers, and many other similar bodies are employed.

When wine has become very acid, it is rendered again drinkable by the addition of a suitable quantity of carbonate of soda, potash, or lime. Sometimes this acidity is removed by a far more dangerous remedy, viz., by the addition of litharge (oxide of lead or ceruse, carbonate of lead); in this case, of course, the wine is eminently poisonous. The presence of lead, however, may arise from accidental causes, as I shall hereafter show.

Some of the salts of copper are occasionally employed to impart an additional astringency to wines.

Wines are not only strengthened by raw grain spirit, but they are diluted very considerably by water; indeed, the addition of grain spirit is generally consequent on that of water. Various spices are also added to increase the flavour of spoiled or musty wine.

The addition of Colouring Matters.— The colour of red wines is derived from the husk of the grape from which they are made. I shall now give some details of a very interesting research on the natural colouring matter of wines by M. Chevallier, and also some results arrived at by Vogel, Nees van Esenbeck, and other chemists who have experimented on this subject.

The foreign colouring and astringent matters employed in these experiments to imitate the red wines, were logwood, Brazil wood, elderberries, the berries of the dwarf elder, privet, mulberries, and sloes. M. Chevallier experimented with the wines of Beaune and Dijon, of Langres, Mèze, of Nuit, and of Paris.

The wines, bright, limpid and possessing every desirable quality, were mixed with various reagents, such as potash, acetate of lead, sulphate of alumina, with addition of potash, ammonia, di-acetate of lead, and lime water.

On the addition of a sufficient quantity of potash to saturate the free acid naturally present in the wine, all became of a greenish-brown colour, which was intense in proportion to the original colour of the wine, and at the end of several hours became completely brown. The wines thus treated gave no precipitate. Those of Nuit and Beaune only let fall a few flocculent particles, but were not decolorized. A certain quantity of each of these wines was then mixed, and the mixture submitted to the action of potash, no precipitate was produced, but the colour changed from red to green, and lastly to brown. A whitish deposit was found in the lower part of the vessel, but none of the colouring matter was precipitated.

A sample of each of the wines just mentioned was treated with acetate of lead, with the following results:—

Wine of	Beaune	(coloured)	precipitate	bright violet.
"	Dijon	"	"	same.
"	Langres	"	"	bluish violet.
"	Mèze	"	"	violet.
"	Same, less coloured		"	reddish white.
"	Nuit, pure colour		"	whitish blue.
"	Paris, coloured		"	bluish violet.

Samples of these wines were also placed in contact with sulphate of alumina and a little potash; all gave dull grey precipitates. Chloride of tin, acetate of lead, and lime water were also added, but, according to Chevallier, no difference was perceptible in the action of these reagents in wine, whether coloured or in a normal state.

Recently, M. Jacob has made many experiments on the colouring matters of wines, and the reagent he employs seems to give tolerably constant results with all; he, however, has only operated on three kinds of colouring matter, viz., the petals of the red poppy, logwood, and Brazil wood.

He employs a solution of sulphate of alumina (10 parts of the salt and 100 of water), mixing it in equal volumes with the wine to be assayed (about half a fluid drachm), and pours into this mixture some drops of a solution of carbonate of ammonia (8 parts of carbonate of ammonia to 100 of water), an abundant precipitate of alumina is immediately produced as a variously coloured lac, according to the nature of the colouring matter in the wine. Twelve or fifteen drops generally suffice to give a very marked coloration. If, instead of adding this quantity of carbonate of ammonia to the wine to be assayed, a few drops, as six or eight only, are added, the precipitate does not form immediately, but the liquid assumes the same colour as the precipitate would possess when produced.

It is necessary, however, to avoid the addition of a great excess of the precipitant, for in such a case the tints produced by logwood or Brazil wood are not sufficiently distinct to prove their presence with accuracy. After about seven or eight minutes, the action becomes most marked. The natural colouring matter of wine, treated as above, gives a greyish white precipitate, which varies according to the colouring matter added.

The following reactions were obtained by treating pure wine, and the same wine coloured by means of the petals of the red poppy, logwood, and Brazil wood, with sulphate of alumina and carbonate of ammonia :—

Normal Wine gave a slightly coloured greyish precipitate.

Normal Wine and Brazil wood gave a carmine-red precipitate, which varied in intensity with the quantity of colouring matter added.

Normal Wine and Logwood gave a fine deep violet precipitate.

Normal Wine and Red Poppy Petals gave a precipitate of a slate-grey colour, varying in intensity with the quality of the colouring matter added.

Two drops of an infusion, made with 8 parts of one of the above substances and 250 parts of water, added to 2 parts of wine, gave a very decided reaction.

Mr. Vogel has proposed to mix the suspected wines with di-acetate of lead. In pure wine this substance gives a greyish-green precipitate ; in wines coloured by Brazil wood or elderberries, the precipitate is indigo-blue; and when beetroot or sandal wood has been employed, it is red.

If a solution of di-acetate of lead be added to pure

Madeira wine, the precipitate is bright yellow. In pure Port wine the precipitate is greyish, with a slight tinge of green.

In an infusion of logwood, the precipitate produced by di-acetate of lead is purple-red; if the colouring matter be very much diluted, the precipitate is not only less in quantity, but has a leaden or blueish hue.

With the juice of beetroot the colour is puce; when diluted with water, the tint becomes a pale salmon-red.

Berzelius asserts that the colouring matter of red wines gives different coloured precipitates with di-acetate of lead, according to the age of the wine. Thus, in new red wine the di-acetate generally forms a blue precipitate, this, of course, much diminishes the value of the test.

According to M. Nees van Esenbeck, the best method of testing the colouring matter of wines, is to prepare two solutions; one of one part of alum in eleven parts of distilled water, and the other, one part of carbonate of potash in eight parts of water. The wine to be tested and the solution of alum are to be mixed in equal bulks, and the solution of carbonate of potash gradually poured in, taking care to decompose the whole of the alum. The alumina during precipitation unites with the colouring matter of the wine, and furnishes with that which is normal a dullish grey, but having a more or less decided red tinge. An excess of alkali re-dissolves a portion of the precipitate, rendering the remainder ash-grey. In new wines, the precipitate formed under the before-mentioned circumstances receives a greenish tinge with excess of potash.

According to M. Nees van Esenbeck, red wines artificially coloured, present with the same reagents the following phenomena:—

Wine coloured with *red poppy petals,* gives a brownish-grey precipitate, which becomes black by an excess of alkali.

Wine coloured by *privet berries,* gives a brownish violet precipitate.

Wine coloured by *elderberries,* a violet precipitate; by *Brazil wood,* a greyish-violet; and by *logwood,* a *rose* coloured precipitate.

The presence of tannic acid in wines can be ascertained by a solution of a persalt of iron, which changes their red colour to brownish-black, or blackish-violet, and also by the formation of a precipitate by solution of gelatine.

From the experiments of M. Nees van Esenbeck, it therefore results, that all those wines which, when treated with a solution of alum and carbonate of potash, give BLUISH-VIOLET or ROSE coloured precipitates, may be suspected of having been artificially coloured.

Colouring matters, as before stated, are sometimes added to wines which have only a faint tinge, to render it deeper, or sometimes to mere mixtures of water and alcohol, with flavouring matter, to form an entirely fictitious wine.

I may mention, that among the substances convertible into wine, by the addition of colouring and flavouring matters, is cider, many thousand pipes of which, in a state not drinkable as cider, are manufactured into fictitious Port wine. The following recipes may give some notion of how this may be accomplished. They are extracted from Dr. Reece's "Gazette of Health."

"*To make British Port Wine.*—Take of British grape wine, or good cider, four gallons; of the juice of red beet-root two quarts, brandy two quarts, logwood four ounces; rhatany root bruised half a pound; first infuse the logwood and rhatany root in the brandy and a gallon of grape wine, or cider, for one week; then strain off the liquor, and mix it with the other ingredients. Keep it in a cask for a month, when it will be fit to bottle.

British Champagne.—Take of white sugar eight pounds, the whitest brown sugar seven pounds, crystalline lemon acid (citric acid) or tartaric acid one ounce and a quarter, pure water eight gallons, white grape wine two quarts, or perry four quarts, of French brandy three pints: put the sugar in the water, skimming it occasionally for two hours; then pour it into a tub, and dissolve in it the acid;

before it is cold add some yeast, and ferment. Put it into a clean cask, and add the other ingredients. The cask is then to be well bunged, and kept in a cool place for two or three months: then bottle it, and keep it cool for a month longer. If it should not be perfectly clear after standing two or three months in the cask, it should be rendered so by the use of isinglass. By adding one pound of fresh or preserved strawberries, and two ounces of powdered cochineal, the PINK *champagne may be made.*"

The following is another recipe which has been published, and is in considerable use for the manufacture of a fictitious Port wine;—

Southampton Port.—Take cyder thirty-six gallons, elder wine eleven gallons, brandy five gallons, damson wine eleven gallons, and mix.

On the presence of Alum in Wine.—Alum, as before stated, is employed to give additional brightness of colour and astringency to red wines. It may be detected by evaporating half a pint of the suspected wine to dryness; then igniting the dry residue in a platinum crucible. Dissolve the ignited mass in as small a quantity as possible of hydrochloric acid, and evaporate to dryness; add a little more hydrochloric acid and some water; then filter; add excess of caustic potash; filter, and add to the filtered liquid some solution of chloride of ammonium (sal ammoniac). If a white precipitate appear immediately, or after some time, alum has been added to the wine examined.

On the presence of Carbonate of Potash and Lime.—Wine, to which lime or carbonate of lime has been added, to correct its acidity, gives an immediate precipitate on the addition of a solution of oxalate of ammonia. Normal wine, however, always contains a small quantity of lime in solution, and also gives a precipitate with oxalate of ammonia; but in the latter case, the deposit is scarcely visible, excepting after some time; whereas, in the former, it is produced immediately, and is more or less abundant, according to circumstances.

By taking, however, a rather more circuitous method, the addition of lime or its carbonate to wine may be positively determined. Lime exists in wine naturally, in the states of tartrate and sulphate; and if good wine be evaporated to about one-tenth of its original volume, and twice its bulk of strong alcohol added, the naturally existing tartrate and sulphate of lime will be deposited; and the filtered liquid evaporated very nearly to dryness, re-dissolved in water, and filtered, will give no precipitate with oxalate of ammonia; but if lime has been fraudulently added, it will exist in the state of acetate, which salt is soluble in alcohol, and will consequently be separated by the filtration from the tartrate and sulphate. If now, to such a solution of acetate of lime, obtained as above, oxalate of ammonia be added, oxalate of lime will be immediately precipitated; thus proving the abnormal presence of lime.

Carbonate of Potash.—This salt is added for the same reasons as the preceding; that is to say, to avert fermentation, and to saturate any free acetic acid the wine may contain. In order to detect this addition, the wine must be evaporated to a syrupy consistence; after which it must be agitated for a few minutes with a little strong alcohol, and slightly warmed, by which means the acetate of potash is taken up; the liquid is then filtered, and divided into two parts, one of which is heated with bichloride of platinum, which produces a yellowish granular precipitate (indicative of potash), and the other by strong sulphuric acid, which disengages when heated a mixture of the vapours of acetic ether, which is very characteristic of the presence of acetic acid.

It is true, however, that genuine wine contains a little acetate of potash, but in such small quantity, that the indications, as above-mentioned, are scarcely perceptible.

On the addition of Litharge and Ceruse.—These are the most dangerous and insidious of all the substances added to wine, either fraudulently or accidently, and their presence should be most carefully guarded against. These bodies are employed to sweeten wines which have become acid, and also for the purpose of clarifying white wines when muddy. It seems, moreover, that there is not as yet known to the trade any other method of recovering ropy wines, and the small quantity of lead which is necessary to be employed, emboldens the dealer to continue its use, by imagining that the very smallness of the quantity prevents any harmful effects following the constant use of wine thus treated; this is, however, contrary to all that is at present known, and the author fully agrees with Mr. Accum, who, when speaking on this subject, says—"Lead, in whatever state it is taken into the stomach, occasions terrible diseases, and wine adulterated with the minutest quantity of it, becomes a slow poison. The merchant or dealer who practices this dangerous sophistication, adds the crime of murder to that of fraud, and deliberately scatters the seeds of disease and death among those consumers who contribute to his emolument." Such, indeed, may be said of all those who adulterate any substance which is employed in an article of food.

Lead, however, may occur accidentally in wine, from the following circumstances:—It is a very common practice to cleanse bottles by shaking within them a quantity of leaden shot; now, it may so happen, as has been often proved, that a few of the shot become lodged in the creviced portion of the bottom of the bottle, and there, despite of the rincing and washing, they remain. If under these circumstances wine be poured into such bottles, it will invariably take up a portion of the lead so lodged, and, of course, the same deleterious effects will be produced as if litharge or ceruse had been added to sweeten sour and spoiled wines.

The following case, illustrative of the last position, appeared in the Philosophical Magazine of 1819, No. 257, page 229 :—" A gentleman who had never in his life experienced a day's illness, and who was constantly in the habit of drinking half a bottle of Madeira after dinner, was taken ill with a severe pain in the stomach and violent bowel colic, which gradually yielded, within twelve hours, to the remedies prescribed by his medical adviser. The day following he drank the remainder of the same bottle of wine which was left on the preceding day, and within two hours afterwards, he was again seized with the most violent colliquative pains, headache, shiverings, and great pain over the whole body. The apothecary becoming suspicious that the wine he had drank might be the cause of the disease, ordered the bottle from which the wine had been decanted to be brought to him, with a view that he might examine the dregs. The bottle happening to slip out of the hand of the servant, discovered a row of shot, wedged forcibly into the angular bent-up circumference of it. On examining the beads of shot, they crumbled into dust, the outer crust (defended by a coat of black-lead with which the shot was glazed) being alone left unacted on, whilst the remainder of the metal was dissolved."

The wine, therefore, had become contaminated with *lead* and *arsenic,* the shot being a compound of these metals, which had no doubt caused the mischief.

In Graham's Treatise on Wine Making, under the article of secrets belonging to vintners, page 31, lead is recommended to prevent wine from becoming acid. The following lines are copied from Mr. Graham's work:—

"*To hinder Wine from turning.*—Put a pound of melted lead in pure water into your cask, pretty warm, and stop it close.*

"*To soften Grey Wine.*—Put in a little vinegar wherein litharge has been well steeped, and boil some honey to draw out the wax, strain it through a cloth, and put a quart of it into a tierce of wine, and this will mend it."*

From all that has been stated, it is therefore the duty of every one to examine the wine he drinks as to its freedom from lead, the adulteration in colouring, flavouring,

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* These paragraphs have been copied *verbatim.*—J. M.

&c., with organic substances, falls into insignificance, when compared with the direful effects produced by constantly taking into the system a small quantity of lead, and the method of ascertaining its presence is so easy and certain, that the mere description will enable any person to execute it with facility.

A quantity of the suspected wine is to be evaporated to dryness in a porcelain crucible; when dry, the crucible must be heated so strongly, that the whole is carbonized; the carbonized contents must be ignited with about twice their weight of nitre. The substance thus treated is to be acted on with dilute nitric acid, and the resulting liquid filtered. If the addition of dilute sulphuric acid to the filtered liquid produce a white,—if chromate of potash a yellow,—and, lastly, if sulphuretted hydrogen a black precipitate, the presence of lead is fully determined.

*On the presence of Copper in Wine.**—Everything appertaining to the nature of wine is of such interest, that the author will here give a *résumé* of the researches of Pierre Peretti, Professor of Chemistry to the Great College (*Archiginasio*) at Rome.

"Since many talented chemists have proved by analysis

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* Des Falsifications des Substances alimentaires, par Jules Garnier et Ch. Harel, p. 171.

the existence of copper in blood and vegetables,* it is difficult to ascertain if this metal, which is found in wine, really pre-exists, or has been fraudulently or accidentally introduced. It is, therefore, not without interest to be enabled to determine, by experiment, if the copper which is met with in wine has been conveyed into it by the act of vegetation, or has been otherwise introduced."

Chemists have employed many methods to discover copper in wine. They have been sucessful; but none of them have paid attention to the free acids existing in wine, or to those which exist in the state of lime salts—as, for instance, phosphoric acid.

The process employed always commences with incineration, by which the vegetable acids are destroyed, but no attempt is made to ascertain if the copper present is combined with them.

The following method seems to solve the question:—

In order that it might not be suspected that the wine employed in the experiments had been in contact with copper vessels, that used was obtained from a vineyard contiguous to the Tiber. About 10 lbs. of this wine, which was cherry-coloured, was divided into two parts of 5 lbs. each. The one was perfectly decolorized by animal charcoal, and reduced by

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* It appears to me, however, that copper has never been satisfactorily detected, either in blood or vegetable matter.—J. M.

evaporation to one-fifth, which then was submitted to a second treatment with animal charcoal. A portion was poured into a test glass, and a few drops of a solution of ferrocyanide of potassium added. The mixture was agitated; but after a considerable time showed no change of colour, neither was any precipitation effected. In another portion of the same decolorized liquid, which had been yet more concentrated, a plate of polished iron was plunged, and allowed to remain in that position for a considerable time, without the slightest appearance of the deposition of copper.

The other 5 lbs. of wine were evaporated to dryness in a glazed earthenware vessel, and burnt in a platinum crucible to complete incineration.

The ash was acted on by nitric acid, and after evaporation to dryness, the residue was dissolved in distilled water by evaporation, a greenish saline mass was obtained.

This substance being re-dissolved in distilled water, a plate of iron plunged into a portion of the solution was very rapidly coated with copper. Some few drops of a solution of ferrocyanide of potassium added to another portion of the liquid, gave an immediate iron-red coloration, which after a time became violet, denoting the presence of iron. It is shown by the foregone remarks, that the copper found in wine, by the process of incineration, cannot be recognized by the same reagents in the merely decolorized wine, because the metal present did not exist in combination with the free acids naturally present in the wine; for the smallest possible quantity so contained would have been detected by the ferrocyanide of potassium.

The presence of iron itself has not been evidenced by the above reagents in wine simply decolorized, although both metals are found in the examination of the incinerated wine.

M. Peretti knowing that in the vegetable kingdom, generally, iron is combined with the colouring portion, he thought that the same occurred in wine. For instance, wine being decolorized and incinerated, and the residue treated as above, with nitric or sulphuric acid, copper, but not iron, is found in solution; but if the examination be pursued on the charcoal employed in the decoloration, which is to be washed with alcohol, the residue incinerated, and treated with hydrochloric acid and ferrocyanide of potassium, Prussian blue will be the result.

If now, 5 lbs. of wine, to which one grain of oxide of copper has been added, be treated as above by decoloration and concentration, and to a portion of the liquid one drop of solution of ferrocyanide of potassium be added, the whole will immediately assume a rose-red tint, and after a time, a precipitate of the same colour is formed, without indication of Prussian blue.

Thus, M. Peretti attained the end he had in view, since the presence of copper which had been added, and thus dissolved in the free acids of the wine, had been detected in the decolorized liquid reduced by evaporation to one-fifth, by means of a solution of ferrocyanide of potassium.

In order to complete his researches, he yet made another experiment.

The acids in wine are the malic, tartaric and acetic; they exist partly in the free state, and partly combined with metallic oxides. By carbonizing wine, these acids are decomposed, and in the carbonaceous mass is found the copper, either metallic or as oxide; and, if this carbonaceous matter be treated with water containing a little ammonia, the ammoniacal liquid will remain colourless, if the substance has been produced by the incineration of normal wine; but it will become blue if the same experiment be made on the ash of wine to which has been added one grain of oxide of copper.

"From all that has been stated, it may be concluded," says M. Peretti, "that if in a wine merely decolorized, or carbonized, copper be discovered by ferrocyanide of potassium, or solution of ammonia, that metal has been either fraudulently or accidentally introduced; whereas if copper be not found by the same means (except under the circumstances before detailed) it is clear that it has been derived from the soil."

The above experiments completely solve the question; but it yet remains for chemists to discover in what state the metal does really exist in the wine, as it is not found combined with any of the free acids.

On the addition of Alcohol and Water to Wine.— M. Orfila says: "That if the quantity of water contained in wine were always the same, it could be readily ascertained whether that liquid had been added or not; for we should simply have to prove by any method the amount of contained alcohol; but as it is not so, and as the quantity of alcohol varies considerably in the same class of wine, according as the year has been more or less favourable, chemistry offers no method of arriving at the solution of this problem; and the taster can only be guided by the more or less aqueous flavour of the wine in question."

Thus it will be seen that we are in possession of no test whereby the addition of water to wine can be directly detected, although we can detect the addition of spirit, that is, to a certain extent, and can thus indirectly detect water. The spirit that is employed in the adulteration of wine is generally very inferior in quality, and contains a small quantity of a peculiar substance known as fousel, or grain oil. It is this substance which gives the unpleasant characteristic smell to all inferior spirits, and which is present in those samples which become milky when added to water.

The method of procedure which the author recommends, in attempting to ascertain whether alcohol has been added to the wine, is based upon the presence of fousel oil, as determined by its peculiar odour. If spirit that is perfectly free from this substance be poured into the palm of one hand, and then rubbed with the other hand until it has disappeared, it will be found, on smelling, that neither of the hands have contracted any disagreeable odour; but if, on the contrary, spirit containing fousel oil has been operated on, the hands will retain a peculiarly disagreeable smell, and, if a considerable quantity be present, will excite an unpleasant irritation in the throat.

If now, the alcohol employed in this experiment has been obtained by the distillation of any sample of suspected wine, it will be readily ascertained by the smell eliminated by the above treatment, whether fousel oil is present or not: if it be, the only inference to be drawn is, that alcohol has been added to the wine; and, consequently, in certain cases, the presence of water may be considered to have been negatively established.

This, although certainly not a correct method, is preferable to the complete uncertainty which before existed, and is, it is thought, all that the present state of chemistry will allow to be done under this head.

The addition of some spices can also be detected as above, only instead of using the alcohol distilled from the wine, the wine itself must be employed.

Not only does the wine dealer adulterate the wine he sells, but he falsifies the casks and bottles containing it, as well as the very corks he employs.

Thus, for instance, bottles intended to contain "old port," have introduced into them a strong solution of bitartrate of potash, or cream of tartar mixed with colouring matter, which crystallizing, constitutes the "crust;" this is occasionally employed in preparing casks for the same purpose. Again, the corks used for port wine are stained at the lower side, in order that it may appear that the wine has been in contact with them for a considerable time, and, consequently, that it has been long in bottle.

On the determination of the per centage of alcohol in Wine.—The money-value of spirituous liquids generally depends in the amount of alcohol each particular sample contains, therefore its estimation is of some considerable importance, there have been many methods contrived for estimating the alcoholic richness of wines, but the best and most simple, is the method recommended for the same determination in beer, and is the one the author is in the habit of using.

On the estimation of the amount of Tartar in Wine.—About a pint of the wine to be examined is evaporated to dryness, and the residue ignited. If the ignited mass be now acted on by water, and the resulting solution filtered, it will contain an amount of carbonate of potash equivalent to the quantity of tartrate of potash originally existing in the wine, for during ignition, the tartrate of potash is decomposed with the formation of carbonate of potash. A little more carbonate of potash will, however, be formed than is entirely due to the quantity of tartrate originally existing; for the other organic acids in the wine, as acetic, &c., also furnish a little carbonate of potash, but the quantity is so small it may be safely neglected.

If the solution of carbonate of potash, so obtained, have a dilute sulphuric acid of known strength added to it, so long as it continues to be alkaline to test paper, and the amount of sulphuric acid so employed be noted, the quantity of bitartrate of potash originally present in the wine can be readily determined; for 40 parts of dry sulphuric acid correspond to about 188 parts of bitartrate of potash.

As the author will have hereafter to advert to the determination of the quantity of alkali existing in a solution, he will fully describe the preparation of a test acid, of a known strength; the apparatus to be employed (Schuster's Alkalimeter), and mode of use having already been pointed out at page 97. The test acid is thus prepared.

Take a pint or so of water, and add to it one fourth its weight of the concentrated sulphuric acid of the shops. Care must be taken to mix the liquids gradually, and in an earthenware vessel, because if mixed suddenly, and in glass, the temperature would be so rapidly augmented as to occasion a fracture of the vessel, and consequent loss of material. After mixture, it must be allowed to cool, and if not quite bright, filtered. The specific quantity must now be taken as explained (page 95), and reference had to the table in the appendix to ascertain the per centage of dry acid the liquid contains ; when this is known, the analysis can be proceeded with.

Determination of the amount of sulphuric acid in Wine.—This may be effected by evaporating a pint of wine to about one fifth the original volume, then adding an excess of solution of chloride of barium, together with as much hydrochloric acid as will render the whole considerably acid. The precipitate of sulphate of baryta which falls is to be collected on a filter, washed, dried, ignited, and weighed, every 116 parts correspond to 40 of sulphuric acid.

Estimation of Lime.—A pint of the wine is to be evaporated to one-fifth its original volume, and an excess of solution of oxalate of ammonia added. The precipitate of oxalate of lime which is thus produced, is to be collected on a filter, washed, dried, ignited, treated with strong sulphuric acid, and the resulting sulphate ignited and weighed, every 68 parts correspond to 28 of lime. Or the oxalate produced as above may be ignited at a gentle red heat, and allowed to cool, a few drops of solution of carbonate of ammonia are added, and the whole evaporated to dryness, and gently heated to drive off the excess of carbonate of ammonia, every 50 parts of the resulting carbonate of lime correspond to 28 parts of lime.

The following table shows the quantity of alcohol generally contained in the classes of wine mentioned. Those marked M are determinations made by the author, the others are Brande's : —

Names of the Wines.	Proportion of spirit, per cent., per measure.	
Lissa		26·47
“		24·35
Average	25·41	
Marcella		26·03
“		25·05
Average	25·09	
Madeira		24·42
“		23·93
“ (M)		24·10
“ (Sercial)		21·40
“		19·24
Average	22·62	
Port		25·83
“		24·29
“		23·71

Names of the Wines.	Proportion of spirit, per cent., per measure.
Port	23·39
" (M)	24·64
" (M)	22·18
" (M)	25·20
Average	24·17
Sherry	19·81
"	19·83
"	18·79
"	18·25
" (M)	20·14
" (M)	19·93
" (M)	17·26
Average	19·00
Teneriffe	19·79
Colares	19·75
Lachryma Christi	19·70
Constantia (white)	19·75
" (red)	18·92
Lisbon	18·94
Malaga (1666)	18·94
Bucellas	18·49
Red Madeira	22·30
"	18·40
Cape Muschat	18·25
Cape Madeira	22·94
"	20·50

Names of the Wines.	Proportion of spirit, per cent., per measure.
Cape Madeira	18·11
Vidonia	19·25
Alba Flora	17·26
Malaga	17·26
Hermitage	17·43
Roussillon	19·00
“	17·20
Claret	17·11
“	16·32
“	14·08
“	12·91
“ (M.)	16·84
“ (M.)	15·19
Average	14·74
Malmesey Madeira	16·40
Lunel	15·52
Sheraaz	15·52
Syracuse	15·28
Sauterne	14·22
Burgundy	16·60
“	15.22
“	14·53
“	11·95
Average	14·57
Hock	14·37
“	13·00

Names of the Wines,		Proportion of spirit, per cent., per measure.
Hock (old in cask)		8·68
Average	12·08	
Nice		14·62
Barsac		13·86
Tent		13·30
Champagne (Still)		13·80
“ (Sparkling)		12·80
“ (Red)		12·56
“ (ditto)		11·30
Average	12·61	
Hermitage (Red)		12·32
Vin de Grave		13.94
“		12·80
Average	13·37	
Frontignac		12·79
Côte Rôtie		12·32
Tokay		9·88

HOME-MADE WINES.

Home-made wines are not generally subject to the kind of adulteration which affects the foreign wines; and, even if they were, it would be next to impossible to detect any addition. I may mention, however, that there are only two or three which ought to be consumed; the rest, are all, to a certain extent, unwholesome; indeed, some parties are always indisposed after partaking of them. Ginger, grape, and dry raisin are the only wines of this class to be tolerated. The others owe the power they possess of disarranging the animal economy to the presence of considerable quantities of malic acid, which is but imperfectly covered by the addition of sugar. Moreover, they are all mixed with brandy, most commonly raw-grain spirit, and that alone is sufficient to act in a most injurious manner on those who partake of the so-called wine.

Ginger, grape, and dry raisin wine are free from malic acid, so that this cause of unwholesomeness is removed; but to these even, raw-grain spirit is added. It is better, therefore, to avoid partaking of home-made wines, as they are all more or less liable to produce much inconvenience to the consumer.

SECTION IX.

SPIRITUOUS LIQUORS AND THEIR ADULTERATIONS.

Spirituous liquids, as brandy, gin, rum, &c., being unfortunately in such common use, and bearing so high a price, are peculiarly adapted for the purposes of adulteration, which may be of various kinds, the most general, however, is the addition of water. Were this the only adulteration practised, it would be rather productive of good than harm, from obvious reasons; yet, in reality, it has the very opposite effect, for in order to disguise the dilution, it is necessary to add some substance, capable by its pungency or other similar property, of completely counteracting the addition of water; such substances are capsicum, Guinea pepper, oil of turpentine, &c., all of which, when taken in combination with the spirit, affect the stomach very injuriously.

The author of a treatise on Brewing and Distilling,*

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* Observations on Malted and Unmalted Corn connected

gives the following advice to the trade, which will serve to unfold the secrets of the manufacture, and put the unwary on their guard.

"It is a custom among retailing distillers which I have not taken notice of in this directory, to put one third or one fourth part of proof molasses brandy, proportionably, to what rum they dispose of, which cannot be distinguished but by an extraordinary palate, and does not at all lessen the body or proof of the goods, but makes them about two shillings a gallon cheaper; and must be well mixed or incorporated in your retailing cask; but you should keep some of the best rum not adulterated to please some customers, whose judgment and palate must be humoured.

"When you are to draw a sample of goods to show a person that has judgment in the proof, do not draw your goods into a phial to be tasted or make experiment of the strength thereof that way, because the proof will not hold except the goods be exceedingly strong, but draw the pattern of goods either into a glass from the cock, to run very small, or rather draw off a small quantity into a little pewter pot, and pour it into your glass, extending your pot as high above the glass as you can without wasting it, which makes the goods carry a better head abundantly,

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with Brewing and Distilling, p. 167; and Shannon on Brewing and Distilling, pp. 232, 233.

than if the same goods were to be put and tried in a phial."

English spirit is made to resemble French brandy by the addition of a small quantity of burnt sugar (caramel) as "colouring," and of spirit distilled over wine-lees as "flavouring." It is common also to employ a spirit distilled from raisin wine, which has been allowed to become partially sour, for the purpose of flavouring raw-grain spirits to imitate brandy.

New brandies and rum are flavoured with oak saw-dust and a tincture of raisin stones, to impart the "ripe taste" which such spirits acquire by being long kept in an oaken cask.

Shannon gives the following method of compounding, or "making up," as it is technically termed, brandy for retail:—

" To ten puncheons of brandy	1081 gallons
Add flavoured raisin spirit	118
Tincture of grains of paradise	4
Cherry laurel water . .	2
Spirit of almond cakes .	2

"Add also ten handfuls of oak saw-dust, and give it 'complexion' with burnt sugar."

Detection of Malt Spirit in Brandy.—The addition of malt spirit to brandy may be determined in the same manner as directed for wine under like circumstances.

Detection of Capsicum, &c.—If the brandy suspected to contain capsicum, Guinea pepper, or grains of paradise, be evaporated to dryness in a water-bath, the residual matter will, if the sample had been adulterated, taste of the above-mentioned substances, and in proportion to the quantity present.

Detection of Cherry Laurel Water, or Spirit of Almond Cakes.—Take a portion of the suspected brandy, and distil it very nearly to dryness, add to the distilled liquid a slight excess of caustic potash, and evaporate until the bulk of the liquid is considerably diminished. Divide the evaporated liquid into two equal portions, to the one add a few drops of a solution obtained by dissolving protosulphate of iron (green vitriol) in water, and exposing the so made solution to the action of the air for a short time, (ten or twelve hours), and a few drops of a solution of potash. If now a little hydrochloric acid be added, and the liquid acquires a blue tinge, the brandy under examination has been falsified with cherry laurel water, or spirit of almond cake.

The rationale of the above process is as follows,—both cherry laurel water and spirit of bitter almond cakes contain hydrocyanic (prussic) acid. When brandy thus adulterated is distilled, hydrocyanic acid passes over with the spirit, and on the addition of caustic potash, is converted into cyanide of potassium. It is then concentrated by evaporation, and the addition of the salt of iron and hydrochloric acid, causes the formation of Prussian blue, which is a certain indication of the presence of hydrocyanic acid, and consequently of cherry laurel water, or spirit of almond cakes.

The following process can be performed on the other half of the liquid. This method has lately been described by Liebig, and is far more sensitive than the above, so that smaller quantities of the substances in question can be detected.

Hydrochloric acid, in slight excess, must be added to the reserved portion of liquid, and then a drop of sulphide of ammonium added, and the whole heated until colourless. If now a little perchloride of iron be added, a blood-red colouration will immediately ensue. This depends on sulphocyanide of ammonium being formed by the reaction of sulphide of ammonium on hydrocyanic acid, which strikes a blood-red colour with a persalt of iron, in common with all the soluble sulphocyanides.

Gin is usually adulterated with water, in considerable quantity; sugar is also added, and a mixture composed of alum, carbonate of potash, almond oil, sulphuric acid and spirit of wine, this compound not only fines the gin, but communicates to it the property of "beading," or hanging in pearly drops or beads on the sides of the glass containing it. When gin does this, it is generally supposed to be strong in proportion as it beads, and the above mixture communicates to weak gin that property, so that it will be evident gin can be considerably diluted with water, and yet, by the addition as above, appear its proper strength.

Shannon gives the following recipe for the reduction of unsweetened gin :—

" *To reduce unsweetened Gin.*

" A tun of fine gin . .	252 gallons
Water	36
Which, added together, make	288
*The doctor is now put on,** and it is further reduced with water . . .	19
Which gives a total of .	307 gallons of gin.

" This done, let one pound of alum be just covered with water and dissolved by boiling; rummage the whole well together, and pour in the alum, and the whole will be fine in a few hours."

" *To prepare and sweeten British Gin.*†—Get from your distiller an empty puncheon or cask which will contain about 133 gallons. Then take a cask of clear rectified spirits, 120 gallons, of the usual strength as

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* A technical term.

† Shannon on Brewing and Distilling, p. 199.

rectifiers sell their goods at; put the 120 gallons of spirit into your empty cask.

"Then take a quarter of an ounce of oil of vitriol, half an ounce of oil of almonds, a quarter of an ounce of oil of turpentine, an ounce of oil of juniper berries, half a pint of spirits of wine, and half a pound of lump sugar. Beat or rub the above in a mortar. When well rubbed together, have ready prepared half a gallon of lime water, one gallon of rose water, mix the whole in either a pail or cask with a stick, till every particle shall be dissolved, then add to the foregoing, twenty-five pounds of sugar dissolved in nine gallons of river or Thames water, or water that has been boiled, mix the whole well together, and stir them carefully with a stick in the 133 gallon cask.

"To *force down* the same, take and boil eight ounces of alum in three quarts of water for three quarters of an hour, take it from the fire and dissolve by degrees, six or seven ounces of salt of tartar. When the same is milk warm, pour it into your gin, and stir it well together as before for five minutes, as you would a butt of beer newly fined. Let your cask stand as you mean to draw it. At every time you purpose to sweeten again, the cask must be well washed out, and take great care never to shake your cask all the while it is drawing."

Mr. Accum mentions that diacetate of lead is employed in fining gin, but I have never yet detected it. When present, it can be readily recognised by the means pointed out for the detection of lead, page 39.

In shrub, and in some brandies, copper is present, this I believe to be accidental. It can be detected as at page 68, with ferrocyanide of potassium.

In all these cases where the spirit is weakened by the addition of water, some acrid substance, as grain of paradise or Guinea pepper, is added for the purpose of procuring a *false strength.*

The amount of spirit contained in brandy, gin, &c., can be determined in the same manner as the spirituous contents of beer and wine.

The following table of substances which furnish alcoholic liquids, and the countries producing them, may prove useful and interesting :—

Names of Spirits.	Fermented Liquids producing them.	Countries where Manufactured.
Grain spirit	Beer and fermented cereals	France, Northern Europe
Hollands	The same, with Juniper berries	The same
Goldwasser, Goldwater	The same with the addition of aromatic substances	Dantzic
Whiskey	Barley, Rye, and Potatoes	Scotland and Ireland
Lau	Fermented Rice	Siam

Names of Spirits.	Fermented Liquids producing them.	Counties where Manufactured.
Potato or starch spirit	Pulp, or starch of potatoes	Europe
Kirchenwasser	Cherries and their stones, crushed and fermented	Switzerland, Germany
Maraschino	The same	Zara
Schis - Kaya-vodka	Wine lees with fruits	Scio
Kakia	Grape, mace and spices	Dalmatia
Troster	The same, with some of the graminaceæ	Banks of the Rhine
Tafia (rum)	Juice of sugar-cane	Antilles
Rum	Molasses and skimmings of cane sugar syrup	Ditto
Rum	Juice of maples	North America
Agua Ardiente	Pulque of the Mexicans	Mexico
Araka, Arki, Arici	Koumiss, fermented mare's milk	Tartary
Rack, or Arrach	Fermented rice	The greater portion of th East
Rack	Palm-juice	Siam
Rach, or Arach	Cane juice fermented, with the addition of the aromatic bark of a tree called "Jagra"	Hindostan

Names of Spirits.	Fermented Liquids producing them.	Countries where Manufactured.
Rack	Juice of the Cocoa tree	America
Araki	Fermented Palm-juice	Egypt
Arrack	The same, with the bark of an acacia	India
Arrack Mahwah	The same, with flowers	Ditto
Arrack tuba	Fermented Palm-juice	Phillipines
Statkaiatrava	An unknown saccharine herb	Kamschatka
Y-wer-a	The baked and pulverized root of the "Terroat" fermented	Sandwich
Waiky	Rice spirit	Kamschatka

In the following table, the amounts of spirit generally contained in brandy, rum, &c. is pointed out. The numbers with (M) affixed have been found by the author; the others by Brande and Beck:—

	Proportion of alcohol, per cent., by measure.
Brandy, Cognac, average proportion of four samples	52·75
Brandy, Cognac, three samples (M) .	51·84
" Bordeaux, four samples . .	54·50
" Cette, four samples . . .	53·00

	Proportion of alcohol, per cent., by measure.
Brandy, Naples, three samples . .	53·25
“ Spanish, six samples . . .	52·28
Rum, Leeward, nine samples . . .	53·00
“ four samples (M) . . .	53·51
Scotch Whisky, six samples . . .	53·50
“ “ four samples (M) . .	52·91
Irish “ four samples . .	54·25
“ “ four samples . .	54·10
“ “ Kinnahan LL, three samples (M)	55·07
Gin, Hodges, three samples procured from retail dealers (Accum) . . .	48·25
“ “ procured from the manufacturer (Accum)	52.35
Gin, average of eight samples . .	51.74
Arrack, Batavia	49·52
Dutch Geneva	52·25

SECTION X.

COFFEE AND ITS ADULTERATIONS.

Coffee is subject to many adulterations, and unless the whole coffee be purchased, the purity of it can seldom be depended upon, and even then it is somewhat questionable; for the author has been assured on good authority, that there is grown in England a kind of bean which so much resembles the coffee berry, that none but a practised eye can detect the difference; so that even buying an unground article, the purchaser cannot consider himself safe. He has also paid much attention to the subject of coffee, and has devised methods by which all its ordinary adulterations can be detected in a very ready manner.

The substances employed in the adulteration of ground coffee are chicoree, ground and roasted peas and beans, coffee-grounds that have been exhausted by water, and coffee spoilt by sea water. It is necessary to examine in detail in what manner coffee is affected by the addition of either of the above substances; and to do so, there must be a standard of comparison, which shall be the composition of the very finest roasted coffee, as adduced by the author's analyses.

Composition of the finest roasted coffee, dried at 212° :—

Matter soluble in water . .	35·06
Matter insoluble in water . .	64·94
	100·00

Ash per cent. 2·806

Matter soluble in water . .	2·042
Matter insoluble in water . .	·764
	2·806

An aqueous solution of the above coffee behaves in the following manner with reagents :—

It is decidedly acid to test paper.

Protochloride of Tin causes an immediate turbidity, which is very considerable ; but which disappears in a great measure upon standing, leaving but a slight precipitate, which becomes perfectly black, leaving the liquid quite colourless.

Nitrate of Silver.—A copious precipitate, which by reflected light is greyish-green, and the liquid yellowish ; the latter, however, has a Port wine shade by transmitted light.

Chloride of Gold gives a brownish-crimson tint by transmitted, but a blackish-green by reflected light.

Aqueous solution of Iodine.—No change.

Chloride of Lime.—On the first addition, a very dark green, almost black, coloration; after which the liquid bleaches.

Protosulphate of Iron.—A very considerable dark-green precipitate.

Chloride of Platinum.—Considerable brown precipitate.

Persulphate of Iron.—Deep greenish-black coloration.

Such are the changes induced by the above reagents in a decoction of pure coffee.

The following is an analysis of chicoree, also roasted, as well as the behaviour of its decoction with reagents.

Analysis of Roasted Chicoree, dried at 212°.

Matter soluble in water . .	71·712
Matter insoluble in water .	28·288
	100·000

Ash per cent. 12·666.

Matter soluble in water . .	1·554
Matter insoluble in water .	11·112
	12·666

The above analysis, as well as that of the coffee, was made as follows:—100 grains of the coffee or chicoree were boiled repeatedly with water, until that liquid ceased to be coloured, the unacted on residue was dried and weighed, it corresponded to matter insoluble in water, and the weight required to make 100 grains, to the matter soluble in water. 100 grains of fresh substance were heated to incipient redness, in a platinum crucible in a muffle (this method, by the way, is the best for preparing ashes of plants for analysis), until all organic matter was destroyed, which takes place in a few minutes: the amount of ash was then weighed, it was digested with water until everything soluble was taken up, and the residual matter then dried and weighed. If necessary, the water in the coffee or chicoree was estimated by heating 100 grains in a water-bath, until they ceased to lose weight; the loss of weight corresponds to the per centage of water.

It will be seen, by comparing the analysis of coffee with that of chicoree, that a very great difference exists between the two substances. Coffee contains 64·94 parts of matter insoluble in water, whilst chicoree contains only 28·288 per cent.; again, coffee yields but 2·816 per cent. of ash, while chicoree yields 12·666. Here we have at once an almost positive method of detecting the adulteration of coffee with chicoree, but yet we can arrive at a perfect certainty by a still closer examination.

Behaviour of Decoction of Roasted Chicoree with reagents.—The decoction is decidedly acid to test paper.

Protochloride of Tin.— A slight yellowish white precipitate.

Nitrate of Silver.—No precipitate

Chloride of Gold.— Gradually deepens the tint, which becomes in a few minutes a fine Port-wine colour, which keeps increasing in intensity.

Chloride of Lime.—Immediately bleached.

Aqueous solution of Iodine.—No change.

Protosulphate of Iron.—No change. On the addition of carbonate of ammonia a dark-green precipitate falls.

Chloride of Platinum.—Deepens slightly in colour.

Persulphate of Iron.—Deepens slightly in colour.

On comparing the action of these reagents on chicoree and coffee, we cannot fail to perceive that some very marked differences in behaviour exist. Protochloride of tin merely produces a slight yellowish white precipitate in chichoree, whilst in coffee it gives a precipitate, which, after a time, becomes perfectly black. Nitrate of silver gives no precipitate with chicoree but does with coffee, and chloride of gold has a very marked reaction, as well as most of the other tests.

Again, chicoree contains so much gummy matter, that if the fingers be moistened, and a little of the powder taken up between them, and well pressed together, it will adhere strongly, and form a mass of a very coherent nature, which can be moulded into any form. Pure coffee, when treated in this manner, does not cohere in the slightest degree.

Chicoree also differs from coffee when ground, in the following particular:—Pure coffee, when sprinkled on the surface of water, remains there for some time, and does not sink to the bottom, but chicoree sinks almost immediately and tinges the liquid brownish yellow, the intensity of colour is in proportion to the quantity of chicoree present.

From these data, we may form a plan of detecting chicoree when mixed with coffee, and, indeed, of separating and estimating its quantity, at least approximatively.

A decoction of the suspected article should be examined with the just mentioned reagents, and the results carefully noted. The quantity of ash can then be ascertained in a sample dried at 212°, and the amount of matter soluble and insoluble in water, both of the ash and of the whole substance. These operations will give a tolerable idea of the purity of the substance. The portion of the powder is now to be taken up with the moistened fingers and kneaded. If it cohere, the presence of chicoree is pretty well proved. Another portion is sprinkled on the surface of some water in a glass vessel, and its behaviour noted, seeing whether it sinks or swims, and if so, whether the liquid becomes coloured.

The following is a case in which the trial by the addition of reagents to the decoction produced no satisfactory results, as will sometimes be the case in unpractised hands; the following experiments, however, can be performed by any one, with ease and certainty.

100 grains of the coffee give 7·736 grains of ash, 53·386 grains of matter soluble in water, and 46·614 grains insoluble in water, the analysis would stand thus :—

Matter soluble in water .	53·386
Matter insoluble in water .	46·614
	100·000
Ash, per cent. . .	7·736

100 grains of the coffee are to be gently sprinkled on the surface of water contained in a glass, and the whole allowed to repose for a few minutes; a considerable quantity of substance falls to the bottom, when no more falls, pour off the supernatent liquid, and substance on it, and add repeated quantities of hot water until the last passes off colourless, then collect and dry the residue; on weighing, it is found to be 14·144 grains.

A portion kneaded in the moist fingers gives a coherent mass.

It is quite evident, on referring to the analysis, that we have much more ash than pure coffee contains, and less than is yielded by chicoree; that the quantity of extractive matter is more than ought to be obtained from coffee, and less than from chicoree, and the matter insoluble in water is much less than that of coffee, and more than of chicoree.

It is found that 14·144 grains of matter have been collected by subsidence from, and washing with, water, and that 14·144 grains correspond with 50 grains of chicoree, as shown by its analysis. What remains to be done now, is to calculate how much extractive, water, ash, &c., 50 grains of chicoree and 50 grains of coffee, contain; if the amount corresponds to the numbers obtained by the analysis of the suspected compound, then the only inference that can be drawn is, that the coffee is adulterated with chicoree, and to the extent of 50 per cent., as in the case supposed. Thus, it will be seen, that this process enables us to determine, not only the presence of chicoree in coffee, but absolutely its relative quantity.

Detection of Coffee-grounds.—This is comparatively simple, and depends on the same mode of operation (that is as regards analysis), as the determination of chicoree. It is clear that coffee which has been exhausted by water, cannot furnish so much soluble matter, and will yield more insoluble matter than normal coffee, so that the only thing to be done is, to exhaust a given portion with water, ascertain the amount of soluble and insoluble matter as before, and to compare the results with the analysis of genuine coffee. The amount of addition can be pretty well calculated, more especially by aid of the property which coffee-grounds possess in common with chicoree, viz., that of sinking in water when sprinkled on its surface, so that the amount of adulteration can, in this case, also be tolerably well determined.

Detection of roasted Peas and Beans.—This is still more simple than any of the rest, and depends on the action of a watery solution of iodine on the starch of the above substances, whilst it does not affect a solution of either coffee or chicoree.

A decoction of the suspected coffee is made in the usual manner and strained, when cold, a little solution of iodine is added, if peas or beans be present, the liquid will assume a blue or greenish tinge; greenish when the quantity present is only small, blue when large. Where very small quantities only are present, it is necessary to decolorize the decoction with animal charcoal before filtration, otherwise the change of colour, on the addition of iodine, will not be perceptible.

*On Coffee spoilt by Sea-water.**—M. Girardin examined some coffee which had been in sea water in

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* Girardin.

contact with copper, and was supposed to be impregnated with diacetate of copper (verdigris). He says—"The coffee was in berries of variable size, amongst which were many torn and flattened; outside they possessed a brownish-black colour, inside a greenish tinge; they smelt musty and tasted rather soapy.

"Roasted in the ordinary manner, no aromatic odour, like that produced under similar circumstances by good coffee, was produced; the berries did not become oily and shining by torrefaction, but remained dry and dull; when cold, their smell recalled that of liquorice juice.

"The unroasted grain gave to boiling-water, a brownish tinge, and the decoction was very black and difficult to filter: it had no bitter taste or sensible odour, but when left in the mouth for a little time, it tasted like a weak solution of soap. The colour was the same after many days. Good coffee gives, on the contrary, a golden yellow decoction, possessing a slightly bitter and herbaceous taste, and a faintly aromatic colour. At the expiration of about twelve hours, this decoction becomes green, and remains perfectly bright."

Coffee impregnated with sea-water, when roasted and infused in water, colours it a bright-brown. This liquid has neither the taste nor perfume of ordinary coffee.

A decoction of the above coffee was tested with a variety of reagents, as was also a decoction of unroasted Martinique coffee. Only those reagents which produced decidedly different actions with the two decoctions are mentioned.

The decoction of Martinique coffee is designated by A; that of the coffee spoilt with sea-water by B.

Caustic Potash (A).—The liquid took a gamboge-yellow colour, and, after a time, was rendered slightly turbid.

(B).—The decoction underwent no sensible change, and only deposited a few flakes after a considerable repose.

Lime Water (A).—An intense yellow colour.

(B.)—No effect.

Acetate of Lead (A).—Considerable flocculent precipitate of a fine yellow colour.

(B).—A considerable precipitate, flocculent, and greyish-white.

Protosulphate of Iron (A).—The solution becomes intensely green, but is not rendered turbid.

(B).—Becomes greenish-brown, and slightly opalescent.

Perchloride of Iron (A).—A deep-green, almost black, which gradually increases in depth of tint.

(B).—A brownish flocculent precipitate, which rapidly falls, leaving a colourless liquid.

Sulphate of Copper (A).—A fine green tint, which deepens on addition of reagent. If ammonia be added, a pistachio-coloured precipitate falls.

(B).—An abundant greenish-brown flocculent precipitate. If ammonia be added, the precipitate increases in quantity, and acquires a more decided greenish tinge.

Protochloride of Iron (A).—Yellowish white flocculent precipitate.

(B).—An abundant greyish flocculent precipitate.

Protonitrate of Mercury (A).—Yellow flocculent precipitate.

(B).—White flocculent precipitate.

Gelatine (A).—No change.

(B).—Slight cloudiness.

Nitrate of Silver (A).—A slight cloudiness, which gradually increased, producing a small precipitate, which was soluble in ammonia.

(B).—An abundant white flocculent precipitate, soluble in ammonia.

Chloride of Barium (A).—Slight cloudiness.

(B).—The same.

Oxalic Acid (A).—White precipitate, very small, after the end of a certain time.

(B)—A white precipitate, much more abundant, at the end of the same time.

Sulphuretted Hydrogen (A).—The solution bleached.

(B).—The same; no cloudiness.

Ferrocyanide of Potassium (A).—No change.

(B).—The same.

The foregone reactions shew that the coffee impregnated with salt water had undergone a very considerable alteration in its chemical constitution. In order to prove to what extent this alteration had taken place, it was treated repeatedly with boiling water, so that all the soluble constituents might be removed. It was found by this treatment, that only ten per cent. of soluble matter had been taken up. The various decoctions were mixed together, concentrated by evaporation, and mixed with a slight excess of neutral acetate of lead, which produced an abundant brown precipitate, which was removed by filtration. A current of sulphuretted hydrogen was passed through the filtered liquid to remove excess of lead. The solution was again filtered, evaporated at a low temperature to a syrupy consistence, and left to itself for two days; at the end of which time no crystals of caffein were deposited, nor could any trace of this substance be obtained by any other process.

The total absence of this substance in coffee acted on by sea-water, shews the considerable alteration which the coffee must have undergone by such contact.

In order to ascertain if the green colour of the coffee were due to a salt of copper, 100 parts were incinerated in a platinum crucible; about 9 per cent. of ash was the result. It was slightly alkaline, and water dissolved a notable proportion of common salt, sulphate of potash, and chloride of calcium. The residue, insoluble in water, was acted on by nitric acid, in which very nearly the whole dissolved under powerful effervescence, furnishing a yellow solution. This solution, neutralized by ammonia, gave a very abundant blue precipitate on the addition of ferrocyanide of potassium. Another portion, saturated with ammonia, gave a copious flocculent precipitate: the supernatant liquid was colourless. No precipitate was produced by arsenite of potash, caustic potash, ferrocyanide of potassium, or the alkaline sulphurets; neither was there any deposit on a plate of iron after forty-eight hours. These negative results indicate the absence of copper in the ash, and consequently its absence in the coffee damaged by sea-water.

The coffee so spoilt gave more ash than the varieties found in commerce, which furnish from 5 to 6* per cent. of very alkaline ash. There are few vegetable matters which give ash so rich in iron as coffee. According to Girardin, 1 per cent. of oxide of iron is present.

From the above statement it can be proved—

Firstly, that the coffee in question is very materially altered in its chemical constitution, since many of the proximate principles contained in the berry are no longer present, and that others have undergone

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* This amount of ash is greater than any I have found.—J. M.

such modifications, that they give other than their proper reactions with test-solutions.

Secondly, that no salt of copper, or other poisonous metallic matter, is present.

Thirdly, that the greenish colour which the interior of the berries possess, is to be attributed, not to the presence of a salt of copper, but to a mouldiness analogous to that which is observable in many vegetable matters undergoing a spontaneous decomposition.

Fourthly, and lastly, that the coffee so impregnated with sea-water is, in consequence of its whole chemical constitution being changed, totally unfit for the purposes for which coffee is generally employed: in other words, it is unwholesome.

SECTION XI.

TEA AND ITS ADULTERATIONS.

Tea, like coffee, is continually subject to adulteration, and up to the present time, little has been done with the view of detecting any admixture.

In general, the adulterations of tea have been discovered by finding on the premises of the vendor many leaves common to this country, either in the fresh state, in a state of manufacture, or finished and ready for sale. In other cases, it has been proved by such evidence as the above, that tea-leaves which have been once used, have been collected and prepared for sale. No attempt, however, as before stated, has been made to experimentally prove such adulteration.

With the view of solving this question, the author has made many experiments, and has fortunately been to a certain extent successful; that is to say, he can determine whether tea is genuine or not, and in certain cases can detect the adulteration as to the substance, provided it be one in ordinary use. Unfortunately, however, the means are not such that any person (as in the case of coffee) may undertake the examination, as a certain amount of skill in chemical manipulation is necessary to completely determine whether a tea be adulterated or not; yet some experiments that may be performed with ease, will give a tolerable idea of the genuineness of any particular sample.

As in the case of coffee, it will be necessary to chemically examine a few varieties of tea, together with the substances generally employed in the adulteration.

In this section the author will avail himself of many experiments on the proximate constitution of tea, as adduced by Peligot:[*] in addition to which he will add many more made by himself, not only on tea, but on its adulterating substances, with the view of ascertaining if any difference in composition could really be detected; and will, he thinks, be enabled to prove that such marked differences do exist, that the addition of any substance, usually employed for such purpose, can be detected.

The substances generally employed in the adulteteration of tea, are the leaves of the elder, hawthorn and sloe, together with exhausted tea-leaves, rerolled, dyed, and dried.

Besides these, powdered talc, plaster of Paris,

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[*] Annales de Chemie, 1844.

indigo, Prussian blue, chromate of lead, and occasionally carbonate of copper are employed for the purpose of colouring and blooming green teas. That most of the above substances are employed is very clear, from the fact that many cases have been very lately recorded in the public papers, in which parties have been detected in adulterating with the leaves already mentioned; and it has been proved by analysis that chromate of lead, copper, and Prussian blue have been here present: and the author has been assured by a friend, who was many years in China, that in finishing some of the green teas, finely powdered indigo and talc are used.

The various samples of tea were examined in the following manner:—

The tea was dried in a water-bath until it ceased to lose weight: 100 grs. of tea so dried were boiled with repeated quantities of water, until the latter ceased to be coloured, or possess taste. The undissolved matter was then dried at 212°, and weighed: it represented the per centage contained in tea of matter insoluble in water.

It was then burnt with soda lime, and the amount of nitrogen determined as platinum, or by the author's modification of Peligot's method.

The amount of matter soluble in water was determined by the loss of weight in the 100 grains of tea originally employed, and controlled by evaporating the liquid to dryness in a water-bath. The weight thus obtained ought to correspond with that furnished by calculation.

The solid matter obtained in the last operation was burnt with soda lime, and its contents in nitrogen determined.

The nitrogen in a given weight of the tea dried at 212° was then determined: it ought to correspond to the sum of the two previous determinations.

One hundred grains of tea dried at 212° were incinerated in a platinum crucible, and the weight of ash obtained carefully noted.

The amount of theine in the tea was ascertained (that is to say, the comparative amount in many samples, not the whole quantity) by completely exhausting 100 grains (dried at 212°) with water. This solution, whilst warm, had a slight excess of diacetate of lead added to it, then a little ammonia, and the whole was boiled for a few minutes; then filtered, and a stream of sulphuretted hydrogen passed in until in excess: the solution was again filtered, and evaporated at a gentle heat to a syrupy consistence: when nearly pure theine was deposited on cooling. The mother liquor furnished yet another quantity on further evaporation and cooling. The theine so obtained was dried between folds of fine blotting paper, exposed to a heat of 212°, and then weighed.

The above process is essentially Peligot's, who further determines the amount of theine yet remaining in the mother liquor by means of a standard solution of tannin. This process is not at all necessary in this method of investigation.

The author has occasionally determined the amount of water, tea in its commercial state contains, and finds it to vary from 7 to 11 per cent; he does not believe genuine teas contain more than the latter quantity. This determination, however, answers no useful end in detecting the ordinary adulterations.

EXAMINATION OF BLACK TEAS.

Congou dried at 212°.

Matter soluble in water . .	29·869
Matter insoluble in water .	70·131
	100·000

Theine per cent .	2·79
Ash per cent . .	5·89
Nitrogen per cent .	5·942

Nitrogen in the matter insoluble in water of 100 grains of tea 3·213. The soluble matter, therfore, in 100 grs. of Congou contains 2·729 grs. of nitrogen.

Souchong dried at 212°.

Matter soluble in water . .	32·642
Matter insoluble in water .	67·358
	100·000

Theine per cent .	2·92
Ash per cent . .	5·125
Nitrogen per cent .	6·01

The insoluble matter from 100 grains of tea contains 3·318 grains, and the soluble 2·692 grains of nitrogen.

Pekoe dried at 212°.

Matter soluble in water . .	31.412
Matter insoluble in water .	68·588
	100·000

Theine per cent .	3·02
Ash per cent . .	5·24
Nitrogen per cent .	5·912

The insoluble matter from 100 grains of tea contains 3·149 grains, and soluble 2·763 grains of nitrogen.

A mixed Black Tea (*Congou and Souchong, the former common*) *dried at* 212°.

Matter soluble in water . .	29·88
Matter insoluble in water . .	70·12
	100·00

Theine per cent .	2·74
Ash per cent . .	5·00
Nitrogen per cent .	5·764

Nitrogen in matter insoluble in water 3·089 grains, and in matter soluble 2·675 grains.

Average of matter soluble in water of the four samples of black tea 30·95 per cent.

Average of matter insoluble in water 69·05 per cent.

Average of theine 2·867 per cent.

Average of ash 5.313 per cent.

Average of nitrogen 5·907 per cent.

Average of nitrogen in soluble matter from 100 grains of tea 2·715 grains.

Average of nitrogen in insoluble matter from 100 grains of tea 3·192 grains.

EXAMINATION OF GREEN TEAS.

Imperial dried at 212°.

Matter soluble in water . .	34·304
Matter insoluble in water .	65·696
	100·000

Theine per cent .	3·68
Ash per cent . .	4·896
Nitrogen per cent .	4·69

Nitrogen in matter insoluble in water 3·1906 grains, and in matter soluble 1·4994 grains.

Hyson dried at 212°.

Matter soluble in water . .	35·787
Matter insoluble in water .	64·213
	100·000

Theine per cent .	3·497
Ash per cent . .	5·264
Nitrogen per cent .	5·7977

Nitrogen in matter insoluble in water 3·4621 grains, and in soluble matter 2·3356 grains.

Young Hyson dried at 212°.

Matter soluble in water . .	34·789
Matter insoluble in water .	65·211
	100·000

Theine per cent .	3·614
Ash per cent . .	5·384
Nitrogen per cent .	5·984

Nitrogen in matter insoluble in water 3·521 grains, and insoluble matter 2·463 grains.

Gunpowder dried at 212°.

Matter soluble in water . .	35·842
Matter insoluble in water .	64·158
	100·000

Theine per cent .	3·804
Ash per cent . .	3·412
Nitrogen per cent .	5·714

Nitrogen in matter insoluble in water 3·214 grains, and insoluble matter 2·500 grains.

A mixed Green Tea dried at 212°.

Matter soluble in water . .	34·104
Matter insoluble in water .	65·896
	100·000

Theine per cent .	2·911
Ash per cent . .	5·199
Nitrogen per cent .	5·928

Nitrogen in matter insoluble in water 3·428 grains, and in soluble matter 2·500 grains.

As Imperial differs considerably from any other kind of tea, not only in its amount of ash and nitrogen, as well as in its appearance (which is very characteristic), I shall not include it in the following averages.

Average of matter soluble in water of four samples of green tea 35·133 per cent.

Average of matter insoluble in water 64·867 per cent.

Average of theine 3·7165 per cent.

Average of ash 5·3148 per cent.

Average of nitrogen 5·8559 per cent.

Average of nitrogen in soluble matter from 100 grains of tea 2·44965 grains.

Average of nitrogen in insoluble matter from 100 grains of tea 3·40625 grains.

From the foregone analyses, it will be seen that the results afforded by the different samples come very close to each other for each kind. We are, therefore, tolerably safe in assuming the average of the numbers for each class as the standard of comparison for that class.

Peligot, in his analyses, gives different numbers for the amount of soluble and insoluble matters contained in various kinds of tea, he invariably making the soluble matter higher than the author has done. He is, however, completely certain of the accuracy of the experiments in his particular samples, as the numbers given are those determined by many analyses.

The amount of nitrogen, theine, and ash, correspond tolerably well with those obtained by Peligot.

Behaviour of an infusion of Tea with reagents.—The infusion, whether made from black or green tea, behaves very nearly in the same manner under like treatment. In colour it is from yellowish to deep-brown, according to the class of tea it is prepared with.

Infusion *slightly acid* to litmus paper.

Chloride of Tin.—Copious yellowish-white precipitate.

Nitrate of Silver.—After some time, an olive-green coloration.

Chloride of Gold.—Becomes immediately purple, and rapidly darkens until the tint is of considerable intensity.

Sulphate of Copper.—When an infusion of tea is heated with sulphate of copper, it becomes green, and lets fall a darkish looking precipitate. If an excess of caustic soda be now added, a copious olive-greenish precipitate is formed, which, upon being heated to ebullition, becomes blackish-brown if there be a considerable excess of oxide of copper, but reddish-brown if only a small quantity be present.

If an excess of acetic acid be now added, the blackness or brownness will disappear, and a yellowish-red or orange residue of hydrated suboxide of copper left. The solution above it will have a yellowish-brown tint, very like a solution of perchloride of iron.

If to the clear solution (which contains a considerable quantity of copper), caustic soda be added in excess, the liquid remains brown, but contains a precipitate, which, if separated by filtration, allows a brown liquid to pass through, while a brownish precipitate remains on the filter. If the brown solution be neutralized with acetic acid, and acetate of lead added, no precipitate is formed.

If tea-leaves be placed in a solution of caustic soda, sp. gr. 1018, a dark-brown coloration is immediately produced; on boiling, the liquid becomes much darker, and the leaves assume a semi-transparent appearance, and appear delicately thin and of a fine amber-brown colour, which does not change until a considerable time has elapsed, when they are exposed to the air, still moist with the caustic alkali.

EXAMINATION OF THE VEGETABLE SUBSTANCES USED IN THE ADULTERATION OF TEA.

Sloe Leaves dried at 212°.

Matter soluble in water . .	36·667
Matter insoluble in water .	63·333
	100·000

Ash per cent . .	7·842
Nitrogen per cent .	2·7956

Nitrogen in matter insoluble in water 2·3132 grains, and in soluble matter ·4824 grains.

Behaviour of an infusion of Sloe-leaves with reagents.

Infusion *slightly alkaline* to reddened litmus paper. This is only decidedly shewn when the paper is allowed to remain in the infusion a considerable time.

Chloride of Tin.—A slight turbidity.

Nitrate of Silver.—A slight turbidity.

Chloride of Gold.—Same behaviour as with tea infusion, but action not so rapid.

Sulphate of Copper.—An infusion of sloe-leaves heated with sulphate of copper, becomes green, and lets fall an insignificant light-coloured deposit. The addition of excess of caustic soda, produces a very bright, grass-green precipitate, which, when heated, becomes black. If excess of acetic acid be now added, a bright grass-green solution is formed; and, after a time, a small quantity of a greyish-black precipitate falls. If to the bright solution an excess of caustic soda be added, a bright blue precipitate falls, and on filtering a colourless liquid passes through. If this liquid be neutralized with acetic acid, and acetate of lead added, a precipitate falls.

Sloe-leaves, heated in a solution of caustic soda, sp. gr. 1018, colour the liquid deeply, and assume a green colour, but covered with black spots: when the liquid boils, it has a very deep colour, almost purple, but the leaves appear a dark-green, with a tinge of brown.

When exposed to the action of the air, yet moistened with the alkaline solution, the leaves become a deep reddish-brown.

Hawthorn Leaves dried at 212°.

Matter soluble in water	47·981
Matter insoluble in water	52·019
	100·000

Ash per cent	7·5
Nitrogen per cent	1·5433

Nitrogen in matter insoluble in water 1·0612 grains, in soluble matter ·4821 grains.

Behaviour of Infusion of Hawthorn Leaves with reagents.—Infusion *slightly alkaline* to reddened litmus paper.

Chloride of Tin, Nitrate of Silver, and Chloride of Gold behave as with infusion of sloe-leaf.

Sulphate of Copper.—A decoction of hawthorn-leaves, when treated with sulphate of copper, becomes brownish-green, with the formation of a dark coloured precipitate. If excess of caustic soda be now added, a bright grass-green precipitate falls, which, when heated, becomes black if a large quantity of oxide of copper be present: if not, it assumes a dark olive-green appearance.

On the addition of excess of acetic acid, a green coloration ensues, together with a dirty orange-coloured residuum.

If an excess of potash be now added to the bright solution, a blue precipitate falls, which, when thrown on a filter, allows a colourless liquid to pass through. This liquid, when treated with acetic acid and acetate of lead, behaves as that produced under the same circumstances with sloe-leaves.

Hawthorn leaves, treated with caustic soda, sp. gr. 1018, become in parts green, in others dark marks of a reticulated form appear; some of them, indeed, are spots like those produced in the sloe-leaf, when treated in the same manner, but the greater part are reticulated. On boiling, the behaviour is the same as that of the sloe-leaf. When the moistened alkaline leaf is exposed to the action of the atmosphere, it becomes a very dark brown, approaching black, when viewed by reflected light; by transmitted light, a very deep rich brown, much richer than that of the sloe-leaf.

Elder Leaves dried at 212°.

Matter soluble in water . .	59·874
Matter insoluble in water .	40·126
	100·000

Ash 11·25 per cent.

Nitrogen 3·822 per cent.

Nitrogen in matter insoluble in water 2·486 grains, in soluble matter 1·336 grains.

Behaviour of Infusion of Elder Leaves with reagents.—With reddened litmus paper as those with sloe and hawthorn.

Chloride of Tin.—A copious bright yellowish precipitate.

Nitrate of Silver and Chloride of Gold.—As with sloe and hawthorn.

Sulphate of Copper.—An infusion of elder leaves, when heated with sulphate of copper, becomes bright green, and deposits no precipitate: on addition of excess of caustic soda, a deep green precipitate is formed, which becomes black on boiling. If excess of acetic acid is now added, a bright green solution is formed, which deposits a yellowish-brown precipitate, small in quantity. If the solution have now added to it excess of caustic soda, a bright pea-green precipitate forms: and if the whole be thrown on a filter, a colourless liquid passes through, which behaves with acetic acid and acetate of lead as does that produced by the like treatment of sloe and hawthorn leaves.

Elder leaves, when heated with caustic soda, sp. gr. 1018, colour the liquid slightly, and become a fine green colour: when the liquid boils, its tint is still light, and the leaves retain their fine green colour. On exposure to the atmosphere, moistened with alkali, even after a length of time, their green appearance suffers no change.

Neither elder, hawthorn, nor sloe-leaves, when treated as tea for theine, furnish any crystallizable matter; that is, when 100 grains are operated on.

Behaviour of an Infusion of Tea and Sloe-leaf with Sulphate of Copper.—This infusion, when heated with sulphate of copper, deposits a slight very light-coloured deposit. On being boiled with excess of caustic soda, and then excess of acetic acid added, a light brownish-green precipitate falls, leaving a bright-green solution, which, with excess of caustic soda, gives a bright-green precipitate; the whole thrown on a filter, a brownish-green liquid passes through.

Behaviour of an Infusion of Tea and Hawthorn Leaf with Sulphate of Copper.—When heated with sulphate of copper, this infusion deposits a copious chocolate-brown substance. On the addition of caustic soda in excess, a darkish-green precipitate falls, which boiled, and acted on by excess of acetic acid, gives a brownish-green solution, and a light brownish-yellow residue.

If an excess of caustic soda be now added to the clear solution, and the whole thrown on a filter, a brightish-green precipitate, having a shade of brown, remains on the filter, and a brownish liquid passes through.

Behaviour of an Infusion of Tea and Elder Leaves with Sulphate of Copper.—This infusion, heated with sulphate of copper, gives a very slight brown deposit. On the addition of excess of caustic soda, ebullition, and excess of acetic acid, a light brownish-green precipitate forms, and a dark-green solution, which, when treated with excess of caustic soda, furnishes a dark greenish-brown precipitate, and a greenish-brown liquid.

Mixtures of infusions of tea with sloe and hawthorn, sloe and elder, and sloe, hawthorn and elder, behave in much the same manner as already described. Whenever sloe-leaf is present, the liquid, after treatment with excess of acetic acid, always possesses a very bright green colour, as does the precipitate produced in this solution by excess of caustic soda. Indeed, when only a very small quantity of sloe-leaf is present, this green colour predominates.

The presence of hawthorn leaf can be tolerably well determined by the copious chocolate-brown precipitate, which forms when the infusion that leaf mixed with tea occasions, on being gently heated with sulphate of copper.

The presence of elder leaf can be readily distinguished by heating the suspected tea with caustic soda, sp. gr. 1018, when, if present, it will assume its characteristic green colour, which does not change on exposure to the atmosphere.

In this way, also, hawthorn can be detected.

Whenever tea is adulterated with either of the three leaves already mentioned, the residual brownish-green liquid from the action of sulphate of copper, caustic soda and acetic acid, when treated with excess of acetic acid and acetate of lead, gives a precipitate.

The following is the general method of examination I would recommend:—

Dry the tea at 212°, and exhaust 100 grains with water: note the amount of insoluble and soluble matter, and determine the amount of nitrogen in the tea, and in its soluble and insoluble portions.

Determine the amount of ash and of theine.

Treat a portion of the infusion with sulphate of copper, and notice if any coloured substance separate during the time it is gently heated. If a copious chocolate-brown precipitate separate, hawthorn is present. Add excess of caustic soda, and notice the colour of the precipitate: if it be a very bright green, sloe-leaf is most likely present; and if, on the addition of acetic acid, the solution possesses a very bright grass-green colour, its presence is certain.

If an excess of caustic soda be now added to the solution, and the whole filtered, and the substance on the filter have a green colour, the presence of either elder, hawthorn, or sloe-leaf is certain.

If the liquid passing through is brownish, the sample contains some genuine tea. In case this brownish liquid, on the addition of acetic acid and acetate of lead, furnish no precipitate, the sample is genuine: if a precipitate forms, it is adulterated.

A sample of the tea is heated with caustic soda, sp. gr. 1018, and attention paid to the appearance offered by the leaves during the process;—if bright-green leaves appear, which on exposure, keep their green colour, elder leaves are present. This can be verified by the large amount of ash, tea adulterated with elder leaves yields, and the comparatively small quantity of nitrogen in its soluble parts.

If any of the leaves appear spotted with dark marks of a circular form, sloe-leaf is present; and, if the marks are reticulated, hawthorn is present. The presence of the latter can be very readily determined, as the hawthorn leaf, when moistened with alkali, and exposed to the air, becomes nearly black.

The presence of hawthorn and sloe can also be determined by the very small amount of nitrogen in the soluble part, as well as the increased amount of ash.

If the amount of theine obtained be very small, the tea may be suspected; but it is in the amount of nitrogen that I principally depend in this examination.

This determination, aided by the tests I have already described, is quite sufficient to determine the adulteration in a tea, as well as to point out in an approximative manner the quality of the adulteration.

The inorganic adulteration of tea can be determined in the manner I have already pointed out in many sections.

SECTION XII.

ON CHOCOLATE AND ITS ADULTERATIONS.

This delicious article of food is much subject to vexatious adulteration, which is not absolutely injurious to health, but much depreciates, as a nourishing substance, the chocolate so treated. Sometimes, however, the sophistication is dangerous; for it is manufactured from the cocoa-bean, which has been spoilt by sea-water, and hence it is as much altered in its chemical and other characters, as the coffee-bean is under the same circumstances. Besides the above addition, chocolate is adulterated with flour, potato-starch and sugar, together with cocoa-nut oil, lard, or even tallow. Even the so-called finest chocolate is made up with clarified mutton-suet and common sugar, together with ordinary cocoa.

If in breaking chocolate, it is gravelly;—if it melt in the mouth without leaving a cool refreshing taste;—if it, on the addition of hot water, becomes thick and pasty; and, lastly, if it form a gelatinous mass on cooling—it is adulterated with starch and such like substances.

When earthy and other solid substances are deposited from chocolate mixed with water, either the beans have not been well cleansed, inferior sugar has been employed, or mineral substances have been added to it, either for the purpose of colouring or of increasing its weight.

Moreover, when chocolate has a kind of cheesy taste, animal fat has been added; and when very rancid, either vegetable oil, or even the seeds themselves, have been employed in the sophistication.

If the chocolate be very bitter, the bean has either been burnt in the roasting, or it has been impregnated with sea-water. In either case, the product is unfit for use as an article of food.

The animal substances employed in the making up of chocolate, are some of the ochres, both red and yellow, together with minium (red lead), vermillion, sulphate of lime, chalk, &c. Chocolates, so adulterated, more especially with the preparations of lead, are highly injurious: it is, however, only the inferior chocolates that are thus adulterated.

Dr. Ure states that cocoa-nut shells are also used in the adulteration of chocolate, and remarks that of "cocoa-nut shells 612,122 lbs. were consumed in Ireland, and less than 4,000 lbs. of cocoa.

" How scurvily are the people of Ireland treated by their own grocers! Upwards of 60,000 lbs. of worthless cocoa-husks served out to them, along with only 4,000 lbs, of cocoa-beans!"

Detection of Flour, Starch, &c.—Act upon about half-an-ounce of the suspected chocolate with a tea-cupful or more of hot water. Mix all well together in a mortar, and set aside to cool: when cold, add a few drops of a solution of iodine in water (prepared as described under the article Flour). If starch or flour be present, or ground beans or peas, or any substance containing starch, a blue coloration will occur. This coloration will be intense in proportion to the quantity of starch present. If only a very small quantity of starch be present, it will be advisable to strain the mixture of chocolate and water through a linen cloth, and act on the strained liquid with the solution of iodine. An alcoholic solution of iodine is also suited to this purpose. If the chocolate acted on be pure, only a yellowish-brown coloration will take place.

Detection of Foreign Fatty Matters.—The adulteration by lard, tallow, oils, and suet, are best detected by the taste, after the chocolate has been exposed for some time to the action of the air in a tolerably warm place. In order to effect the desired change rapidly, the chocolate should be scraped very fine, and spread out upon a plate or piece of paper. In a few days, the foreign fatty matters will become rancid, and can then be detected by the peculiarly disagreeable taste and smell, which fatty substances in that condition possess.

Detection of Earthy Matters.—A considerable quantity of the suspected chocolate must be treated with successive portions of hot water as long as anything seems to be dissolved. The best method of operating is as follows :—

The finely scraped chocolate (say a quarter of a pound) is placed in a large vessel, and two or three quarts of warm water poured upon it, and the whole well stirred. After about a quarter of an hour, the supernatant liquid may be poured off, and the residual matter again treated with hot water until nearly tasteless. It is now to be collected and dried.

Chalk.—If a portion, moistened with weak acetic acid, effervesce, chalk is most likely present. This can be satisfactorily proved by filtering the acetic acid solution, and adding solution of oxalate of ammonia : if a white precipitate is produced, chalk is present, as proved by the evolution of carbonic acid, and by the presence of lime.

Sulphate of Lime.—Add a little water to the dry residue, and filter ; to the filtered solution add solution of chloride of barium : a white precipitate, insoluble in dilute nitric acid, indicates the presence of sulphuric acid. To another portion of the solution, add oxalate of ammonia ; a white precipitate indicates the presence of lime. Here sulphate of lime has been added.

Red and Yellow Ochre.—The presence of these substances may be best detected by the colour of the dried residue.

Red Lead, Minium.—A portion of the residue must be boiled with nitric acid, some water added, and the solution filtered. To one portion of the solution thus obtained, add solution of iodide of potassium ; a yellow precipitate will fall. To another portion, add some dilute sulphuric acid; a white precipitate will fall, which, if collected and dried, then mixed with carbonate of soda, and heated on charcoal before the blowpipe, will afford a button of malleable lead.

Vermillion can be detected as in lozenges, to which article the reader is referred for fuller information concerning the method of detecting such metallic substances as are generally employed in the adulteration of articles of food.

SECTION XIII.

ON SUGAR AND ITS ADULTERATIONS.

This article, perhaps, more than any other, is subject to adulteration. Luckily, however, the substances added to it are generally harmless, merely weakening the article, and imparting no poisonous quality.

Of inorganic substances, sand, chalk, plaster of Paris, and pipeclay, are employed; of organic, potato-starch and flour; and, lastly, a comparatively new substance, viz., potato or starch sugar, which is made by boiling potato-starch for many hours with dilute sulphuric acid, neutralizing the excess of acid by chalk, and evaporating the clear liquid to a certain specific gravity, at which point it solidifies into a mass of crystals, which are drained, and are then fit for adulterating sugar, or adding to the sweetness and strength of wine and beer, and also for falsifying honey.

The addition of this substance to ordinary or cane sugar, has the effect of rendering the sweetening power of the latter much less considerable; for cane sugar possesses a sweetening power twice and a half as strong as that of potato-sugar. Hence a very much larger quantity of sugar thus adulterated must be employed to produce a given effect, and hence sugar in this condition is much more expensive in use than pure cane sugar. It must have been noticed by every one that, within these last few years, many sugars, in which neither sand or other inorganic insoluble matter was present, possessed scarcely any sweetening power. This is owing to the introduction of potato-sugar, which is dependent on the cheap rate at which by improved processes it can be manufactured.

Sand, chalk, plaster of Paris, and pipeclay, can be detected by dissolving the suspected sugar in water, and proceeding as in the case of lozenges. Starch, &c. can also be detected by the aid of iodine, as described under the same head. As for starch-sugar, other and more delicate means must be adopted; and so important do I consider this part of my subject, that I shall give the whole of the processes with which I am acquainted, so that by either one or the other, the adulteration may certainly be detected. I am also happy in being able to bring before my readers a process, by means of which they with a little skill, induced by practice, may be enabled not only to detect the presence of starch-sugar, but also to estimate its quantity, as well as that of the genuine cane-sugar present.

Detection of Starch-sugar (*synonimes; Grape-sugar, Glucose*).—The following process is that adopted by M. Pensier, who was led to it by some remarks of Professor Liebig, in his Treatise on Chemistry. M. Pensier tried the action of sulphuric acid and caustic potash on cane and starch sugar. Very decided results were obtained, which made him undertake some comparative experiments, the result of which gave him a complete confidence in the new reagent. He observed that cane-sugar, and even molasses, when boiled with a solution of potash, gave a liquid which had merely a brownish colour; whilst, under the same circumstances, the smallest quantities of grape (potato) sugar gave a very decided black tint.

It is easy, therefore, by this mode of analysis, to ascertain in a decided manner the admixture of potato with cane-sugar.

M. Lassaigne has also made many experiments on this subject. His experiments, made with weak solutions of ordinary sugar and starch-sugar, have shown that a solution of sulphate of copper, and a solution of caustic potash, can indicate very sensibly the $\frac{1}{1000}$th part of starch-sugar in distilled water, by the formation, after a few minutes' ebullition, of a yellow precipitate of hydrated suboxide of copper. By the employment of a concentrated solution of potash, added to a solution of starch-sugar, containing $\frac{1}{1000}$th, $\frac{1}{2000}$th, $\frac{1}{3000}$th, $\frac{1}{4000}$th, $\frac{1}{5000}$th, and even $\frac{1}{10000}$th, a sensible yellow coloration ensued on two minutes' ebullition; but when the proportion of sugar is $\frac{1}{15000}$th, the coloration is not perceptible.

Dr. Ure* says "Good muscovado sugar, from Jamaica, fuses only when heated to 280°; but it turns immediately dark brown, from the disengagement of some of its carbon at that temperature, and becomes, in fact, the substance called 'caramel' by the French, which is used for colouring brandies, white wines, and liqueurs. Grape-sugar, when heated to 270°, boils briskly, gives off one-tenth of its weight of water, and concretes on cooling into a bright-yellow, brittle, but very deliquescent mass, like barley-sugar." Thus we see that starch or grape-sugar is well distinguished from cane-sugar by its unalterability at a pretty high temperature.

Dr. Ure, in speaking of an inquiry by Tromner on the same subject, says, "I have repeated his experiments, and find them to give correct results when modified in a certain way. His general plan is to expose the hydrated oxide of copper to the action of solution of grape or cane-sugar. He first renders the solution alkaline, then adds solution of sulphate

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* Supplement to Dictionary of Arts and Manufactures.

of copper to it, and either heats the mixture, or leaves it for some time in the cold. By pursuing his directions, I encountered contradictory results, but by the following method, I have ensured uniform success :—

" I dissolve a weighed portion of sulphate of copper in a measured quantity of water, and make the solution faintly alkaline, as tested with turmeric-paper, by the addition of potash lye in the cold, for if the mixture be hot, a portion of the disengaged green hydrate of copper is converted into black oxide ; this mixture being always agitated before applying it from the test liquor. The solution is applied as directed by Dr. Ure, thus :—The liquid containing the sugar is boiled, and the test-liquor, containing a known quantity of sulphate of copper, is gradually added, drop by drop, till the whole assumes a greenish tint, and continue the heat until the colour becomes bright-orange. Should it remain green, it is a proof that more hydrate of copper has been introduced than has been equivalent to the de-oxidizing power of the starch-sugar. I have found that one grain of sulphate of copper in solution, supersaturated very slightly by potash, is decomposed with the production of orange protoxide (hydrated suboxide), or, more exactly, 30 parts of the same sulphate, in the state of an alkaline hydrate of copper, pass altogether into the state of orange oxide by means of 100 parts of granular starch-sugar.

The following method of determining amounts of sugar was contrived by M. Peligot, and deserves the greatest attention, as it is by far the simplest plan yet imagined; for not only can the per centage of cane-sugar be ascertained, but if it be mixed with starch or potato-sugar, the per centages of both can be determined.

M. Peligot says, " The method which I am about to describe is based on well-known chemical properties and reactions. It is applicable to the sugars reduced to a solid state, such as the raw sugars, and likewise to saccharine fluids of whatever kind and origin. It requires no other instruments and reagents than those commonly met with in all manufactories; no other manipulations than those requisite for an alkalimetric test; an operation familiar to most persons engaged in chemical pursuits. It is founded on the essentially distinct action which the alkalies exert on the two kinds of sugar, the ordinary sugar (cane or beet-root sugar), and glucose (starch or grape-sugar).

" Ordinary sugar combines with the alkalies, and forms with bases compounds in definite proportions, from which the sugar may be re-obtained without its having undergone the least alteration. Glucose (starch-sugar) likewise combines with the alkalies, but it yields compounds, the existence of which is of so short duration, that it is impossible to preserve them unaltered more than a few instants. In fact, if a solution of glucose and potash be left to itself at the ordinary temperature, the quantity of free potash contained in the liquid is found to decrease every day, and finally disappears entirely when an excess of glucose is employed. In fact, the glucose is converted into one or several acids, which colour the liquid brown, and form with the potash neutral salts.

" The action which the alkalies exert on glucose is instantaneous, when the solution of these bodies is heated to boiling; in a few minutes the conversion of the glucose into the above acids is complete.

" The alkali which I employ for these experiments is lime. It is well known that pure water does not dissolve more than one thousandth of its weight of lime, while sugar-water dissolves a considerable quantity, proportioned to the weight of sugar it contains. The compound which is formed when a solution of ordinary sugar is brought in contact with an excess of slaked lime, has been pointed out by M. Soubeiran. It consists of 4,275 parts by weight of sugar, and 1,050 parts by weight of lime.

" In examining a raw sugar, 10 grammes of the sample are weighed off, and dissolved in 75 cubic centimetres of water. To this solution, which is made in a glass or porcelain mortar, 10 grammes of slaked and sifted lime are added. The whole is well triturated from eight to ten minutes, and the mixture brought on a filter to separate the undissolved lime; an excess of this base having been employed. It is well to return the liquor which has passed through, a second time to the filter, in order to dissolve rapidly the whole of the lime which the sugar is capable of combining with.

"Ten cubic centimetres of the solution of saccharate of lime are now taken with a graduated pipette, diluted with two or three decilitres of water, and to this liquid a few drops of blue tincture of litmus are added; upon which it is accurately saturated with a solution of sulphuric acid of a known strength. This test-liquor contains in the litre 21 grammes of pure hydrated sulphuric acid. A litre of this liquor saturates the quantity of lime which is dissolved by 50 grammes of sugar.

"The normal solution of sulphuric acid is first conveyed into the burette used for alkalimetric purposes, or into a burette graduated into cubic centimetres, each of which is divided into ten parts. The burette is filled up to zero, and the acid liquid poured into the alkaline solution, constantly stirring, until the blue tint becomes reddish from the last drops of test-liquor. On reading off the divisions on the burette of the quantity of normal acid required to attain this point of saturation, we have the quantity of lime, and consequently of sugar, contained in the solution of saccharate of lime.

"For the ordinary raw sugars this suffices. I have found, indeed, that the proportion of glucose which they contain, is too small to be appreciated by the second operation, which I shall presently describe; but it has sometimes happened, that granulated glucose has been fraudulently introduced into the raw sugars previous to their refinement. To detect this fraud, and also to analyse the molasses and commercial sugars of inferior quality, which contain variable proportions of glucose, resulting from the partial alteration of the ordinary sugars, consequent upon the processes employed in extracting or refining it—to analyse a product containing ordinary sugar and glucose—we proceed at first as above described for raw sugars. After the first assay, a portion of the alkaline liquid is poured into a flask or vial, which is heated in a water-bath to 212° for a few minutes. If the liquid contains only saccharate of lime produced by ordinary sugar, it is rendered turbid by heat, owing to a very curious property this compound possesses, of coagulating in the same way as albumen of egg when heated to 212°. But this turbidity disappears on the cooling of the liquid, and the latter does not acquire a deeper tint than it possessed previous to its being heated; on submitting it to a second alkalimetrical assay, after it has cooled, the quantities are found to be the same as before.

"But if the saccharine products contain glucose, the solution heated in the water-bath acquires a brown tint; it yields a brown deposit, which does not disappear on cooling: when the glucose is in large proportion, it gives off a decided odour of burnt sugar; lastly, the second alkalimetric assay shews a less quantity of lime than the first. This quantity belongs wholly to the ordinary sugars, the lime dissolved by the glucose in the cold having yielded neutral salts, on which the normal solution of sulphuric acid has no action.

"In case the specimen examined consisted entirely of glucose, the first alkalimetric assay after the saccharine liquor had been triturated in the cold with the lime, would indicate very nearly the same amount of alkalinity as with ordinary sugar: the second assay, made on a portion of the liquid heated to 212°, would indicate the same quantity of lime as that which would have been dissolved by an equal quantity of pure water.

"This quantity is very small; a decilitre saturates four cubic centimetres of the normal acid. Although the liquid is then coloured brown, its point of saturation is readily determined by taking care to add a little more tincture of litmus, and to stop the moment the solution, which becomes greenish, assumes a lighter tint by the addition of sulphuric acid.

"The examination of saccharine liquids is effected in the manner above described; the only precaution necessary is to operate on liquors indicating from 6° to 8° on Beaume's areometer. The juices of beet-root, and of the sugar-cane occur naturally of this density. On employing more dilute solutions, there is great risk of not dissolving rapidly the whole of the lime they are capable of taking up: if they are more concentrated, they do not filter quickly. The quantity of slaked lime to be employed for these liquids should be such that its weight is nearly equal to that of the sugar presumed to exist in the product to be examined. This quantity is indicated approximatively by the specific gravity of the liquid."

I have thought it better to give the whole of Peligot's process, even with the French weights and measures, because their use in England is becoming more general; but for such as cannot employ them, I subjoin the process modified, so as to be readily performed by any one with a moderate share of skill and patience.

It will be found by calculation, that 24·56 parts of lime combine with 100 parts of pure sugar; therefore, the quantity of sulphuric acid which will neutralize 24·56 parts of lime, is also equal to and represents 100 parts of pure sugar. The preparation of a test-acid to determine the amount of lime present is very simple. Take any quantity of strong sulphuric acid, dilute it with about four times its weight of water; allow the whole to cool, and filter if necessary. When cold, partially fill a Schuster's alkalimeter with the acid liquid, and weigh it: having noted the weight, take 100 grains of white barley-sugar, dried at 212° in a water-bath, and dissolve them in about two fluid ounces of water; then mix the solution with 100 grs. of recently slaked quicklime, and filter, returning the filtered liquid as described in Peligot's paper. When the whole of the liquid is bright, make it up to about a quarter of a pint with water, and add a few drops of tincture of litmus, and the fluid is ready for the second operation. Now add the test-acid from the alkalimeter, drop by drop (agitating the liquid after the addition of each drop), until the blue of the litmus has changed to a decided red, at which time the whole of the lime is neutralized. The alkalimeter is now to be weighed, and the loss of weight indicates the amount of dilute sulphuric acid, which is equivalent to 100 grains of pure cane-sugar.

This point fixed, it is of course very easy to calculate the amount of sugar corresponding to any other quantity of the dilute acid. This will be readily seen by an example.

Suppose that 200 grains of dilute acid were found to exactly neutralize the lime combined with 100 grains of pure sugar, and that a sample of raw sugar was to be examined as to its per centage in sugar; it would be dissolved in water, mixed with its own weight of lime and filtered, a few drops of tincture of litmus would be added, and then acid from the weighed alkalimeter, until the blue of the litmus became red. The alkalimeter would then be weighed, and we will suppose it to have lost 140 grains; now, as 200 grains of acid correspond to 100 of sugar, we shall find that 140 grains of acid correspond to 70 of sugar, the richness therefore of the sugar examined is 70 per cent.

In order now to ascertain whether the sugar in question contains starch-sugar, and if so, its quantity, the following operations are necessary.

Another 100 grains of sugar are dissolved, treated with lime, and filtered as before, the whole of the solution is heated in a water-bath to 212°. If, during this operation, it turns brown, the presence of starch-sugar is certain. It must now be allowed to cool, a little tincture of litmus added, and then acid from a weighed alkalimeter, the amount of acid is now to be noted, we will suppose it to be 100 grains. Now 100 grains are equal to 50 grains of sugar, therefore as 70 grains were found before heating in the water-bath, and only 50 grains afterwards, it must be concluded that the whole saccharine per centage of the sample is 70, but that the saccharine per centage of cane-sugar is only 50, it has therefore been adulterated with about 20 per cent. of starch-sugar.

SECTION XIV.

HONEY AND ITS ADULTERATIONS.

This substance is very often adulterated with potato starch, flour of wheat, and bean flour, the latter, however, is seldom employed on account of its taste; these substances, of organic origin, are employed to give brown honeys a certain degree of whiteness, and to add to their weight. Bodies of inorganic origin are also employed for both these purposes, and chalk and plaster of Paris are generally used, as is also pipe-clay.

Starch-syrup and starch-sugar are also used in bringing down the standard of honey; and, lastly, cane-sugar of various kinds of pureness is admixed with the substance in question.

To detect potato starch, and matters of that class, some of the honey is boiled in water, and the cold solution tested with iodine.

Chalk, plaster of Paris and pipe-clay may be shewn to be present by mixing the honey with a large quantity of water, as in the case of the detection of those substances in lozenges, and the following operations are carried on as described under that head.

SECTION XV.

ON LOZENGES AND THEIR ADULTERATIONS.

There are few substances so subject to adulteration as lozenges and similar preparations consumed by children: not only are substances added to them which are cheaper than the sugar in their composition, but others, also, of a very deleterious character, as preparations of lead, arsenic, copper, &c., for the purpose of colouring.

The substances employed in the adulteration in bulk, are chalk, pipe-clay, plaster of Paris, sand, and starch, all of which bodies can be readily detected, and are very often present in such lozenges as are sold in small quantities; and are, therefore, consumed by children, occasioning severe constipations, and all the diseases arising from such a source, indeed there is little doubt that many children are thus annually sacrificed.

Chalk, its detection.—The suspected lozenges are to be boiled in a considerable quantity of water, and the liquid allowed to clear itself by precipitation; the clear liquid is to be poured off, and reserved for another operation (detection of starch), and the residue placed on a filter, and washed with water. These washings are also to be reserved; for detection of plaster of Paris. The washed matter on the filter is now to be treated with a little dilute hydrochloric acid: if an effervescence take place, carbonate of lime (chalk) is present. This can be further proved by adding to a little of the solution in hydrochloric acid, ammonia in excess, and then a few drops of a solution of oxalate of ammonia, when a white precipitate of oxalate of lime will be produced.

Detection of Starch.—The first liquid which was poured off in the examination for chalk is to be treated with a little solution of iodine in water. If starch be present, a blue coloration will appear, which will be intense in proportion to the amount of starch present.

Plaster of Paris, its detection.—This substance will exist in solution in the washings of the chalk, in the detection of the latter substance. The liquid is to be divided into two portions, one of which is treated with oxalate of ammonia; if a white precipitate or cloudiness ensue, lime is present. The other portion is acted on with a solution of chloride of barium; the formation of a white precipitate or cloudiness, is indicative of sulphuric acid. These two reactions prove the presence of plaster of Paris.

Clay, its detection.—About 200 grains of the suspected lozenges are to be ignited in a platinum or porcelain capsule, until all organic matter is consumed; the remaining ash is to be fused in a platinum capsule (porcelain will not serve this purpose), with twice its weight of carbonate of soda. The fused mass must be dissolved in dilute hydrochloric acid, the solution evaporated to dryness, a few drops of strong hydrochloric acid added, and then water. The whole is thrown on a filter; if a residue remain on the filter, silica (this may also proceed from sand if no clay is present) is present: this indicates the presence of clay. Another operation, however, is necessary to render this certain. An excess of ammonia is to be added to the filtered solution; if a white or even yellowish-looking gelatinous precipitate be produced, alumina, and consequently clay, is present. In this operation, also, the presence of lime may be determined; for if the alumina be separated by filtration from the liquid containing it, and oxalate of ammonia be added to the bright solution, a white precipitate will be formed if lime enters into the constitution of the lozenges.

Sand, its detection.—To determine the presence of this body, it is merely necessary to examine the residue left after the action of hydrochloric acid in the detection of chalk. If this residue be gritty, the presence of sand is undoubtedly proved.

I may here add, that all the cheap lozenges I have examined contain starch, and very nearly all, chalk and plaster of Paris ; only a few contain sand, such being a very palpable adulteration. The quantity of chalk and plaster of Paris varied from 1 to 12 per cent.

I now have to treat of a far more dangerous adulteration : I allude to the colouring matters used in the manufacture of lozenges, &c. ; the papers also in which some of these substances are wrapped, have also a great tendency to communicate a poisonous character, on account of the presence of salts of arsenic, copper, &c.

In addition to my own experiments, I shall give the greater portion of a paper on this subject by Dr. O'Shaughnessy, which appeared in the second volume of the "Lancet," 1830-31 ; and I must also state, that I can fully confirm that gentleman's experiments as to the various substances used in this most infamous manufacture.

Dr. O'Shaughnessy says—" In the following observations, it is my principal aim to lay before the public and the medical profession, a calm, dispassionate statement of the existence of various poisons (gamboge, lead, copper, mercury, and chromate of lead) in several articles of confectionary, the preparation of which, from their peculiar attractions to the younger branches of the community, has grown into a separate and most extensive branch of manufacture. I am fully aware of the hazardous task, that individual undertakes, who ventures in this country to signalize such abuses. The wrath of the particular trade is, of course, especially excited; the sneers and ridicules of the ignorant are also abundantly provoked, principally through the recollection of the indiscreet and mischievous efforts which over-zealous or designing alarmists have occasionally made to terrify the public mind by topics of this description. I hope, however, by a plain narrative of facts, and by reference to justly accredited authorities, to avoid at the same time these unpleasant imputations, and to show the real extent of the danger in question."

It may be as well in this place, to follow the example of Dr. O'Shaughnessy, and give the reader a Report, forwarded by M. Andral to the Prefect of Police; and which led to an Ordonnance of Police, for the suppression of the adulteration in question.

Report addressed by M. Andral to the Prefect of Police, by order of the Council of Public Health, on the dangers which may result from the use of coloured Confectionary.*

" M. le Prefect,—You have instructed the Council

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* Lancet, and "des Falsifications des Substances alimentaires," par Jules Garnier et C. Harel.

of Health to report to you on the danger which may result from the use of coloured confectionary, and on the measures necessary to be adopted to prevent the manufacture and sale of any such pernicious articles.

" The Delegates of the Council have the honour to submit to you the following propositions:—

" Firstly, it will be important to specify in the Ordonnance what colouring matters should be prohibited. These substances are, in the first place, all those derived from the mineral kingdom, excepting the oxides of iron, ferruginous lakes, and Prussian blue, the uses of which are attended with no danger. Of vegetable substances, gamboge should be severely proscribed, as being a drastic cathartic, which, even in minute doses, necessarily occasions violent intestinal irritation. *Litmus* should be equally prohibited, as well on account of its being occasionally incorporated with putrefied urine, as that some manufacturers mix it with common *arsenic*, and the *peroxide of mercury*.

" The most diversified colours can be obtained by the confectioners from totally harmless compounds. Thus, from the lakes of cochineal and carmine, they can prepare all the reds; the lakes of logwood will afford them the violet; the lakes of dyers' broom, &c. will give the yellow; the lake of Persian berries with Prussian blue, form a more beautiful green than any mineral can produce: finally, by mixture of these harmless colours, all the intermediate tints and shades will be obtained.

"Secondly, the papers used for wrapping up sugar-confectionary should also be strictly attended to, since they are coloured with the same poisonous materials; *children will invariably suck or eat these papers,* from which it is evident the most fatal accidents may occur. *A member of the Council of Health, a short time since, snatched a coloured paper of this description from an infant's mouth, and by analysis obtained from it both* ARSENIC *and* COPPER.

"Thirdly, the Delegates of the Council are of opinion, that to ensure the observance of the ordonnance, you should determine, M. le Prefect, that a committee be appointed to visit the workshops of the manufacturers of this species of confectionary; all the poisoned articles should be seized, and their vendors fined.

"Lastly, the Delegates of the Council recommend, as a measure of great utility, that on the day following the seizure, the names of the confectioners should be published in all the journals, and placarded over the walls of the city.

"In conclusion, the Delegates of the Council believe that an ordonnance, founded on the principles thus pointed out, will prove of essential service, by suppressing a practice so pernicious to the public health."

Dr. O'Shaughnessy purchased various lozenges and articles of confectionary, both coloured and colourless, and wrapped in stained papers. I have also purchased such samples at various shops, as have my friends, who have furnished me with them. I have also used Dr. O'Shaughnessy's classification. Of the coloured articles, the greater number (class 1) were sold expressly for eating; some (class 2) were cut into small figures, and intended apparently for ornament, but were sold without restriction; and lastly, some (class 3) were expressly designed for ornament alone. Of the first class, about thirty different kinds were examined:—

Ten Specimens of Red Comfits, &c.

1	Minium, or red oxide of lead.
2	Red sulphuret of mercury (vermillion),
1	Mixture of both the former.
1	Of a yellowish or orange tint, chromate of lead, and a vegetable lake of lime.
2	Cochineal alone.
2	Vegetable lakes of alumina and lime.
10	

In addition to the above samples, I have examined a lozenge of an orange tinge, coloured with chromate of lead and minium (red lead). Dr. O'Shaughnessy states that of the ten specimens he examined, which were expressly designed for eating, six were coloured with mineral poison, and all, with only one exception, were coloured externally.

"Of the *yellows* (class 1), seven specimens of different forms and tints; 4 *gamboge* coloured externally; 1 coloured throughout with a vegetable lake of lime; 1 coloured throughout *oxide of lead,* and traces of antimony or Naples yellow. Six of the seven, consequently, contained deleterious substances."

Of yellows, I have found some coloured with gamboge, others by some vegetable colouring matter, not gamboge, and some coloured both on the surface and throughout by chromate of lead.

"Of the *greens* (class 1), several specimens, all were coloured by Prussian blue and a vegetable yellow lake of alumina, mixed with sulphate of lime, except one specimen, of which I had only two comfits, and which gave me a mixture of copper and lime."

In the greens, I have very often found copper, but in no case have I examined any sample containing Scheele's green, or the arsenite of copper, although many such exist, as is fully proved by a case which a gentleman had the kindness to communicate to me. In this instance four children were the sufferers, the youngest of whom was not expected to survive, but ultimately recovered the effects of the poisonous lozenges eaten. Both the lozenges and the contents of the stomach, which had been ejected, were examined, and each contained copper and arsenic in notable quantities, quite sufficient to account for the illness which had occurred.

" The blues (class 1) were chiefly Prussian blues, and contained no poisonous compound."

In the second class, or those apparently intended for ornament, but sold without restriction, and formed into all sorts of fantastic shapes, of eight forms of yellow, three contained chromate of lead, one Naples yellow, one massicot or yellow lead, and three vegetable lakes of alumina and lime. All these were coloured throughout, and contained, moreover, sugar and plaster of Paris, or sulphate of lime.

The reds in this class were of six specimens; three vegetable lakes of alumina or lime, one chromate of lead, with a red vegetable lake, and two red lead.

The greens and blues were as described in class 1.

In the third class, the composition was precisely the same.

I may mention that a friend brought me, some little time since, a piece of sugar, " rock" (such as is sometimes found in cakes), from a highly respectable confectioner; and, on examination, it was found that the colour was due to the presence of verdigris (acetate of copper), which is an exceedingly poisonous salt. I have also examined the paper in which confectionary, &c. has been wrapped, and found it generally coloured with some very poisonous substance.

Dr. O'Shaughnessy, in speaking of the extent of this most pernicious practice, says—"I will merely remark, that one concern in the City, from which I have obtained the greatest number of poisonous specimens, employs eleven men daily in the preparation of these articles, furnishes immense quantities of them to country confectioners, supplies many of the minor shops in the metropolis, and, if I am rightly informed, exports to our foreign possessions to a considerable amount. Extent of manufacture always implies extent of sale, and in this case, of course, the ratio of the consumption equals both. I cannot, therefore, be accused of exaggeration, when I assert that millions of children are thus daily dosed with metallic and vegetable poisons; in minute quantities, it is true, but in quantities dependent for their amount on the caprice of a workman or a machine, and sufficient in the minutest degree to exercise their peculiar insidious effects, if taken as a practice from day to day. Neither are these effects chronic alone; for, not long since, an acute case of poisoning, arising from the use of confectionary of this description, occurred in the children of a highly respectable family in Southwark; and, on analysis, the comfits were found to contain minium, or red oxide of lead."

I will now proceed to point out the methods to be pursued in detecting any poisonous colouring matter which may exist in confectionary, or in the paper in which it may be wrapped.

General Operations.—If the lozenge be merely superficially coloured, which can be ascertained by its fracture, the colouring matter can be removed for examination by mere washing in water. In case the supernatant liquid should be transparent, and no colouring matter visible at the bottom of the vessel, it may be filtered to render it perfectly bright. If, however, the specimen should be coloured throughout, it must be boiled in water, which dissolves the sugar, and leaves the mineral substance, vegetable lake, &c., which should next be transferred to a watch-glass, or evaporating basin, and dried in a water-bath at 212°.

If the supernatant liquid in either case remain transparent and colourless, it is an indication that the colouring matter is either a mineral substance, or a vegetable lake. In this case the fluid may be rejected, and attention confined to the deposit alone. If again a coloured fluid, and a considerable residuum, it indicates a vegetable colouring extract, and a lake or mineral colour, and both are to become the subject of experiment.

ANALYSIS OF THE YELLOW.

Gamboge.—The yellows, coloured by gamboge externally, when washed as just described with distilled water, form an opaque yellow emulsion, which lets fall no deposit. By evaporating this emulsion to dryness, a little alcohol added to the residuum immediately dissolves the gamboge. The alcoholic solution is then to be transferred to a test-tube, and an equal quantity of distilled water added. The gamboge is by these means precipitated of a lively yellow colour. If a drop or two of strong ammonia be now added, it re-dissolves, producing a blood-red solution, from which it is precipitated pale yellow by nitric acid. This simple series of experiments affords abundant proof of the presence of the substance in question. If the yellow colour was due to saffron, turmeric, or other similar substances, a *solution* and not an *emulsion* would be produced; neither would there be any precipitate produced in the alcoholic solution by the addition of water, nor would there be any precipitate in the ammoniacal solution by means of nitric acid. Two or three small comfits are amply sufficient for the process, which is so delicate as to detect the $\frac{1}{100}$th of a grain of gamboge. The first evaporation may be saved by acting at once on the comfits by alcohol.

If the yellows, when washed with water and the comfits removed, let fall a yellow deposit, and leave the supernatant liquid colourless and transparent, the deposit is either chromate of lead, Naples yellow (oxide of lead and antimony), massicot (yellow oxide of lead), or, finally, a vegetable lake of alumina or lime. In most cases, also, the precipitate contains sulphate of lime.

To ascertain whether it be a mineral or vegetable colour, that is to say, a lake of lime or alumina, a portion of the dry colouring matter must be heated to redness on a plate of mica, or in a small iron spoon. A spirit-lamp is the most convenient source of heat for these experiments. If a vegetable lake of lime or alumina be present, it first chars, blackens, exhales smoke, and then leaves a brilliant white soft earthy mass; a portion of this mass, if lime, stains moistened turmeric paper brown, and reddened litmus paper blue; if alumina, no such effect takes place. If instead of charring and becoming white, other changes ensue, then the colouring matter is entirely mineral, and other means must be taken for its detection.

Chromate of Lead.—A portion of the colouring matter is fused in the iron spoon, with twice its weight of a mixture of nitrate of potash and carbonate of soda, for a few minutes. If on cooling the fused mass gives a yellow solution with water, chromate of lead is the colouring matter. This can be more fully proved by filtering the aqueous solution, and adding to it a few drops of solution of acetate of lead, a bright yellow precipitate of lead will fall, indicating the presence of chromic acid. To the residue of the fused mass, insoluble in water, after having been well washed, add acetic acid; boil and filter; to one portion of the filtered solution add a little solution of iodide of potassium; a yellow precipitate of iodide of lead will fall. To the other portion add some dilute sulphuric acid; a white precipitate of sulphate of lead will fall, which can be collected, and heated on charcoal before the blow-pipe with carbonate of soda, when a bead of metallic lead will be produced.

Naples Yellow (*oxide of lead and antimony.*—The colouring matter is acted on by strong nitric acid, and the whole evaporated to dryness; water is then added. If Naples yellow be present, a white residue of antimonic acid will remain, which is to be collected and dried. If a portion be heated before the blowpipe with carbonate of soda on charcoal, white fumes will be given off, and a bead of metallic antimony produced, which may be distinguished from a bead of lead by it possessing no malleability, but breaking when struck with a hammer. The other portion of antimonic acid is to be placed on a watch-glass or evaporating basin, and heated with a little caustic potash; when dissolved, a few drops of hydrosulphuret of ammonia are to be added, and a drop or two of strong hydrochloric acid, a bright orange-yellow precipitate of sulphuret of antimony will be produced.

The aqueous solution poured off the antimonic acid, is tested for lead as before, by means of iodide of potassium, sulphuric acid, and the blow-pipe.

These tests are conclusive of the presence of Naples yellow.

Massicot (*oxide of lead*).—This substance can be readily detected by merely acting on the colouring matter with acetic acid, and filtering the solution, and treating with iodide of potassium, &c. as before.

ANALYSIS OF THE RED.

The *Red*, on being washed or boiled with water, either form a coloured transparent solution, which affords no deposit; or is coloured, and gives a deposit; or affords a dense deposit, leaving the fluid transparent and colourless.

In the first case, the solution is decolorized by a little chlorine or common bleaching liquid, chloride of lime, or soda. If a second portion be changed to orange-yellow by sulphuric acid, and a third assume a violet with ammonia, and if no black colour is produced by the addition of sulphate of iron, it may be concluded to be a solution of cochineal.

If a deposit take place, which, when dried and heated, blackens and chars, a vegetable lake is present, either of alumina or lime, which can be determined as before; or it may be carmine, which is entirely soluble in ammonia.

If the deposit be bright-red, and subsides rapidly, it may be minium (red lead), or vermillion (sulphuret of mercury), both of which may be readily detected.

Red Lead (*minium*).—May be boiled with acetic acid, and the lead detected as in former instances.

Vermillion.—Boil with a few drops of nitric and hydrochloric acids (aqua regia), dilute the solution with water; add to a portion a small quantity of a dilute solution of iodide of potassium; a bright scarlet precipitate of biniodide of mercury will fall, which can be re-dissolved, forming a colourless solution, by the addition of a further quantity of iodide of potassium. Pour the rest of the solution on a piece of polished copper (a bright penny for instance), when it will be covered with a white metallic film, which is metallic mercury. The copper returns to its original colour when gently heated.

ANALYSIS OF THE BLUE.

Prussian Blue.—On agitation with water, a blue deposit is produced, which, after washing, is boiled with a little red oxide of mercury. The blue colour disappears, and brown-red flocks of peroxide of iron floats on the liquid, which is to be filtered. To the mass on the filter, add hydrochloric acid, and to the solution so obtained a few drops of ferrocyanide of potassium, Prussian blue will be reproduced. In order more fully to prove the presence of Prussian blue, boil the liquid filtered from the oxide of iron and excess of red oxide of mercury with caustic potash, add a small quantity of a solution of per and protoxide of iron, and then a little hydrochloric acid, when Prussian blue will be immediately produced.

Carbonate of Copper.—The deposit produced in this case can be dissolved in a little hydrochloric acid, and the solution treated as in the detection of copper in bread, with ferrocyanide of potassium, caustic ammonia, on a plate of polished iron.

ANALYSIS OF THE GREEN.

If the green be produced by Prussian blue and a vegetable yellow lake, it can be detected as already detailed. If produced by a preparation of copper, that metal can also be detected as above. In the detection, however, of arsenite of copper (Scheele's green), other methods must be employed.

If a portion of the colouring matter be heated on charcoal before the blow-pipe, an odour of *garlic* will be distinctly perceptible. This indicates the presence of arsenic. Or a portion may be mixed with a little charcoal and carbonate of soda, or, better still, a mixture of cyanide of potassium and carbonate of soda, and introduced into a hard glass tube, and the portion of the tube containing the mixture heated to redness; in a few moments, a bright metallic ring will be produced in the cooler part of the tube. This ring is metallic arsenic, and may be driven from one part of the tube to the other by a gentle heat. The copper may be detected by the methods already pointed out.

EXAMINATION OF THE COLOURED PAPERS.

Green; Arsenite of Copper, Scheele's Green.—The presence of arsenic in paper can in general be very readily detected, for any paper containing that substance, when burnt, gives off the garlic odour indicative of that deadly metal. To detect the copper, burn a sheet of the paper, and treat the ash with nitric acid; dilute with water, and filter; divide the filtered solution into two parts, to one of which add excess of ammonia, when the deep blue colour, indicative of copper, will be produced. Evaporate the other portion to dryness, and heat to redness; act upon the residue when cold with hydrochloric acid, dilute with a small quantity of water, and plunge into it a piece of polished iron, which will, after a certain time, be covered with a film of metallic copper. If only very minute traces of copper be present, several hours are necessary to produce the effect.

Yellow and other Papers.—Burn a sheet of the papers, and act on the ash in the same manner as in the deposits obtained by washing or dissolving lozenges, &c., as just described; or the colouring matter may be washed off the specimens of papers, in which case the analytical processes to be followed are just the same.

In conclusion, I may mention that the following colouring matters, which are entirely harmless, can be employed with equal effect.

Blues.—Indigo dissolved in strong sulphuric acid.

Prussian Blue.—These colours mix readily with all others, and can be used for all tints of which blue is a constituent.

Reds.—Cochineal.
Carmine.
Carmine lake.
Brazil-wood lake.

Yellows.—Saffron.
French Berries.
Persian Berries.
Quercitron.
Fustic;

And the aluminous lakes of these substances.

The yellows obtained from many of the above substances, more especially French and Persian berries, are more brilliant than those obtained from chromate of lead, the use of which is so pre-eminently dangerous.

COMPOUND COLOURS.

Green.—This tint can be produced by a mixture of blue and various yellow colours, but the finest is obtained from Prussian blue and Persian berries. It is not at all inferior in brilliancy to Scheele's green, which is a deadly poison.

Violet: Logwood, and Prussian Blue.—By suitable mixtures of these colours, all tints may be obtained.

Purple: Carmine, and Prussian Blue.—It is easy to see from these few examples, that all colours may be prepared from perfectly innocuous substances; and that there is, in reality, no need for the employment of the colouring matters which are now unfortunately so much used.

SECTION XVI.

CHEESE AND ITS ADULTERATIONS.

Mr. Accum states, that "several instances have come under my notice, in which Gloucester cheese has been contaminated with red lead, and has produced serious consequences on being taken into the stomach." In one poisonous sample which it fell to my lot to investigate, the evil had been caused by the sophistication of the annatto employed for colouring cheese. This substance was found to contain a portion of red lead, a method of sophistication which has lately been confirmed by the following fact, communicated to the public by Mr. J. W. Wright, of Cambridge, in the "Repository of Arts":—

"As a striking example of the extent to which adulterated articles of food may be unconsciously diffused, and of the consequent difficulty of detecting the real fabricators of them, it may not be uninteresting to relate to your readers the various steps by which the fraud of a poisonous adulteration of cheese was traced to its source.

" Your readers ought here to be told, that several instances are on record, that Gloucester and other cheeses have been found contaminated with red lead, and that this contamination has produced serious consequences. In the instance now alluded to, and probably in all other cases, the deleterious mixture had been caused ignorantly, by the adulteration of the annatto employed for colouring the cheese. This substance, in the instance I relate, was found to contain a portion of red lead, a species of adulteration, which subsequent experiments have shown to be by no means uncommon. Before I proceed further to trace this fraud to its source, I shall briefly relate the circumstance which gave rise to its detection.

" A gentleman, who had occasion to reside for some time in a city in the West of England, was one night seized with a distressing, but indescribable, pain in the region of the abdomen and of the stomach, accompanied with a feeling of tension, which occasioned much restlessness, anxiety, and repugnance to food. He began to apprehend the access of an inflammatory disorder, but in twenty-four hours the symptoms entirely subsided.

" In four days afterwards, he experienced an attack precisely similar, and he then recollected, that having, on both occasions arrived from the country late in the evening, he had ordered a plate of toasted Gloucester cheese, of which he had partaken heartily, a dish which, when at home, regularly served him for supper. He attributed his illness to the cheese. The circumstance was mentioned to the mistress of the inn, who expressed great surprise, as the cheese in question was not purchased from a country dealer, but from a highly respectable shop in London. He, therefore, ascribed the before-mentioned effects to some peculiarity in his constitution. A few days after, he partook of the same cheese, and he had scarcely retired to rest, when a most violent cholic seized him, which lasted the whole night and part of the ensuing day. The cook was now directed henceforth not to serve up any toasted cheese, and he never again experienced those distressing symptoms.

"Whilst this matter was a subject of conversation in the house, a servant-maid mentioned that a kitten had been violently sick after having eaten the rind cut off from the cheese prepared for the gentleman's supper. The landlady, in consequence of this statement, ordered the cheese to be examined by a chemist in the vicinity, who returned for answer, that the cheese was contaminated with lead! So unexpected an answer arrested general attention, and more particularly as the suspected cheese had been served up for several other customers.

"Application was, therefore, made by the London dealer to the farmer who manufactured the cheese, he declared that he had bought the annatto of a mercantile traveller, who had supplied him and his neighbours for years with that commodity, without giving occasion to a single complaint. On subsequent inquiries through a circuitous channel, unnecessary to be detailed here at length on the part of the manufacturer of the cheese, it was found, that as the supplies of annatto had been defective and of inferior quality, recourse had been had to the expedient of colouring the commodity with vermillion. Even this admixture could not be considered deleterious. But on further application being made to the druggist who sold the article, the answer was, that the vermillion had been mixed with a portion of red lead, as frequently practised, on the supposition that the vermillion would be only used as a pigment for house-painting. Thus the druggist sold his vermillion, in the regular way of trade, adulterated with red lead to increase his profit, without any suspicion of the use to which it would be applied, and the purchaser who adulterated the annatto, presuming that the vermillion was genuine, had no hesitation in heightening the colour of his spurious annatto with so harmless an adjunct. Thus, through the circuitous and diversified operations of commerce, a portion of deadly poison may find admission into the necessaries of life, in a way which can attach no criminality to the parties through whose hands it has successively passed."

I have frequently examined specimens of annatto which have been contaminated with red led, or a mixture of red lead and ochre, so that any cheese, which might have been coloured by such annatto, would be decidedly poisonous. I have only met with cheese that contained lead on one occasion, although it may be comparatively common, as the matter with which it is coloured is very often adulterated with red lead.

Cheese is also adulterated with potatoes boiled and mashed. There is nothing in this adulteration that is harmful to the animal economy; it is merely a simple fraud, and is, moreover, easily detected; indeed, in some parts of Saxony, potatoes in the above state, are added to render cheese more nutritive.

Red lead in cheese is detected after burning a certain amount, and acting on the ash as I have described under other sections.

The presence of starch-flour, or potato, is determined by boiling a certain portion of the suspected cheese with water, and when the decoction is cold, adding a small quantity of iodine, dissolved either in spirit or water; if starch be present, a fine blue colour will be produced.

Cheese, however, is, under certain circumtsances, very unwholsome, even when it has not been adulterated, for it spontaneously undergoes changes which renders it unfit for an article of food; indeed, most cheese has undergone a slight alteration of the kind I now allude to, and it is, I suspect, owing to this that cheese disagrees with so many persons; not because it is so especially indigestable, but because the peculiar matter the cheese contains in its altered state, has much more action on some than on other persons. This kind of partial action is very common, as is well known to medical men, who are constantly finding some medicament they may be exhibiting have no effect, or even the very contrary effect to that which they had intended.

The following case may not be uninteresting, it is related by Dr. Pollius, and extracted from Harel's work on the "Adulteration of Articles of Food."

"Nine persons of both sexes became exceedingly ill after having partaken of some strong cheese; they were seized with distressing pains in the region of of the heart and epigastrium, after which the symptoms extended over the whole of the abdomen. Violent vomitings in some, even of blood, supervened; then an abundant diarrhœa and severe cramps in the joints. Many were attacked with a shivering, which extended all over the body, alternately hot and cold, the extremities ice-cold; pulse small, frequent, and slightly hard, abdomen tense and very tender, or, on the other hand, much contracted. All the patients were troubled with vertigo, lassitude, anxiety, and thirst.

"Under the influence of suitable treatment, the patients recovered their health in a space of time varying from eight to twenty-four hours.

"The quantity of cheese consumed by each individual varied from $\frac{1}{6}$th to $\frac{1}{2}$ ounce. The cheese had been prepared in the ordinary manner. It was soft, and of an uniform dullish-white colour, and some portions in their substance had a deeper tint, and a firmer consistence than others, they exhaled a peculiar, disagreeable odour, and their taste was nauseous and acid, and lastly, neither mites, mouldiness, or other cryptogamic production could be detected.

"By boiling the cheese with water, the disagreeable smell became stronger; and the decoction, filtered and slightly concentrated by evaporation, became milky, and had an acid reaction. The cheese, by digestion with weak nitric acid, furnished a yellowish liquid." Dr. Pollius states that the poisonous effects produced by the cheese can be owing to nothing else but an *acid caseate of ammonia*(?), and to an acidified fat. He isolated these two bodies, and prepared pills with them with bread crumbs, and gave them to mice, and one which had taken the pill containing the fat, was seized with violent tremblings.

According to Dr. Bruck, cheese can become poisonous under various circumstances, and this poisonous action is not the same with all persons, as I have already stated. Mr. Westrumb places the poisonous principle of cheese under the *narcotico acid* class. Sertuerner, on analysing this article of food, showed that it could undergo a chemical decomposition giving rise to an essentially poisonous principle, and Julia de Fontenelle and Witling, thought that cheese, in its alteration, became impregnated with hydrocyanic (prussic) acid, and that it was owing to this substance that certain cheeses owed their poisonous effects.

This subject requires a most careful investigation. I have already commenced such an one, and hope very shortly to bring the results before the public.

SECTION XVII.

VINEGAR AND ITS ADULTERATIONS.

This is a well known acid liquid, prepared from either sugar and water, the saccharine juices, infusions of malt, malt liquors, wine, cider, and, lastly, by the destructive distillation of wood, in cast-iron cylinders.

There are various kinds of vinegar in the market, viz., white vinegar, which ought to be prepared from white wine; the white vinegar sold in London, however, is more generally strong acetic or pyroligneous acid, diluted with water: such a mixture is also sold under the name of distilled vinegar.

Brown vinegar is the most common. It is prepared from malt, and ought to be of a pale-brown colour, of a very pleasant acid, though somewhat pungent taste, and fragrant odour, but without acrimony. The colour varies from pale-yellow to deep-red. When long kept, particularly if it be exposed to the air, it becomes muddy and ropy, acquires an unpleasant smell, loses its acidity, and putrifies. It, however, may be kept good for a much longer time, if it be boiled for a few minutes, and then preserved in well-corked bottles.

Wood vinegar, or pyroligneous acid, is prepared, as just stated, by the destructive distillation of wood in cast-iron vessels. From its mode of formation, it generally possesses a slightly empyreumatic taste and smell, by which it can generally be distinguished. The crude acid, which possesses this empyreuma to a considerable extent, is much employed, and is exceedingly useful in preserving and pickling tongues, beef, &c.

White Vinegar, Wine Vinegar.—This vinegar contains water, acetic acid, a small quantity of alcohol, bitrartrate of potash, tartrate of lime, extractive matter, colouring matter, and small quantities of sulphate of potash and chloride of potassium.

When pure and prepared from good wine, it is bright and limpid, possessing a peculiar alcoholic odour, and a refreshing acid taste, which is generally very agreeable to the palate.

Vinegars of all kinds are generally adulterated with sulphuric acid, to give them more acidity, and with different acrid vegetable substances, to produce an apparently stronger vinegar. The substances usually employed are grains of Paradise, spurge flax, capsicum, and pellitory root.

Several saline substances are also added to vinegar, for the purpose of increasing its density, when its strength is ascertained by means of the hydrometer or specific gravity bottle; and, lastly, some metallic salts, as those of lead and copper, are found in vinegars. These arise from contact of the vinegar with metallic vessels.

Estimation of the amount of acid in Vinegar.—For this purpose, the following method may be employed, which, though rough, admits of tolerably accurate results; and as it may be performed by any one who is in possession of a balance, the author is inclined to think that, although not new, and, as he before stated, not very accurate, yet it may be found useful to many of his readers :—

Weigh out any number of grains of vinegar to be examined, 100 or 200 grains, or more if thought necessary; add to the vinegar a weighed piece of marble (say 100 grains), and allow the acid to act upon it until no further amount seems to be dissolved. This can be ascertained by the cessation of effervescence. Care must be taken, however, not to agitate the liquid very violently during the operation (although it must be gently stirred from time to time), otherwise fragments of the marble will be broken off, and the result spoilt.

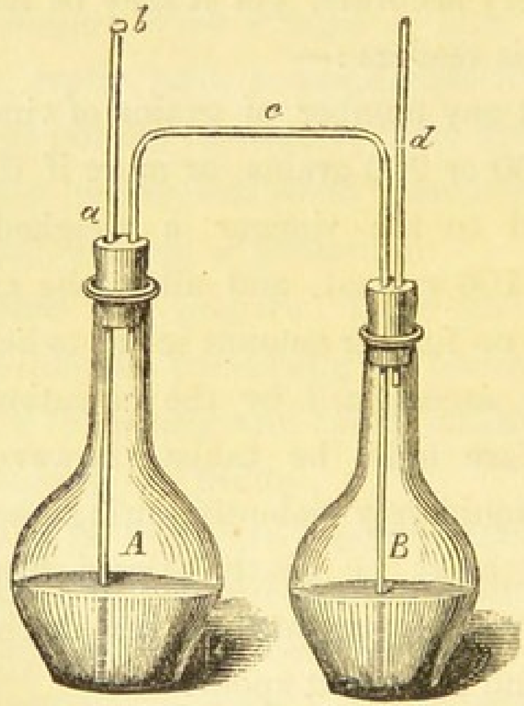
When all action has ceased, remove the piece of marble, wash it in running water, avoiding all friction, and place it before a fire to dry; when dry, weigh it; the loss of weight it has suffered corresponds to the quantity of pure acetic acid present in the vinegar:

that is, supposing 200 grains of vinegar had been employed, and 10 grains of marble dissolved, the vinegar in question would contain 5 per cent. of pure acid.

The following methods are, however, more accurate, but they require particular apparatus. I may here mention, that by either of these methods, the strength of any acid liquid may be ascertained.

The first process is that lately described by Fresenius and Will. The apparatus is composed of

FIG. 4.



two flasks; one (A, see Fig. 4) must hold from 2 ounces to 2½ ounces, and the other (B) about 1½ ounces. Both flasks are closed by accurately fitting corks, each of which has two holes bored in it. Through a hole in each cork passes the two ends of a glass tube (*c*) bent twice at right angles, which enters at its one end, just about a quarter of an inch past the cork (through which it passes) into the flask A, the other and longer end reaches to the bottom of the flask B. Into the other hole of the cork appertaining to the flask B, is inserted a straight tube (*d*), which merely passes into the flask for about a quarter of an inch, and rises above the cork about three inches. A similar straight tube (*b*) is placed in the cork of the flask A, rising the same height above the cork as that in B, but descending to the bottom of the flask.

To use the apparatus, B is half filled with strong sulphuric acid, and into A is placed any amount (say 100 grains) of the acid to be examined, and about half-an-ounce of water. A quantity (say 50 grains) of pure bicarbonate of soda is introduced into a short test-tube, which is suspended by a silk thread in the flask A. The suspension is managed by inserting the thread between the cork and the neck of the flask, in such a manner that the test-tube, containing the bicarbonate of soda, shall stand very nearly upright in the flask. The flask containing the sulphuric acid is now connected, by means of the appropriate cork and tube, with that containing the bicarbonate and acetic acid to be examined, and the whole is accurately weighed, and weight noted.

When things are in this condition, the cork of the flask A is so loosened, that the tube containing the bicarbonate of soda can drop gently into the acetic acid and water; which being accomplished, the cork must be instantly replaced. As soon as the bicarbonate comes in contact with the acid, an evolution of carbonic acid commences, the gas passing through the sulphuric acid in the smaller flask becomes perfectly dry, and therefore no loss of weight in the apparatus can be caused by the evolved gas carrying off water with it. When no more gas passes over, the flask A is to be gently warmed by wrapping a towel round it, which has been recently dipped in hot water and wrung out. This seems to expel the last traces of carbonic acid, and when the apparatus is completely cold, it may be wiped quite dry and weighed. Every grain lost by the apparatus, is equivalent to 1·158 grains of dry acetic acid.

The following process is, I think, the most simple, and at least as accurate. The only apparatus required is a balance, a Schuster's alkalimeter, an evaporating basin, some test-paper, or tincture of litmus, and a standard solution of carbonate of soda.

The standard solution of carbonate of soda is made in the following manner:—"Dissolve 54 grains of pure fused carbonate of soda in such a quantity of water that the solution shall weigh 1000 grains, every grain of such solution being equal to ·051 grains of dry acetic acid.

The operation is now as follows:—Weigh off 100 grains of the vinegar to be examined into an evaporating basin, and add about half-an-ounce of water, then a few drops of tincture of litmus, or a strip of litmus paper, and warm the whole to about 180°. Then gradually drop into the dilute acid some of the standard solution of carbonate of soda (which has been previously introduced into the Schuster's alkalimeter, and the whole weighed,) until the red of the litmus becomes decidedly blue. Weigh the alkalimeter, and every grain it has lost is equal to ·051 grains of dry acetic acid.

This same solution and mode of use is also applicable to the determination of the per centage of other acids.

Every grain of the soda solution is equal to :—

·0400 grains of dry sulphuric acid.
·0365 ,, ,, hydrocloric acid.
·0540 ,, ,, nitric acid.
·1920 ,, ,, crystallized citric acid.
·1500 ,, ,, ,, tartaric acid.

Vinegar adulterated with sulphuric acid; Wine vinegar.—There are many methods of detecting this adulteration, a few of which I shall give. If a drop or two of pure vinegar be placed upon blue litmus paper, the latter will be reddened, but when dried before a fire, the red colour disappears, and the original blue again presents itself; but if the vinegar contains any free sulphuric acid, then the red colour is persistent, no matter how long the drying operation is continued.

Again, if vinegar containing sulphuric acid be dropped upon white paper, and very strongly dried before the fire, that part of the paper which has been moistened will become charred and black from the action of the sulphuric acid; it requires, however, a considerable per centage to produce this effect.

The salts of baryta, as the nitrate or acetate can be employed in the detection of sulphuric acid; but as this kind of vinegar always contains soluble sulphates, this method is open to great objection; the following method, however, is perfectly free from any objection whatever, it was contrived by R. Böttger, who says:—" The ordinary vinegars of commerce frequently occur adulterated with powerful mineral acids, especially with sulphuric acid, and hitherto it is only by a somewhat minute and tedious process that it has been possible to prove with certainty a sophistication of this nature, in fact, the ordinary reagents, such as the nitrate and acetate of baryta are here of no service, since almost all vinegars contain small quantities of sulphates, which are readily detected by the addition of the above reagents." I believe that the following process, which is as simple and as easy of execution as it is certain, will be received with some interest. I observed that all the vinegars without exception, vinegars made from wine, brandy, cider, or beer,* no matter which one, notwithstanding the small quantities of sulphates they may contain, are perfectly indifferent to the action of a concentrated solution of *chloride of calcium*. If, consequently, a few drops of a concentrated solution of chloride of calcium are added to any unsophiscated vinegar whatever, not the least turbidity is evident, still less the formation of a precipitate, because the total quantity of the sulphates which occur in ordinary vinegar is so small that it does not decompose a saturated solution of chloride of calcium, either at the ordinary temperature, or at that of ebullition. Now the result is very different when free sulphuric acid is present in the vinegar, for instance, if two drachms of vinegar which has been previously mixed with scarcely a thousandth part of free sulphuric acid, and a fragment of crystallized chloride of calcium about the size of a nut is added, and the vinegar then heated to boiling, it is sure,as soon as it has become perfectly cold, to exhibit a very considerable turbidness, and soon afterwards to deposit a very abundant precipitate of sulphate of lime. This never happens, as I have stated, when ordinary vinegar, which has not been adulterated with sulphu-

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* This does not apply to English vinegar, as will be hereafter shown.

ric acid, is employed for the experiment. If the proportion of sulphuric acid in the vinegar is larger than one thousandth (it always exceeds this when vinegar has been adulterated by the greedy manufacturer or shop-keeper,) this precipitate, or at least a turbidness is found to appear in the vinegar even before it has become perfectly cold. In case the vinegar should contain free tartaric acid, or bitartrate of potash, the same treatment with chloride of calcium would not furnish any similar reaction.

The following method by M. Chevallier, is also extremely accurate, and deserves to be extensively circulated, as it is a beautiful application of a principle as yet little applied to analytical purposes. It is based on the power which boiling dilute sulphuric acid possesses of transforming starch at first into dextrine or " British gum," and by prolonged ebullition into grape or starch-sugar; starch, as mentioned several times, possesses the property of striking a blue colour with iodine, dextrine strikes a vinous looking violet tint, and grape-sugar is not altered by it, so that even the gradations of the change in this experiment may be observed, and only free sulphuric acid is enabled to effect the above changes, sulphates being perfectly inactive.

The following is the best method of conducting this experiment. Two samples of vinegar are taken, the one known to be pure, and the other the suspected specimen, half-a-pint of each is to be poured into a flask and, about one grain or one and a half grains of starch added to either, they are then heated about ten minutes, if a portion of the pure vinegar be tested with iodine in water, the blue colouration of the starch will be immediately apparent; if a portion of the other be now treated in the same manner, only a violet tint will be evident. If the whole be now allowed to boil for about half an hour or forty minutes, a violet, or even vinous coloration will not be obtainable, indeed the solution of iodine ceases to discover the slightest traces of starch or dextrine in the vinegar which has been adulterated with sulphuric acid.

British Vinegar, detection of sulphuric acid.—The brown vinegar ordinarily met with in England, is prepared from malt, and is sold of certain definite strengths, called respectively Nos. 18, 20, 22, and 24. The last ought to contain about five per cent. of pure acetic acid. The reason the author has separated the detection of sulphuric acid in British vinegar from that operation with wine and other vinegars, is, that the English vinegar makers are allowed by law to add one thousandth of the weight of the vinegar of sulphuric acid, this is for the purpose of preventing the vinegar from spoiling, for as before stated, it has a great tendency to become ropy and to putrify.

From the circumstance of this quantity of sulphuric acid being here purposely added, it will be quite evident that the processes already cited for the detection of sulphuric acid, fraudently added, are quite inadequate, for by all of them would the presence of sulphuric acid be proved, so that some other method must be employed in this particular case.

The best method is the following: evaporate 1000 grains of the suspected vinegar very nearly to dryness, at first, over a spirit lamp, and lastly in a water-bath; when sufficiently evaporated, add about a quarter of a glassful of ordinary spirits of wine; agitate the whole well, and filter; to the filtered liquid add water and some solution of acetate of baryta, and allow the whole to stand in a warm place for a few hours, then filter and wash the white powder which remains on the filter with hot water, until the fluid passing through is quite tasteless, after which, dry the filter in a water-bath in conjunction with another one of the same weight, (this of course must be previously ascertained,) and when perfectly dry, weigh the filter and precipitate, counterpoising the filter with the accompanying one. The excess of weight of one filter over the other is due to the presence of sulphate of baryta, which if the vinegar contains no more sulphuric acid than that allowed by law, ought to weigh about four grains, every grain above which weight corresponds to a quarter of a grain of sulphuric acid fraudulently added.

Detection of acrid substances in Vinegar, as grains of Paradise, Pellitory, &c.—These and analagous substances are readily detected, it suffices to evaporate some of the vinegar in a water-bath until all acidity has disappeared; the taste of the residual matter will be sufficient to detect the fraud. Pure vinegar merely leaves a kind of extractive matter which does not possess a particularly unpleasant taste.

Addition of certain salts to the Vinegar, in order to augment its density.—The addition of certain saline substances to vinegar to increase its density, is to deceive those who determine the strength of vinegar by means of the hydrometer or specific gravity bottle, and parties employing such instruments may be very readily deceived. The only safe method of estimating the strength of vinegar, is by the quantity of soda requisite to neutralize a given quantity.

The solutions generally employed for the purpose of increasing the specific gravity of vinegar, are common salt and acetate of lime; in many cases, however, chalk is added to the vinegar, so that in this case the fraud is a double one, for not only is the gravity of the fluid increased, and, in proportion to that, its apparent strength, but its real strength is reduced by the neutralizing action of the chalk added.

Common salt may be detected by an abundant white precipitate being produced on the addition of nitrate of silver to the adulterated vinegar, and acetate of lime or chalk by a copious white precipitate consequent on the addition of oxalate of ammonia.

Vinegar, containing poisonous metallic salts.—The salts generally present in vinegar, when any metallic substance is admixed, are the salts of copper, lead and zinc, derived from contact with leaden and brass vessels and taps employed in the apparatus made use of in its manufacture.

The methods of testing for copper, lead and zinc have already been explained in many other parts of the work, as under the heads Bread, Lozenges, &c.

SECTION XVIII.

PICKLES AND THEIR ADULTERATIONS.

Pickles are generally vegetable substances, infused in vinegar, and seasoned with spice of various kinds. In some, the chief aim of the manufacturer is to render them as white as possible, onions, cauliflowers, &c.; in others red, as red cabbage; and lastly, in others green, as capsicum pods, gherkins, beans, &c., and it is these last with which we have principally to deal, for, in the greater part of them, the green colour is due to the presence of copper; indeed, some go so far as to assert that it is impossible to prepare green pickles without the use of that metal. This, however, would seem to be disproved, by the following statement, extracted from the Supplement to "Ure's Dictionary of Arts, &c."

"I have examined the apparatus in the great fish sauce, pickle and preserved fruit establishment of Messrs. Crosse and Blackwell, Soho Square, and find it arranged on the principles most conducive to economy, cleanliness and salubrity, no material employed there is even allowed to come in contact with *copper*."

However much this proves concerning the salubrity of the pickles from the above establishment, it does not disprove the presence of copper in many of the green pickles, indeed it has been the custom, from time immemorial, to use that metal for the purpose of making, "greening," as may be gathered from many cookery books, and, indeed, much of the pickle ordinarily sold, is contaminated with copper, and sometimes in large quantity.

In some of the receipts for greening pickles, it is recommended to boil the vinegar in a bell-metal or copper pot, and pour it boiling hot on to the substance to be pickled; in others, a mixture of verdigris, distilled vinegar, alum and salt is recommended; and in another case, the poisoning is made more simple and easy, for half-pence are to be boiled with the vegetable matter. Not only may copper be present, but also arsenic and other metals of an equally and fearfully poisonous nature. This is fully discussed in the first section, on the vessels employed in domestic economy.

The copper present in pickles may be detected in the same manner as when in bread and other substances.* The processes have been fully described elsewhere.

SECTION XIX.

ANCHOVY SAUCE AND PASTE ; THEIR ADULTERATIONS.

Not only is the sauce and paste prepared from this fish adulterated, but even the fish itself is imitated; and, indeed, very many bottles of so-called anchovies are disposed of in London and its neighbourhood.

I have been told by many parties, that handsome profits are made annually by the manufacture of a spurious anchovy, from the common sprat, and not only is this not confined to those who sell the fish, but even private families deceive themselves into the idea that "anchovy sprats" are at least as good as the real fish; in most cases, they are as good as the fish sold as anchovies, which, indeed, are nothing but prepared sprats. This is, however, easily detected, for the appearance of the two fish is very different, an attentive examination of the form of the anchovy and the sprat will suffice to point out the distinguishing characteristics of each, in such a marked manner that the fraud is very apparent.

The fraud, as regards the fish, is, however, unimportant, when compared with the deleterious nature of the substance employed in manufacturing anchovy sauce and paste. It may not be generally known, that the red colour of both these preparations is due to an admixture of Venetian-red, which, in itself, is comparatively harmless, but which, taken in quantity, might occasion serious obstructions in the bowels; this, however, is not the worst, for Venetian-red is sometimes mixed with red lead to enhance its colour, and it is to be feared, that the more unscrupulous of the manufacturers of anchovy paste and sauce, purposely add this poisonous colouring matter. One thing, however, is certain, that it does exist in some samples, and that too in considerable quantities.

The admixture of any preparation of lead, may be detected by the means already pointed out in several sections for the determination of the existence of that metal.

Anchovy sauce and paste are adulterated in other ways, some of them cannot be detected, others can.

It is very common for sprats, and other cheap fish, to be bruised up into a pulp, mixed with flour and the necessary seasoning for anchovy sauce, and then the flavour of the latter fish is imparted by means of a small quantity of the liquor obtained in salting it, or even an admixture of a small per centage of the fish.

Flour is an ingredient in the manufacture, both of the paste and sauce, yet a very large quantity of it is often fraudulently introduced to the exclusion of a certain per centage of fish, and not only is flour employed for this purpose, but large quantities of Venetian-red, chalk and plaster of Paris, and it is generally when the two latter ingredients are added, that red lead is also added to make up for the decrease of colour the white admixture occasions.

Plaster of Paris and chalk can be detected as under Section IV., on bread.

SECTION XX.

CATSUP AND ITS ADULTERATIONS.

Mr. Accum states, " This article is very often subjected to one of the most reprehensible modes of of adulteration ever devised. Quantities are daily to be met with, which, on chemical examination, are found to abound with copper. Indeed, this condiment is often nothing else than the residue left after the process employed for obtaining distilled vinegar, subsequently diluted with a decoction of the outer green bark of the walnut, and seasoned with allspice, cayenne pepper, onions, and common salt."

He likewise says—" The quantity of copper which we have more than once detected in this sauce used for seasoning, and which, on account of its cheapness, is much resorted to by people in the lower walks of life, has exceeded the proportion of lead to be met with in other articles employed in domestic economy."

I can fully confirm the above statements of Mr. Accum, for I have often determined the presence of quantities of copper in catsup, furnished not only by itinerant dealers, but also by respectable shopkeepers, who, I hope, were not aware of the deleterious nature of the article they were vending.

When catsup, or indeed any sauce in whose composition salt or vinegar enters, is made in a copper or brass vessel, it invariably retains traces, and according to circumstances, even large quantities of copper on the one hand, and of copper and zinc on the other; to the first section, this subject has been fully discussed and made evident. Now, as catsup and some other like sauces, when made in quantity, are generally boiled in copper vessels, it is evident that the produce must always be contaminated with copper; and hence, to a greater or less extent, more dangerous in use. The only method by which this contamination can be avoided, is to have the inside of the coppers employed well tinned, or to use iron vessels, whose inner surfaces have been enamelled.

Surely the expence of this would not be so great but it would be counterbalanced by the superior quality of the sauces produced, and, indeed, every honest manufacturer, if he knew the liability his sauces have to take up copper in the course of their manufacture, and their deleterious nature when taken into the stomach, he would incur the small expence of either tinning his copper vessels, or of providing enamelled iron vessels, instead of disseminating the germ of death and disease among his fellow creatures.

The following case was forwarded by a Mr. Lewis to the "Literary Chronicle," some years back, and as the same thing is continually happening at the present day, the insertion of it will doubtless be followed by beneficial effects, as it will not only spread the knowledge of this fact abroad, but it will bring to the minds of those who still employ the same means, the vile nature of the material they manufacture, and the prejudicial effect its use must have on those who partake of it:—

"Being in the habit of frequently purchasing large quantities of pickles and other culinary sauces for the use of my establishment, and also for foreign trade, it fell lately to my lot to purchase from a manufacturer of those commodities, a quantity of walnut catsup, apparently of an excellent quality, but, to my great surprise, I had reason to believe the article might be contaminated with some deleterious substance, from circumstances which happened in my business as a tavern-keeper, but which are unnecessary to be detailed here, and it was this that induced me to make inquiries concerning the compounding of the suspected articles.

"The catsup being prepared by boiling in a copper (as is usually practised), the outer green shell of walnuts, (after having been suffered to turn black, by exposure to air in combination with common salt), with a portion of pimento and pepper dust in common vinegar, strengthened with wine vinegar extract, lef behind as a residue in the still of vinegar manufacturers; I therefore suspected that the catsup might be impregnated with some copper. To convince myself of this opinion, I boiled down to dryness a quart of it in a stone pipkin, which yielded me a dark brown mass. I put this mass into a crucible, and kept it in a coal fire, red hot, till it became reduced to a porous black charcoal; on urging the heat with a pair of bellows, and stirring the mass in the crucible with the stem of a tobacco-pipe, it became, after two hours' exposure to an intense heat, converted into a greyish-white ash. I now poured upon it some aquafortis, which dissolved nearly the whole of it with an effervescence, and produced, after having been suffered to stand, to let the insoluble portion subside, a bright grass-green solution of a strong metallic taste; after immersing into this solution the blade of a knife, it became instantly covered with a bright coat of copper.

"The walnut catsup was, therefore, strongly impregnated with copper. On informing the manufacturer of this fact, he assured me that the same method of preparing the liquor was generally pursued, and that he had manufactured the article in the like manner for twenty years."

And at the present day, both mushroom and walnut catsup are manufactured in the same manner; indeed, the former is generally a mixture of from one fourth to two-thirds of the latter, to three-fourths or a third of genuine mushroom catsup.

That which is sold by itinerant dealers is generally a heterogeneous mixture of all kinds of materials that are convertible even into the semblance of catsup.

The presence of copper can be discovered in catsup, either by the method indicated by Mr. Lewis, as above, or by any of the methods I have already pointed out in the body of the work.

SECTION XXI.

OLIVE (SALAD) OIL AND ITS ADULTERATIONS.

The adulteration this oil is generally subject to, is the addition of oils of inferior quality and price, but sometimes the admixture of a poisonous substance (lead) can be detected. This, however, is accidental, as it is derived from some of the vessels employed in the manufacture of the oil. Speaking of this, Mr. Accum says: "It is a practice (particularly in Spain) to suffer the oil to become clear in leaden cisterns before it is brought to market for sale." This sufficiently explains the source of the lead. Its detection, too, is comparatively easy, (see methods of detecting lead under Section, Lozenges, &c.*)

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* It is stated by M. Audouard, (Journ. de Pharm. et de Chem.) that symptoms of poisoning have been noticed—caused by the use of olive oil kept in zinc vessels, and he has shown that olive oil kept in contact with zinc gives rise after some time to an oleate and margarate of zinc, the quantity of which is occasionally very considerable.

Besides olive oil, however, there are employed other oils for either the table or kitchen, (more generally the latter,) such as poppy and nut oil, I have been told that the two latter oils are particularly adopted for frying fish instead of other fatty matter.

Olive oil, however, is the most valuable, and hence it is more often adulterated than either of the other oils, they are, however, subject to adulteration, as I shall prove, giving at the same time the most certain methods by which the adulterations may be detected, as well as of the oils employed for other domestic purposes, as sperm oil, &c.,—commencing, however, with those employed for the table.

Olive oil is the product of the fruit of the olive (*Olea Europæa*) and is extracted in Provence, Italy Spain, and the coast of Africa. Pure or good olive oil is slightly yellow, or greenish-yellow, (more especially when new), very fluid, slightly odorous, and possesses a soft and agreeable taste. It commences to freeze a few degrees below 32°. It is one of the least changeable oils, but when not carefully manufactured soon becomes rancid, and then possesses a very disagreeable and repulsive smell and taste.

According to M. H. de Saussure, its specific gravity is ·9192 at 59°·6, ·9109 at 77°, ·8932 at 122°, and ·8625 at 20°·2.

M. Poutet contrived a process for trying the quality of oils, and which has come into general use; and it consists in agitating the oil with one-twelfth of its weight of a solution of mercury, made in the proportion of six parts of mercury, and seven and a half of nitric acid, sp. gr. 1.359.

This mercurial preparation must be employed immediately the mercury is dissolved, which happens a short time after its mixture with the acid. If any crystals appear in the liquid, it is useless to employ it as a test. It is from this that the use of the process has been to a certain extent discontinued; it is, however, so handy on certain occasions, that I shall give some details respecting it, merely stating at present, that the mixture of the mercurial solution with pure olive oil solidifies the latter after a short time, whereas a much longer time is required for other oils, or for a mixture of olive oil with other oils.

Nut oil.—Nut oil is extracted from the fruit of the nut tree or *juglans regia.* It is greenish-white, is inodorous, and has a peculiar taste, it solidifies into a white mass at 16° below Zero on Fahrenheit's scale.

According to M. de Saussure, its specific gravity is ·9283 at 53°·6, ·9194 at 77°, and ·871 at 101°·2.

Poppy oil is extracted from the seed of the white poppy (*Papaver somniferum.*) It is pale yellow, inodorous, and has a slight taste of almonds; its specific gravity is ·9249 at 59°, it solidifies at Zero of Fahrenheit's scale.

To discover whether olive oil is adulterated with either poppy or nut oil, it is well, as a preliminary operation, to take its specific gravity, and compare it with the gravity of olive oil as given above. At a given temperature it is much lighter than either poppy or nut oil, hence this will be some guide, it also congeals at a much higher temperature than either of the other oils, so that if it be placed in a test-tube, and that immersed in melting ice, it will almost immediately solidify, whereas neither poppy or nut oil will solidify at that temperature. The test of M. Poutet may now be applied. Two parts of the mercurial solution already described are to be mixed with ninety-six parts of the suspected oil, and well agitated every half hour, or oftener. If the oil be pure, the mixture ought to become a thick paste in about seven hours, and at the end of twenty-four hours ought to offer resistance to any hard body pressed against it. The other oils do not possess the property of uniting with nitrate of mercury ; and if the olive oil contain any other oil it becomes thick, but never solid. If the quantity of foreign oil amount to twelve per cent., it separates from the thick mass, and forms a distinct layer, the solidity of the mass depending on the amount of olive oil present. If the olive oil contain an equal quantity of foreign oil, the half of the mixture will be solid, and the half liquid.

The following is another method of determining the adulteration of olive oil by that of poppy; it is due to M. Lipowitz.

When eight parts of olive oil are triturated with one part of chloride of lime, and after that agitated in a test-tube, the mixture (if pure olive oil) separates in two perfectly distinct layers, the upper is pure bleached oil, the lower the mass of chloride of lime and part of the oil; in four or five hours, or more, at a temperature of from 64° to 66°, the mixture separates into two equal parts, and in eighteen hours both are separated and clear.

If, however, poppy oil be triturated with chloride of lime, a sensible separation of the mixture is not noticed, even after the lapse of many days. It is possible, therefore, to avail ourselves of this property of olive oil, to detect its adulteration by poppy oil. Olive oil adulterated with twelve parts of poppy oil does not show, even after an hour's repose, any separation into layers, it only commences to separate properly after six hours' rest. A mixture which contains more than twelve per cent. of poppy oil, does not differ in its behaviour from pure poppy oil.

M. Rousseau, has contrived an instrument which he terms a "Diagometer," in order to ascertain the purity of olive oil.

It is founded on the property which olive oil possesses, of conducting electricity with much more difficulty than any other oil. This instrument, however, cannot be come at readily by every one, neither would its use be understood, so I will not take up space by describing it, but will merely state, that olive oil conducts electricity 675 times more slowly than any other vegetable oil.

Sperm oil.—The addition of common fish oil to this, can be generally detected by the smell and taste, especially when the suspected oil is heated, but the best method of determining this fraud, is by ascertaining the specific gravity of the sample. Pure sperm oil, at a temperature of 60°, has a gravity corresponding to ·875, water being 1000, whilst fish oil has a gravity equal to ·922, or ·925 at the same temperature.

SECTION XXII.

ON SOAP, AND THE METHODS TO BE EMPLOYED IN ASCERTAINING ITS COMPARATIVE VALUE.

Consequent upon the last section, in which the means of detecting adulteration in some oils were discussed, it has seemed advisable to the author to point out in this, the following section, methods by which the real value of soap may be determined. As this article forms a very considerable item, not only in every manufacture, but also in every household, it is deemed that the subject will not be uninteresting, although it is somewhat beyond the limits of the work as originally intended.

All hard soaps are manufactured with oil, tallow, or some other fatty matter, and the alkali soda; whilst potash, forms corresponding soft soaps.

All soaps, moreover, contain a very considerable per centage of water, and their value depends, to a great extent, on the amount of this substance present. They also contain saline and other matters; some, accidental impurities, others, substances purposely added, either with the view of improving the quality of the soap, or of increasing its quantity—such bodies are resin, flint, sand, and some others.

The following methods of examining soaps, which the author has found the most simple and correct, are from Dumas, Traité de Chimie:—

In the examination of soap, the object is to ascertain the nature and quantity of fat (fat acids) it contains, the nature and proportion of the base (alkali), the quantity of water, and lastly, to point out the presence of foreign bodies.

It is perfectly evident that the water a soap contains is valueless, and, in consequence, it is a matter of considerable importance to determine its quantity.

Soaps also may contain an excess of non-saponified fat, or of free alkali, or they may have incorporated with them flint, clay, starch, and some other insoluble substances.

To ascertain the amount of water any sample of soap contains, it must be scraped very fine, taking care to properly proportion the quantity from the edges and centre of the mass, according to its size.

From 50 to 100 grs. of the fine shavings of soap may be taken for the experiment, and exposed to a temperature of 212° in a water-bath, until, on repeated weighings, the quantity employed ceases to lose weight. The loss of weight corresponds to the quantity of water present in the amount of soap examined.

If the sample examined be soft soap, it must be weighed in a watch-glass, or small evaporating dish, the weight of which has been previously ascertained.

Well-made mottled soap contains, as a mean quantity, 30 per cent. of water, and white soap 45 per cent., but if they be exposed to a moist atmosphere they gain much in weight, and when plunged into a solution of salt, the amount of water in white soaps can be doubled.

Soap thus fraudulently overcharged with water, is occasionally sold at a very small sum under its full price, as an article that has been spoiled by sea-water, when, indeed, it has been especially prepared for the purpose. Such soap as this, when exposed to a dry atmosphere, shrinks much in bulk; indeed it diminishes occasionally to half its original bulk.

Soft soaps retain from 36 to 52 per cent. of water The commercial value of these is also dependant on the amount present.

The purity of soap may be ascertained, and consequently the quantity of foreign matters present, by treating it with hot spirits of wine. If the soap be white and unmixed, the solution is nearly perfect, and the residue very small, and the best mottled soap does not leave more than one per cent. of its weight.

The quantity of alkali present in the soap, may be determined as already pointed out, by means of a test-acid, and a Schuster's alkalimeter. 100 grains of the soap are to be dissolved in water, and its alkali neutralized by the acid in question. If the acid be so made that 1,000 grains will neutralize 32 grains of soda, then if a soft soap be examined, 1,000 grains will be equal to, and represent 48 grains of potash.

From the residue of the alkalimetrical experiment, the amount of fatty matter present may be determined. For this purpose, 100 grains of pure white wax are to be added to the neutralized soap, and the whole heated together until the fatty matter and the wax have melted and formed one homogeneous liquid. It is then allowed to cool, and the cake of wax, and admixed fat or oil, removed, dried, and weighed. The increase of weight over 100 grains, is equivalent to the quantity of fat present.

The nature of the alkali can be now determined in the liquid left from the fatty matter. If chloride of platinum give no precipitate in it when tolerably concentrated, soda is the alkali; if a precipitate is produced, potash is present, soda may be also; this can be proved by evaporating a portion of the liquid to dryness, and acting on the dry residue by the blow-pipe, a yellow coloration of the flame denotes soda.

The following analysis of some of the more common soaps are by Dr. Ure :—

Ordinary Tallow Soap.

Soda	6
Fatty matters containing at least 90 parts of tallow	52
Water	42
	100

Resin Soap.

Soda	6·5
Fat and Resin	70·0
Water	23·5
	100·0

Soft Soap.

Potash	9
Oil and fat	34
Water	57
	100

SECTION XXIII.

PEPPER AND ITS ADULTERATIONS.

This substance is much subject to adulteration, which, however, merely subdues its strength, and is not injurious to health. It is of course, however, much to be deprecated, as is every species of fraud.

The pepper sold in England is of the kinds, black, white, and long pepper. In reality there are only two kinds generally found in commerce; the black and long pepper, the white being prepared from the black by steeping it in salt water for a few days, after which it is dried till the skin loosens, when it is rubbed off between the hands, and is then white pepper; much, however, of the peculiarly pungent flavour of the pepper is lost by this process, and generally speaking, the white pepper as purchased at the grocers is inferior to the black. There is, however, a native species of white pepper which is little, if any, inferior in flavour and pungency to the black; it is seldom met with.

The adulteration of pepper is not confined to its pulverulent state, fraud has taken up a higher position as regards this condiment than even any other, for factitious pepper-corns are made and sold, sometimes alone, and sometimes mixed with genuine, from which, indeed by their outward appearance, they can be scarcely distinguished, so great has been the skill and labour bestowed upon their manufacture.

They are made of oil cake, either linseed or mustard, with a considerable quantity of clay and a little cayenne pepper as a flavouring matter. This fraud, however, is easily discovered, the genuine pepper berries suffer no change when immersed in water; the factitious, treated in the same manner, fall to pieces.

In the state of powder, pepper is nearly always adulterated, substances being sold for the express purpose. It is often mixed with the powdered husks of mustard, which are openly sold for this purpose, as is also the sweepings from the pepper warehouses, under the name of P. D., or pepper dust. And yet an inferior kind of this adulteration is sold under the name D. P. D., signifying the dust, or dirt of pepper dust.

Earthy matters are also often mixed with pepper powder to increase its weight, this fraud can be readily discovered by igniting a quantity of the suspected pepper, the amount of ash will form a sure criterion.

Cayenne pepper.—This is a variety of capsicum pods ground together, and is often subject to a very deleterious fraud. It, when exposed to light for any length of time, always loses the fine bright red colour it at first possesses, and therefore becomes deteriorated in the eyes of the purchaser; in order to prevent this, a quantity of red lead is added, which not only causes it to keep its colour for a greater length of time, but also adds to its weight, and, consequently, to the profit of the vendor.

This fraud is discovered by any of the methods already pointed out in various parts of the work for the detection of lead, to either of which the reader is referred.

SECTION XXIV.

MUSTARD AND ITS ADULTERATIONS.

The substances employed in the adulteration of this condiment are not generally injurious to health, they only weaken the strength of the material. Pea-flour, ordinary flour, and linseed cake, ground very fine, with tumeric powder as a colouring matter, are the bodies used in weakening the usual pungency of mustard. The mineral substances are yellow ochre, and, as I have been informed, chromate of lead, in small quantities, to give a bright yellow to mustard that has had much coloured vegetable matter, as linseed meal, added to it. I have never found chromate of lead in any sample I have examined, although I am assured that it is occasionally employed.

The best method of detecting pea-flour, ordinary flour, linseed meal, &c., is to take a given weight of mustard seed and pulverize it finely, add to it ten times its weight of water, and mix well together.

Take the same quantity of the mustard to be examined, and add to it the same amount of water as before, (ten times its own weight.) It will now most likely happen that the mixture of water and powdered mustard seed will have a much more pungent taste than the other, if so, water is to be added until both taste alike, from the quantity of water added the probable amount of adulteration may be approximately obtained. This is, however, not an absolutely decisive test, but it is the only one with which I am at present acquainted that is readily performed.

To detect the admixture of turmeric, add a little caustic potash to the suspected mustard, it will immediately become a deep reddish-brown if that substance be present.

The ochre can be detected in the same way as in chocolate, and the chromate of lead as described under the head "Lozenges."

APPENDIX.

ADDITIONS TO SECTION I.

Copper, when exposed to dry air, undergoes little or no alteration, but in moist air it gradually absorbs oxygen and carbonic acid. In contact with air, it is also readily attacked by the weakest acids.* M. Thierry, who wrote on the noxious quality of copper, observes, that "our food receives a quantity of poison in the kitchen by the use of copper pans and dishes. The brewer mingles poison in our beer by boiling it in copper vessels; the oilman boils his pickles in copper and brass vessels, and verdigris is plentifully formed by the action of the vinegar on the metal."

The author of a tract, entitled "Serious Reflections on the Dangers attending the Use of Copper Vessels," asserts, that a numerous and frightful train of diseases is occasioned by the poisonous effects of pernicious matter received into the stomach with our victuals.

In nearly every sample of beer the author has examined, he has found copper; in some samples but mere

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* Gaultier de Claubry, Dictionnaire de l'Industrie, Vol. III, page 699.

traces, in others a notable quantity. Indeed, beer can scarcely be conceived as not containing traces of copper, for if the copper it is hopped in be slightly tarnished, as it generally is, it will be found perfectly bright when the beer is removed from it, showing that the small portion of oxide of copper, coating the interior of the boiler, has been dissolved, either by the saccharine matter or free acid in the beer. There is also another source from whence beer can derive copper. It has just been asserted, that when copper is exposed to moist air, it absorbs carbonic acid and oxygen, forming a compound of copper, which is readily soluble in any acid, however weak. Now, the brass taps, &c., of the publican or private consumer, are always exposed to a moist atmosphere, in contact with carbonic acid and air, and hence their surfaces are continually covered with copper ready to be dissolved. This can be readily proved by the taste, if a beer-tap, which has been in use for a day or two, be applied to the tongue, a very styptic metallic taste is immediately perceptible, and if it be treated with a small quantity of hot water, the presence of copper can be detected in the solution.

From the properties of copper, and the cases the author has already cited, it is quite evident that copper or brass taps should not be employed for beer, but that taps of some other material, as porcelain; or copper, brass, or iron, covered with an enamel, should be substituted.

Cyder, especially, ought not to come in contact with copper, for, if it do, a very large quantity of poisonous metal will be taken into solution.

Sir George Baker, M.D., relates the following case,*

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* Medical Transactions, Vol. I, p. 219.

which, by the way, is an extreme one, although the same thing takes place, but to a less extent when cyder is run through brass taps:—

"Some cyder which had been made in a gentleman's family, being thought too sour, was boiled with honey in a brewing vessel. All who drank this liquid were seized with a bowel colic, more or less violently. One of the servants died very soon in convulsions; several others were cruelly tortured a long time. The master of the family, in particular, notwithstanding all the assistance which art could give him, never recovered his health, but died miserably, after having almost three years languished under a most tedious and incurable malady."

Dr. Johnston* gives an account of the melancholy catastrophe of three men being poisoned and dying, after excruciating sufferings, in consequence of eating food cooked in an unclean copper vessel, on board the Cyclops frigate; and besides these, thirty-three more became ill from the same cause.

M. de Monfalcon, and A. P. T. Polinière† state "that copper vessels employed in the preparation of food, are often, indeed very often, in such an unfit state for use, that they are the cause of serious accidents, sometimes even of death. Oxide of copper, which is one of the most violent poisons, is readily and quickly formed in saucepans and boilers. It is true that we are somewhat protected from its dangerous consequences, by internally coating saucepans, &c., with fine tin, but it forms a source of great uneasiness to think that life or death is dependent on the preservation of this coating, and that

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* Johnston's Essay on Poison, p. 102.

† Traité de la Salubrité.

the slightest abrasion can destroy the balance in favour of health or life."

Whilst treating of the vessels in which food is preserved, it may be as well to allude to the introduction of zinc milk pans into the economy of a dairy. It has been long known that vessels of zinc were favourable to the obtaining of a superior quantity of cream from new milk placed in them, and patents for applying the metal to the manufacture of dairy utensils have been taken out in America, if not, also, in this country. In the "Transactions of the Society of Arts, for 1832," there is an interesting account of some experiments on this subject, together with the description of a vessel for separating cream from milk, and an attempt to account for the effect produced in this process, by the action of the metal upon the fluid, by a Mr. Carter, of Nottingham Lodge, near Eltham. This gentleman reckons the increase in the quantity of cream, from the use of these vessels at 12 per cent., and of butter at upwards of 11 per cent., as compared with the old methods of gathering, and hazards a conjecture, "that the results are owing to a galvanic effect, which is produced by the water and acetic acids, developed in the milk by heat and rest, acting slightly upon the zinc plates of the vessel. We have, therefore, two fluids acting on one metal, which is well known to be a galvanic arrangement of the second order. The acids which would otherwise cause the coagulation of the milk are thus taken up by the zinc, and the milk, by remaining more perfectly fluid, admits the easy ascent of the suspended cream. I have ascertained, on analysis, the presence of acetate and lactate of zinc in the skimmed milk, which would, therefore, seem to favour the hypothesis."

The committee inquired of Mr. Carter, to what use the milk, so separated and impregnated with zinc, was applied. He replied, to the feeding of pigs, and that the animals so fed do not appear to be injuriously affected.

The author has never detected either lead or zinc in milk supplied by the dealers, but it is much to be feared, that the increased amount of cream which is known to be furnished by the use of lead and zinc pans, induces many parties in the neighbourhood of large towns, to subject their milk to such an operation as just described.

The means for the detection of lead and zinc have already been discussed.

ADDITIONS TO SECTION II.

On the detection of Bicarbonate of Lime in Spring Water. —M. Dupasquier* states that the following method is perfectly successful in discriminating between the presence of bicarbonate of lime, and that of any other alkaline bicarbonate, saving that of magnesia.

" M. Dupasquier, takes two glasses filled with the water to be examined, and adds to the one, a few drops of a neutral solution of sulphate of copper, and to the second, some chloride of calcium. If the water contain only bicarbonate of lime, a precipitate of carbonate of copper is formed, from the quantity of which, the amount of bicarbonate of lime present may be estimated. No precipitate is formed by the chloride of calcium; but if carbonate of potash or soda be present, a precipitate

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* Compte Rendus, xxiv, p. 108.

falls on its addition. If the quantity of bicarbonate of potash or soda is very small compared to the amount of lime-salt present, the precipitate, by chloride of calcium, may be prevented by the free carbonic acid of the water, on which account, from ⅓rd to ½ of the water is to be heated in a loosely closed vessel, not to boiling, but nearly, so as to expel the excess of free carbonic acid. If now on the addition of chloride of calcium, a precipitate is formed, bicarbonate of potash or soda is present, but if bicarbonate of lime also is present, it will remain bright.

In Dr. Clark's process for the separation of carbonate of lime from water intended for domestic purposes, it is very evident that only a certain quantity of lime-water must be added to the water to be purified, for if a smaller amount than that required were added, lime in the state of carbonate would still remain in solution, and if a larger, the water would still contain an excess of lime, and that in the caustic state, so that it is necessary to ascertain the amount of carbonate of lime the water contains, so as to properly adjust the quantity of lime-water to be added, and the following are the methods Dr. Clark adopts.

In ascertaining the degrees of hardness of any waters to be purified, Dr. Clark employs "Standard Solutions," (to the amount of sixteen) which are thus made. Sixteen grains of pure Iceland spar are dissolved in dilute hydrochloric acid, (sp. gr. 1·100.) The resulting solution is carefully evaporated to dryness, and then dissolved in about one pint of distilled water. The solution ought to be perfectly neutral to test-paper. Distilled water is now added, so as to form exactly one gallon of liquid, which is labelled standard solution of sixteen degrees of hardness. From the solution thus prepared, fifteen other standard solutions are to be made, thus: one measure of the solution of sixteen degrees of hardness is to be mixed with fifteen measures of distilled water, and the resulting solution labelled standard solution of one degree of hardness. In like manner two measures of standard solution at sixteen degrees are mixed with fourteen measures of water, and the solution thus made, labelled standard solution of two degrees of hardness. In like manner, standard solutions of 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14 and 15 degrees of hardness are to be prepared, observing that the number of measures of solution at 16°, and the distilled water added, must in all cases make up sixteen measures.

Soap Test, its preparation.—The materials employed in the preparation of this test, are white curd soap, and proof spirit. As the quality of white curd soap somewhat varies, it is necessary in order to prepare a soap test of nearly an uniform standard, to make a preliminary trial solution on a small scale, for the purpose of ascertaining by approximation how much of the soap should be dissolved in proof spirit. Accordingly, let a small quantity of solution be made by dissolving the soap in proof spirit, in the proportion of one ounce avoirdupois for every gallon of the standard solution of soap. Now let 100 test measures of the solution of 16° of hardness be put into a phial capable of holding twice this quantity; into the water in this phial let the prepared trial-solution of soap be gradually poured from a measure graduated into test measures, let the mixture be shaken after the addition of each quantity of soap solution, and the operation carried on in this manner until such times as a lather will be formed of a sufficient consistence as to remain for five minutes all over the surface of the water, when the phial is placed on its side. The number of test measures thus required will be either 32, or more or less than 32. If the number prove to be 32, then more solution of soap may be made, in the same proportions as in the trial-solution, and the solution so made will be the soap test. If the number be more than 32, then proportionately more soap must be employed in making the test, and *vice versâ.*

Test Acid is made by dissolving 1¼ oz. avoirdupois of crystals of oxalic acid, free from moisture, in such a quantity of water that the resulting solution will measure exactly one gallon.

Silver Test.—A solution of nitrate of silver in distilled water, in any proportion between 1000 and 4000 grains of the nitrate in a gallon of water.

By means of the foregoing chemical agents, tests and standard solutions, three operations of testing are performed. One operation consists in measuring the hardness of any water; a second, in measuring the alkalinity of any water; the third, in ascertaining whether there be dissolved in water any caustic alkaline, or earthy matter, which caustic matter may be caused by an overdose of lime-water.

In order to measure the hardness of a water, put 100 test measures into a suitable phial, and add thereto, with agitation, the soap test, measured in test measures, until a lather be produced of sufficient consistence to remain all over the surface of the water for five minutes; when the phial is laid on its side. Now in order to form such a lather, the measured water under trial will take 32 test measures of the soap test, or less or more than 32 measures. If the quantity of soap test required be exactly 32 measures, which is the same quantity as is required by the standard solution of 16 degrees of hardness, then the hardness of the water is called 16 degrees, after the standard solution with which it corresponds. If, in like manner, in order to produce the lather, the water under trial for hardness, takes exactly the same proportion of soap test as any other of the standard solutions requires, the hardness will be called after the standard solution. But if to form the lather, 100 test measures of the water require more of the soap test than corresponds to 10 degrees, say of hardness, and less than what is required by the standard solution of 11 degrees, then the water would be said to be 10 and a fraction degrees of hardness, which fraction is to be computed proportionally from the difference in soap-test measures required by the solution of 11 degrees over and above the solution of 10 degrees. Thus, in forming the lather, if 100 test measures of the standard solution of 11 degrees were found to take $1\frac{8}{10}$th measures of soap test more than 100 measures of standard solution of 10 degrees of hardness would require, and if 100 test measures of the water under trial for hardness require $\frac{9}{10}$th of a test measure over and above what the same standard solution of 10 degrees would require, then the water under trial would be said to be $10\frac{5}{10}$th degrees of hardness. This fraction of $\frac{5}{10}$th is obtained by proportion, thus :—

$$\overbrace{1\tfrac{8}{10} : \tfrac{9}{10}}^{\text{Differences of Soap Test.}} \quad :: \quad \overbrace{1 : \tfrac{5}{10}}^{\text{Difference, in degrees, of hardness.}}$$

Again, suppose that 32 test measures of soap test had been added to 100 of water without producing a lather, the next step of the preliminary trial is to add 100 measures of distilled water. To the mixture continue to add soap test as before, until in all 60 measures of soap test have been added, if enough has not been previously added to produce a lather. If at 60 measures of soap test, or at any number of measures between 32 and 60, the proper lather be produced, then the final trial is to be made in the following manner: 100 test measures of the water under trial is to be mixed with 100 measures of distilled water, to this mixture soap test is to be added until a lather is produced. The number of measures of soap test is to be divided by two, and the result will be less than 32, and accordingly may be expressed in a degree of hardness ascertained by comparison with the standard solutions as already described. The double of such degree will be the hardness of the water under trial. For instance, if half the soap test which has been required corresponds to 10$\frac{5}{10}$th degrees of hardness, then the hardness of the water under trial will be 21.

If, however, the addition of 100 measures of distilled water to 100 of water to be tested, do not form a solution which is capable of producing a lather with 60 test measures of soap test, then 100 measures more of distilled water added, and the resulting number of measures of soap test divided by 3 to arrrve at the degree of hardness of the mixture, and that number multiplied by 3, gives the hardness of the water under examination, and so on.

Testing the alkalinity of water.—As preliminary, it is proper to ascertain whether the water be alkaline. For this purpose, pour in a small glass about 20 test measures of the water to be tried, and place in this water a strip of test-paper, if a bluish or purplish tinge be produced, it is alkaline. When the alkaline matter is in very small proportion, some time is necessary in order to produce such alkaline reaction, and if no alkaline reaction be produced at the end of half-an-hour, the alkalinity of the water may be regarded as too inconsiderable for trial. If the water be alkaline enough for trial, a pint of it is to be measured, and put into a large evaporating dish. To it is to be added the test-acid, measured in test measures, so long as any alkaline indication is produced by the water on test-paper.

The third operation of testing consists in ascertaining whether there be dissolved in water any caustic, alkaline, or earthy matter. For this purpose, the silver test is employed. If no caustic matter be present, the test will merely produce a white precipitate or no change, if, however, any alkaline matter be present, a yellowish or brownish precipitate or colouration will take place. This ought to be observed within ten minutes of the application of the test, as exposure to light gives the whole of the fluid a darkish colour.

The following remarks are taken from a private circular published by Dr. Clark, for the use of his chemical friends, and contains some improvements on the foregone observations.

"In June, 1843, having occasionally before met with some few specimens of waters, and more especially soft waters from springs where the indications of the soap test, which, in general, are remarkably distinct, were obscure, I discovered the cause of this obscurity to be an excess of carbonic acid, that is, an excess over and above what is necessary to form alkaline and earthy bicarbonates. This excess has the property of slowly destroying a lather once formed.

"For the purpose of guarding against an excess of carbonic acid in all cases, I recommend that before you measure out the water for trial, you shake it briskly in a stopped glass bottle half filled with it, sucking out the air from the bottle at intervals so as to change the atmosphere in the bottle.

"To obtain uniform results with the soap test, I recommend that as soon as you observe that a lather is formed such as will remain all over the surface of the water for five minutes, you take a note, but only an *interim* one, of the quantity of the soap test that has been added. In about half-an-hour you should shake the bottle again, to see whether the lather will still remain for five minutes. If the water under trial do not exceed 4° or 5° of hardness, it is likely to require a little more soap test on this renewed shaking. This latter quantity and the former will together make up the whole soap test that is to determine the hardness of the water under trial. Four hours afterwards, unless perhaps the water do not exceed 1° or 2° of hardness, a lather lasting five minutes may be restored by shaking the phial.

"*Table for converting soap test measures into degrees of hardness.* — Ever since detecting the fallacy, which might occur owing to excess of carbonic acid, my health has prevented me from performing such a series of experiments as to afford materials for a table of this kind. Pressed, however, by the present occasion, and guided by my former experience, I have endeavoured to frame, as follows, a table worthy of confidence, by comparing together unpublished results obtained since then by others.

"*Table of soap test measures corresponding to* 100 *test measures of each standard solution.*

Degree of hardness.	Soap test measures.	Difference for the next 1° of hardness.
0 (distilled water)	1·4	1·8
1	3·2	2·2
2	5·4	2·2
3	7·6	2·0
4	9·6	2·0
5	11·6	2·0
6	13·6	2·0
7	15·6	1·9
8	17·5	1·9
9	19·4	1·9
10	21·3	1·8
11	23·1	1·8
12	24·9	1·8
13	26·7	1·8
14	28.5	1·8
15	30·3	1·7
16	32.0	

"When the measures of soap test necessary to form a lather with 100 test measures of a water exactly correspond with a standard solution, then the degree of hardness will be the corresponding integral number found in the first column. Thus, 24·9 of soap test will indicate 12^0 of hardness, 26·7 of soap test will indicate 13^0 of hardness.

"But if the measures of soap test do not exactly correspond with a number in the first column, the hardness will be expressed, partly by an integer and partly by a fraction.

"The *integer* will be the hardness corresponding to the next lower number in the soap test column.

"The *numerator* of the fraction will be the excess of the soap test measures in question above this number. The *denominator* of the fraction will be the corresponding difference which follows the soap test in the next column.

"*Example.*—Let 25·8 be the measures of soap test required by 100 measures of a given water.

"24·9 is the next lower number in the soap test column, therefore 12^0 of hardness; the corresponding degree is the integral part of the required hardness.

"The numerator of the fraction is 25·8—24·9=0·9. The denominator is the corresponding difference = 1·8. The fraction itself is $\frac{0\cdot9}{1\cdot8}$ = 0·5.

"The whole hardness, therefore, is 12^0.5.

"*Degrees of hardness and degrees of alkalinity explained. Degrees of hardness.*—Each degree of hardness indicates as much hardness as would be produced by one grain of chalk per gallon, held in solution in the form of bicarbonate of lime free from any excess of carbonic acid. The degree of hardness produced by a lime salt, depends not on the state of combination of the calcium it contains, but on the quantity of the calcium. If instead of being in the form of bicarbonate of lime, the calcium this compound contains were in the form of chloride of calcium, or of nitrate of lime, or of sulphate of lime, or even of lime-water, the soap test destroyed by it, and consequently the degree of hardness indicated would be precisely the same.

"A quantity of a soluble magnesian salt equivalent to one grain of chalk, destroys a like quantity of soap test, and consequently indicates 1^0 of hardness. The same is the case with salts of iron and salts of alumina. Salts of the alkalies do not produce hardness.

"*Degree of alkalinity.*—For each degree of alkalinity that a water possesses, a gallon of it will require as much acid to neutralize it, as 1 grain of chalk would require. Hence, a solution of lime water, or of bicarbonate of lime in distilled water should be of the same degree of hardness as of alkalinity. The most usual cause of alkalinity in water is bicarbonate of lime, but bicarbonate of magnesia, which causes hardness, likewise causes alkalinity, and bicarbonate either of soda or potash, which does not cause hardness, causes alkalinity."

On the presence of lead in water.—The following is an abstract of a paper read by Mr. Osborn before the British Association.

"It is now five years since my attention was first drawn to the investigation of the action of water, or rather of some foreign solvent in water or leaden pipes by the following circumstances.

"Mr. Ware, a medical gentleman of this town, (Southampton), was attending some patients residing at Shirley, about two miles off, who were labouring under symptoms resembling those produced by the absorption of lead, although none of them had been exposed to the fumes of paint, or to the absorption of lead in any form that could be accounted for. Suspecting, nevertheless, that they were suffering from the effects of lead conveyed into the system by some means or other, and that in all probability, it was from the water pipes, he procured some of the water which they were in the habit of using for domestic purposes, and requested me to analyse it. I applied the usual tests for lead, but probably owing to the water having remained in contact with the pipe a short time only, I could scarcely detect a trace of the metal, I then desired him to procure some of the water which had remained in the pump during the night, and I immediately detected a considerable quantity of lead in solution.

"This was sufficient to account for the symptoms they had been labouring under, and suspecting that the water in other parts of Shirley might be capable of acting upon lead in a similar manner to that which had occurred in the present instance, I mentioned the circumstance to Dr. Oke, a physician of this town, who immediately directed his attention to this subject.

"Scarcely a fortnight had elapsed, when Mr. Shelley, of Burley, in the New Forest, consulted him for intestinodynia, accompanied with atrophy and loss of muscular power of the upper limbs, Dr. Oke suspected these symptoms to arise from the poison of lead, and procured some of the Burley water for me to test. Upon examination, I found a large quantity of lead in solution, which proved to be the sole cause of the distressing symptoms which Mr. Shelley was labouring under."

Mr. Osborn further states, that he is anxious to call the attention of all parties who are about erecting pumps, cisterns of lead, or laying down leaden pipes, to ascertain whether the water will have any chemical action on the metal with which they propose it shall come in contact. He also adds, that it would be a much better plan to abandon altogether the use of leaden pipes, and to substitute those of glass or iron.

"During the last five years, I have been frequently solicited by medical practitioners in this town, and by private families residing at Shirley, Bittern, and other places in the neighbourhood, to test the water in these different localities. Sometimes entire families, sometimes individual members of them have been affected in a greater or less degree with the symptoms of saturnine poison.

"Mr. Shelley, whom I have already mentioned, informed me, that his father and two of his brothers died of the same complaint that he was labouring under when he applied to Dr. Oke for advice. This complaint has been traced to the poisonous effects of the impregnation of lead in the water of Burley, and I have no doubt that the loss of many, perhaps hundreds of lives has been caused in a similar manner, not only in this part of the country, but in many parts of England.

"An account was published about twelve months since, of several persons having been attacked with paralysis at Ascot, which Mr. Rust, a surgeon of Windsor, attributed solely to the cause of carbonate of lead in the water."

Dr. J. Robinson* says, "that happening to enter a house, every part of which had been much neglected by its former tenants, I found that the water cistern, among the rest, had come in for its share of carelessness. Previous to emptying it, I thought I perceived a whitish film on the surface, but without further notice I had it subjected to a thorough cleansing. It should be observed, that the cistern could hold about 200 gallons—consequently presented a large surface of the metal. At that time my family used no beverage at their meals, or at any other time, but water, and it struck us that in a few months the health of the children began to decline.

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* Athenæum.

They lost their appetite, and fell away in flesh. They were sent to the sea-side, where they were restored, and came back as healthy as ever. During their absence, happening accidentally to look into the cistern, I discovered one of the zinc rods I am in the habit using, lying at the bottom. This I accounted for, by presuming that the children had been playing with it. On removing the rod, I found that it blackened my fingers. This struck me as deserving attention. This must be metallic lead, and formed—at least its oxide—the base of a salt, the carbonate of the protoxide of lead, a very pernicious salt indeed. It should be here observed, that the poison of lead differs materially from other substances called poisonous. It is not what we call an active poison, and is not accompanied, except when introduced into the system in quantity, by any particular symptoms, on the contrary, it is one of those insidious substances—I mean its salts—which are taken without announcing any peculiarity of taste or smell, but which, gradually introduced into the system through a minute quantity at a time, may eventually produce effects that in all probability will be ascribed to other causes. The effects of all the salts of lead on the system are paralysing, and their action on the wrists and fingers of printers and painters is well known. The latter are subjected to a disease termed the painters' colic, which is understood to be a paralysis of the muscular coat of the intestines. It should be observed, that my family and I discontinued the use of the water, and had a supply from the neighbouring pump. They seemed to thrive and were healthy."

Dr. Robinson now proceeded to ascertain the presence of lead on the water by actual experiment, and took at different times, portions of the water, in all about fifty gallons, "and as I took them I evaporated from a gallon to a fluid ounce. To render the salt of lead, I was desirous to discover, in a more concentrated state, I reduced by the same means, the fifty ounces to four, which I submitted to the following series of experiments. I put the four ounces into four glasses of one ounce each; 1st. glass, on adding hydrosulphuret of ammonia, I had a black precipitate, the sulphuret of lead; 2nd glass, on adding a solution of bichromate of potash, I had a yellow precipitate, the chromate of lead; 3rd glass, on adding a solution of the iodide of potassium, I obtained a primrose-yellow precipitate, the iodide of lead; 4th glass, on introducing a slip of zinc into the fourth, I had the metallic lead adhering. The presence of lead then was sufficiently apparent from the first three tests, but especially from the last, and from this last a thought struck me that I could turn it to a beneficial salutary public purpose. But in order to test its efficiency still further, I selected two rabbits from the same litter, and gave to each, two fluid drachms of a solution of diacetate of lead. Into one of these I had previously introduced a slip of zinc. The result was, the rabbit to which the solution was given that had been treated with the zinc, seemed to suffer no inconvenience, whilst the other died in thirty-five hours after, apparently suffering much pain. I trust that whoever reads these results, will keep in view the importance of the recommendation, that any person possessed of a leaden cistern, should forthwith get for it a temporary zinc bottom to fit inside, and to lay above the other. Once a week, or a fortnight, this bottom should be taken out and carefully cleaned. The metal is wholesome, not expensive, and metallic zinc will be the most convenient for the purpose."

The author cannot but make a few observations on the above extract. There is not the least doubt that lead existed in the water examined by Dr. Robinson, neither can there be any doubt but that metallic zinc would remove the soluble lead, but it appears that the remedy is nearly as bad as the disease, for instead of lead in a soluble form, we have zinc in a soluble form in the water. Now all the salts of zinc are eminently poisonous, and when taken in small doses, act as violent astringents; in fact, they are much more dangerous in their operation than alum, and do not fall very far short of the amount of danger incurred by the continual exhibition of lead.

On April 25th, 1845, a short notice from Dr. Clark was read at the Chemical Society of London, to the effect that, " as lead is the chief poison ever to be apprehended in water, and as its occurrence is not unfrequent where the water has to be conveyed through much length of leaden pipe, it will probably be satisfactory to the society to learn, that this poison may be entirely removed by means of an effective filter."

The filter just spoken of was formed of well washed sand, and has been in use twelvemonths without any apparent diminution of power The author would fear, however, in the absence of any series of experiments on this subject, that it would not be safe to trust to the separation of lead from water by the above method, but that the only thing to be done is to altogether reject the use of lead, and use either earthenware, glass, iron, or zinc, the latter metal seemed to be as good as any in the formation of cisterns. The author has examined many specimens of water kept in zinc cisterns, and has never yet been able to detect the slightest traces of that metal.

ADDITIONS TO SECTION III.

THE substance of the following additions is from a paper on "The means of detecting adulteration in Flour," by M. Donny. *Bulletin de la Société d'Encouragement*, as inserted in *Newton's London Journal, Nov.* 1847.

M. Donny proposes the following plan for the adulteration of flour with potato starch, and has taken advantage of an observation made some time ago by M. Payen, whose numerous indefatigable exertions have thrown such a light upon the chemical history of starch and the various arts in which the natural product is employed. This observation consists in the fact, that a weak solution of potash, which has no visble effect upon starch, possesses, nevertheless, the property of swelling the grains of fecula, and considerably increasing their volume. M. Donny, has examined the action of various alkalies upon starch globules, and finds: 1st, that potash is the alkali which is best suited for experiments of the kind under consideration; 2nd. that the globules of different flours undergo a smaller increase of bulk than others, for instance, wheat globules do not augment much in volume, whilst those of the potato acquire relatively an enormous size; 3rd. that certain flours are much more readily acted on by alkali than others, for instance, a solution of potash, which would cause potato starch globules to increase considerably, may be so weak as to have no action whatever on wheat starch globules.

The solution of potash employed contains 1¾ per cent. of caustic potash. The flour to be examined is to be placed on a plate or glass, diluted with the above solution and inspected by a microscope, the grains of fecula may then be easily detected by their great size compared with the wheat globules, which are not affected by the solution. The operation may be rendered still more certain by adding iodized water to the mixture, after being well dried from the solution, as the blue tint assumed by the potato starch will render the same more apparent.

The difference caused by this process is so great, that it is impossible to be mistaken, the grains of potato starch being by means of the solution increased to a size about 15 times as large as the wheat starch.

Mixture of Wheat flour with Leguminous flour.—Various methods have been proposed to detect the addition of leguminous flour to wheat flour. Some are applicable to all this class of flour, others to a certain one only. M. Donny, after giving a *resumé* of the various methods already in use, states that he has arrived at the following results. The leguminous substances, which when pulverized, are most commonly employed for adulterating wheat flour, are peas, haricot beans, horse-beans, &c. I have already, in common with M. Donny, remarked, that the presence of these substances causes a smell which renders their detection easy. Some of them, such as haricot beans, will not combine in the making of bread, and cannot therefore be employed to any extent. Pease meal will not generally mix well with wheaten flour, and an eye somewhat experienced will easily detect the mixed flour from its general appearance.

All these leguminous meals contain a peculiar substance called *legumine*, which is soluble in water, and may be precipitated by acetic acid, (vinegar). The result of the presence of this matter is, that if the meal of peas or haricot beans be treated with cold water, and a little acetic acid be added to the liquor, it becomes thick, and a white substance (which is legumine) is precipitated, on the contrary, flour from wheat and other species of corn not containing any legumine, furnish on being treated with cold water, and when free from adulteration, a solution which will not furnish any precipitate on being treated with acetic acid. This property has been taken advantage of in order to distinguish fine flour from that which may have been adulterated with one of the above-mentioned substances. This process would be quite perfect if it could be proved, that in consequence of reactions which cannot always be foreseen, the gluten or other nitrogenized matters peculiar to cereals, might not be rendered soluble in water, and partially precipitated by acetic acid. What authorises the doubt on this point, is the difference of opinion existing among chemists who have tried this process. Whatever may be the case, the following is the method proposed by M. Donny, and its efficacy has been proved. This method is founded on the fact, that the flour of leguminous substances always contains portions of cellular tissue, which may be discovered by means of a lens or microscope. In order to expose to view this tissue, (which is reticulated, and consists of hexagonal meshes, and may be easily recognized when once seen), M. Donny, after having placed a small quantity of the adulterated flour on the object-bearer, dilutes it slightly with a solution of potash, of such strength as to dissolve the fecula without touching the tissue. By this means the tissue is laid bare, and its form will be very evident, and if the leguminous flour amounts to only 3 or 4 per cent., it may be discovered with certainty. The only points which require attention is to take care not to agitate the mixture too much while on the object-bearer, for the cellular tissue might thereby be disintegrated, and the operation would thus be rendered more difficult. The solution of potash employed in this experiment, contains about 12 per cent. of caustic potash.

Flour of Vetches and Horse-beans.—These two substances, besides possessing the peculiar characteristics possessed by leguminous substances as above mentioned, and which would be sufficient to distinguished them, have another peculiar feature which has not yet been discovered in any substances. This peculiar feature, which was discovered by M. Donny, has been applied by him, with perfect success, in detecting the presence of these two substances in flour or other mixture. For this purpose the flour is exposed, first to the action of the vapour of nitric acid, and afterwards to that of ammonia The result of which is, that the bean meal will be turned a purple colour, whilst the others will assume a yellowish hue. The following is the method of conducting the experiment. From 15 to 30 grains of the flour to be tested, are to be placed in a small porcelain capsule of from 2 to 3 inches in diameter, which is slightly wetted in order to make the flour adhere to the sides, leaving the bottom empty, and in this empty space, a small quantity of nitric acid is placed so as not to be in immediate contact with the flour. The capsule is then covered with a small glass disc and slightly heated by means of a spirit lamp. The acid becomes vaporized and acts on the flour, causing it to assume a yellow tint. This tint is, however, not uniform, it being deeper at the lower part nearest the acid, and getting gradually lighter towards the top. The operation must be stopped whilst the top edge is still white, and before it has been sensibly affected by the nitric acid. The nitric acid which remains is then thrown away, and ammonia substituted. The operation is then left to itself, and a ring of a bright red colour will be formed around the middle of the capsule, *i. e.* in that part where the action of the acid has neither been too strong nor too weak. As was before observed, under the same circumstances pure wheat flour becomes yellow.

If a mixture of the two flours be operated upon, a pink tint will be produced in depth proportioned to the quantity of bean meal.

The colour, which is doubtful to the naked eye, is very clearly seen under the lens of the microscope, the tint being produced, not by an uniform colouring of the mass, as might be imagined, but by the presence of a certain number of coloured particles, consisting of grains of a deep red colour, disseminated in a white or slightly yellowish mass, which renders their detection very easy and certain. By this means, 4 per cent., and even a less quantity of bean meal in wheaten flour may be detected, and vetch flour may be discovered by the same method.

Horse-bean meal is, of all leguminous substances, that which seems to mix best with wheaten flour, it gives greater tenacity to the dough, but imparts to the bread a disagreeable grey colour.

Maize and Rice flour.—Rice flour could only be added to wheat flour in particular cases, but the flour of maize is frequently used for that purpose. Maize and rice flour may be distinguished from wheat flour, by the fact of their presenting under the microscope angular surfaces, which are not seen in the latter. These fragments are produced by portions of the husk, which is hard in rice and maize, while it is always pulverulent and farinaceous in even the hardest kinds of wheat. When any suspected flour is to be tested, M. Donny advises the gluten to be first separated by mechanical means, (this process has already been described in section III), to collect the starch and submit it (especially the coarser portion, which is quickly precipitated in water), to microscopic inspection, which immediately shows the angular fragments above-mentioned. It is generally advisable, for this purpose, to have a lens of small magnifying power only, which will more closely show the difference between the fragments in question and the grain of starch.

Buck-wheat flour.—Buck-wheat flour, like the preceding, presents angular masses, which result from the agglomeration of grains of starch set closer together. These masses may be easily detected in a mixture of buck-wheat with the best wheat flour. For this purpose, it is only necessary to separate the gluten, and take the thickest part of the starch, which is to be submitted to the microscope. The general form of these fragments is prismatic, and similar to what is called, in commerce, needle starch.

These three latter kinds of flour, maize, rice and buck-wheat, are rough to the touch, the same as potato fecula, they have not that softness and unctuosity possessed by wheat flour, which property is diminished by adulteration.

Linseed Meal—One method of adulteration, which would scarcely have been thought of, but which has been extensively practised in Belgium, consists in adding linseed-meal to flour of grain, but more particularly rye. Linseed meal, on examination through the microscope, may be distinguished by the presence of small fragments (generally square) of a red colour, of nearly uniform size, and very small (smaller than the grains of starch). These fragments, which are not perceptible when the grain has been previously deprived of its bark, appears, from this circumstance and their peculiar colour, to belong really to the husk of the grain; their square form and uniform dimensions, show that these fragments are not the accidental result of mechanical trituration. This regularity of form depends on a circumstance, which it will not, perhaps, be uninteresting to examine. If a mixture of flour containing linseed be treated with a solution of potash containing from 10 to 14 per cent. of alkali, the starch will be dissolved, and the fragments above-mentioned will remain distinctly visible, notwithstanding their small size, in the midst of a mass of yellowish-white colour, the bread appearing of a reddish-brown colour.

ADDITIONS TO SECTION IV.

Detection of Potato Starch in Bread.—This process is also by M. Donny. Take a small quantity of the crumb of the suspected bread, and wet it through with a solution of potash (containing 1¾ per cent. of alkali,) a portion of the liquid is then squeezed out and placed under a lens; on inspecting it, grains of fecula will be discovered by their having swelled considerably, they are, however, more difficult to be distinguished by their being mis-shaped by the baker, but on drying them, and treating them with iodine, the detection will be made with the same facility as when flour is operated on.

Detection of Horse-beans, and Vetch meal in bread.—A portion of the crumb is immersed in cold water for two hours, it is then thrown into a sieve, and the liquor which swims from it allowed to settle, it divides into two strata. The upper stratum is then removed and carefully evaporated, and the residuum is partially dissolved by alcohol, after which the alcoholic solution is evaporated. The residuum of this evaporation, which must be carefully spread upon the sides of the capsule, is submitted to the successive action of the vapours of nitric acid and ammonia, and under the reaction of these reagents, the residuum will assume the characteristic red colour of bean meal.

Detection of Linseed meal in bread.—This substance may by means of potash solution (containing from 10 to 14 per cent. of alkali,) be detected in bread even if the flour from which it was prepared only contain from 2 to 3 per cent. For this purpose it is only necessary to crumble a piece of the crumb into small pieces, steep it in the solution of potash, and examine the liquor resulting from it.

On the influence of Potato meal, on the yield of Bread.—The following are analyses of the potato and wheat flour, by the author. They were published by Mr. Taylor, in "The Farmer's Journal."

100 parts of normal potato yielded,—

Water	74·34
Starch	17·85
Gluten	3·10
Gum, sugar, oil, ligneous matter and salts	4·71
	100·00

Therefore, 100 parts yielded of

Water	74·34
Solid matter	25·66
	100·00

And 100 parts of potato, perfectly free from water, contain,—

Starch	69·56
Gluten	12·10
Gum, sugar, oil, ligneous matter, and salts.	18·34
	100·00

The potato, in its ordinary state, contains ·382 per cent. of nitrogen.

100 parts of perfectly dry potato contain 1·49 parts of nitrogen.

Examination of Wheat flour.

100 parts contained—

Water	13·26
Solid matter	86·74
	100·00

100 parts of the same wheat flour contain 2 parts of nitrogen.

100 parts of the perfectly dry wheat flour contain 2·31 parts of nitrogen.

So that, from the above analyses, it is evident that wheat flour, in any state, is considerably superior to potato meal, that is, even supposing the latter to be perfectly free from water, a state in which it would be very difficult to keep it for ordinary consumption.

Calculating the nutritive powers of potato meal and wheat flour, (perfectly dry) and of wheat flour and potato in their ordinary state, according to their amounts of nitrogen, and taking dry wheat flour as 100, the rest would be as shown below :—

Dry wheat flour . . .	100
Ordinary ditto	86·5
Dry potato	64·5
Ordinary potato . . .	16·5

and the following table shows the quantity of potato in the two states, and ordinary wheat flour requisite to replace in nutritive power 100 parts of dry wheat flour:

Dry wheat flour . . .	100·0
Ordinary ditto . . .	115·5
Dry potato	155·0
Ordinary ditto	600·0

I will now give an idea of the number of quartern loaves capable of being made from 1 sack of flour. A sack of flour weighs 280lbs., and is calculated to make 84 quartern loaves of 4 lbs. 5 oz. each. The bakers, however, admit that if the flour be of good marketable quality, it will make 86 such loaves, or 370 lbs. 14 oz. of bread, equal to 92½ loaves of the present weight, 4 lbs. each.

According to this statement, the bread ought to contain about 24 per cent. of water over and above that naturally contained in the flour. Dumas states, the ordinary white bread of Paris contains from 44 to 45 per cent. of water. I have found that the average amount of water in new bread from various parts of London, to be 39 per cent., and from bread one day and a half old 34 per cent.

According to the analysis of flour just quoted, one sack or 280 lbs. of ordinary flour would yield 242·872 lbs. of dry flour, and 37·128 lbs. of water, or in round numbers 242¾ lbs. of flour, and 37 lbs. of water, therefore the actual quantity of water present in the bread thus made is 34·5 per cent., being 4½ per cent. less than is actually found in ordinary bread, which is possibly owing either to slack baking or the introduction of potato or potato meal.

I will now examine the influence potato meal has on bread, as regards the quantity of water it will take up, and consequently its depreciation as a nourishing agent.

Four and a half pounds of potato meal, and 10 lbs. of flour, produce, as nearly as possible, 25 lbs. of bread, or six full weight quartern loaves*. Now I have already shown that under ordinary circumstances 280 lbs. of flour produce 370 lbs. 14 oz. of bread, but by the use of potato meal in the proportions just stated, 280 lbs. of the mixture would produce no less a quantity than 480 lbs. of bread, equal to 120 quartern loaves, instead of 92½ as with genuine flour. Now it is quite evident that this increase of 27½ quartern loaves can only be due to the

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* See Penny Magazine, p. 67, Vol. v.

assumption of that weight, or 110 lbs. of water, so that the baker can get over and above his ordinary profit on a sack of flour, the full price of 27½ quarterns of bread, (at least sold as such, but in reality only water,) by the use of potato meal in the above proportions. The bread thus made would contain about 50 per cent. of water. The amount of nitrogen, or nourishing principle, the bread thus made contains, stands thus, if we assume wheat flour and dry potato meal to contain the amounts of nitrogen assigned to them by my analyses. Ordinary wheat flour to contain 2 per cent., and dry potato meal 1·49 per cent.

A 4 lb. loaf made without potato meal would contain 425 grains of nitrogen, or 1·518 per cent., being a larger quantity than is contained in an equal weight of perfectly dry potato meal, and a 4 lbs. loaf made with potato meal in the above stated proportion would contain 300 grains of nitrogen, or 1·071 per cent., so that the nourishing power of these two breads would be in the following proportion, taking bread made from genuine flour as 100.

Genuine bread . . .	100
Bread made with the mixture of potato meal, and flour . .	70·58

ADDITIONS TO SECTION VI.

The following analyses of the beers of other brewers, than those cited in the body of the present work, are by the author, and the samples operated on have been procured from the retailer :—

Calvert and Co's. Porter.

Specific gravity	1012·8
Alcohol	5·412
Extract	5·231
Acetic acid	·126
Water	89·231
	100·000

Calvert and Co's. Stout.

Specific gravity	1024
Alcohol	6·525
Extract	7·525
Acetic acid	·107
Water	85·843
	100·000

Truman and Co's. Porter.

Specific gravity	1014·4
Alcohol	5·781
Extract	4·887
Acetic acid	·124
Water	89·208
	100·000

Truman and Co's. Stout.

Specific gravity	1019
Alcohol	6·252
Extract	6·264
Acetic acid	·157
Water	87·327
	100·000

In justice to the Messrs. Holts, the author must candidly say that their beer is much superior to any that has come under his observation, and he believes it to be owing to the fermentation having been carried to a greater extent than is usual with the London houses; this, however, is a point which rests more with the practical brewer than the chemist

The following table shows the relation between the specific gravity and per centage of alcohol (specific gravity ·825) by weight, of any sample of dilute spirit likely to be obtained in the estimation of the amount of alcohol in either beer, wine, or any other spirituous liquid employed in domestic economy :—

Specific gravity.	Per centage of alcohol.
·94597	41·17
·94637	40·82
·94696	40·47
·94756	40·11
·94816	39·75
·95876	39·39
94936	39·02
·94997	38·65
95048	38·27
·95110	37·87
95181	37·50
·95243	37·10
95305	36·70
·95368	36·30
·95430	35·89
95493	35·48
·95555	35·06
·95617	34·64
·95675	33·21

Specific gravity.	Per centage of alcohol.
·95741	33·77
·95804	33·33
·95867	32·88
·95931	32·43
·95995	31·99
·96058	31·50
·96122	31·00
·96185	30·55
·96248	30·06
·96311	29·57
·96374	29·07
·96438	28·57
·96500	28·06
·96563	27·53
·96625	27·00
·96689	26·47
·96752	25·92
·96816	25·37
·96880	24·81
·96944	24·24
·97009	23·64
·97074	23·07
·97139	22·48
·97206	21·87
·97273	21·26
·97340	20·64
·97410	20·00
·97497	19·35
·97550	18·69
·97622	18·03
·97696	17·35
·97771	16·66
·97848	15·96

Specific gravity.	Per centage of alcohol.
·97926	15·25
·98006	14·53
·98090	13·79
·98176	13·04
·98264	12·28
·98356	11·50
·98452	10·71
·98551	9·91
·98654	9·09
·98761	8·25
·98872	7·40
·98991	6·54
·99195	5·66
·99244	4·76
·99380	3·84
·99524	2·91
·99675	1·96
·99834	·99

ADDITION TO SECTION VIII.

In case wine is adulterated, or made up, with cider or perry, the following simple method will reveal the sophistication :—

Evaporate a small quantity of the suspected wine to dryness in a water-bath, then gradually expose it to a slightly increasing temperature by means of a spirit-lamp, when the peculiar smell of either baked apples or pears will be present, according to the liquid employed in the adulteration.

ADDITIONS TO SECTION XI.

The following valuable paper by Mr. Warrington, is extracted from the Memoirs of the Chemical Society, vol. ii. p. 73. I prefer giving it in the author's words, as any attempt to abridge or otherwise alter it, would, I fear, very much lessen its value.

"In examining lately some samples of tea which had been seized from their being supposed to be spurious, my attention was arrested by the varied tints which the sample of green tea exhibited, extending from a dull olive to a bright greenish-blue colour. On submitting this to the scrutinizing test of examination by the microscope with a magnifying power of one hundred times linear, the object being illuminated by reflected light, the cause of this variation of colour was immediately rendered apparent, for it was found that the curled leaves were entirely covered with a white powder, having in places a slightly glistening aspect, and these were interspersed with small granules of a bright blue colour, and others of an orange tint; in the folded and, consequently, more protected parts of the curled leaves these were more distinctly visible. By shaking the whole of the sample mechanically for a short time, a quantity of powder was detached, and from this a number of the blue particles were picked out under a magnifying glass by means of the moistened point of a camel's hair pencil. On being crushed in water between two plates of glass, they presented, when viewed by transmitted light, a bright blue streak. This change in the method of illuminating the object was necessary for the purpose of seeing the action of the following tests. A minute drop of a solution of caustic potash was introduced by capillary action between the glass plates, and the blue tint was immediately converted to a dark bright-brown, and the original blue colour again restored by the introduction of a little dilute sulphuric acid. It was therefore evident that these particles consisted of the ferrocyanide of iron, or Prussian blue. The orange granules on examination proved to be some vegetable colouring substance.

"To ascertain if possible the mixture of the white powder observed in this sample, I separated some of the dust, and heated it to redness, with free exposure to the air, the whole of the vegetable matter and Prussian blue were thus destroyed, and a white powder with a shade of brown was obtained. This dissolved, by boiling in dilute hydrochloric acid, and when tested with solution of chloride of barium, gave indications of sulphuric acid, it was then evaporated to dryness, and again acted on by very dilute hydrochloric acid, a trace of silica remained undissolved, solution of ammonia being added, threw down a little alumina and oxide of iron, and the ammoniacal solution treated with oxalic acid, gave a precipitate of oxalate of lime. A second portion of the powder, after calcination, was boiled for some time in distilled water, and yielded a solution containing sulphate of lime, this latter substance, therefore, and some other substance containing silica, alumina, and perhaps lime, formed the white powder observed. This substance I believe to be kaolin, or powdered agalmatolite, the figure stone of the Chinese. I should venture this conjecture not only from the ingredients found, but from the gloss which the rubbed parts of the curled leaves always assume, and which these materials would be well fitted to produce*.

"Four or five other samples of green tea were then submitted to the same method of examination, and only one of them proved to be free from these blue granules, this sample was a high priced tea, and had been purchased about two years, it appeared covered with a very pale blue powder, instead of the white, with the blue particles interspersed, as exhibited by the others.

"Being still in doubt as to whether this powder and colouring was an adulteration practised in this country or not, I applied to a most extensive wholesale dealer of the highest respectability, and from him obtained a series of samples, each being an average from a number of original chests, and from these I gathered the following results, by examination as before with the microscope. No. 1, Imperial.—The leaf when seen beneath the superficial covering, was of a bright olive-brown colour, with small filaments on its surface; it was covered with a fine white powder, with here and there a minute bright blue particle, at times having the appearance of a stain. No. 2, Gunpowder, similar to No. 1, but the filaments not visible, this may arise from the tight and close manner in which the leaf was curled. No. 3, Hyson, the same as No. 1, the blue particles being perhaps more frequent. No. 4, Young Hyson, the same. No. 5, Twankey, the leaf of this had more of a yellow hue, and was profusely covered with white powder, having the blue particles also more thickly strewn on its surface. It was evident from the examina-

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* Probably this powder was a mixture of talc and sulphate of lime, see page 168, article "Tea."

tion of these teas, that they arrive in this country in an adulterated or factitious state.

" On detailing what I had thus found to the friend who had favoured me with the preceding samples, he enquired if I had examined any *unglazed teas*. This appellation immediately arrested my attention, and I requested to inspect some of them, and found that they possessed externally a totally different aspect, indeed, as far as their colour was concerned, not to be like green teas. They were of a yellow-brown tint, without a shade of green or blue, but rather tending on the rubbed part to a blackish hue. I afterwards received two samples of unglazed teas specified as of very fine quality accompanied by two others of the ordinary, or as they are called in contradistinction, *glazed* varieties, also of a very superior quality. These were, therefore, immediately submitted to examination. No. 6, Unglazed Gunpowder, it presented the same colour under the microscope as when viewed by the unassisted eye, was filamentous, and covered with a white powder inclining to a brown tint, but no shade of blue was visible. No. 7, Unglazed Hyson, the same as No. 6. No. 8, Gunpowder Glazed, filamentous, covered with a powder of a very pale blue, and the blue granules being but rarely seen. No. 9, Hyson, the same as No. 8. No. 10, Pidding's Howqua, purchased at Littlejohn's, at 8*s*. 6*d*. per catty package. This was evidently of the glazed variety, it was filamentous, and covered with a pale blue powder, interspersed with bright blue granules. No. 11, entitled, Canton Gunpowder, this was a splendid sample of the glazed variety, as far as colour was concerned, it was more thickly powdered and blued than any I have yet examined, and the dust rose from it in quantity, when poured from one paper to another. A great many other samples of ordinary green teas, were examined with much the same result, the cheaper teas, or those in general use, and which form the bulk of the imports being similar to Nos. 5 and 11, and being represented by Twankeys, low priced Hyson, and Gunpowders.

" After several unsuccessful experiments, I found that with a little care, the whole of this powder or facing, if I may be allowed the term, it being entirely superficial, could be easily removed from the tea, by simply agitating the sample briskly for a few seconds in a phial filled with distilled water, and throwing the whole on a lawn or muslin filter, in order to strain the liquid and the suspended matter from the leaves as rapidly as possible.* After this operation, the tea presented a totally altered aspect, as may be supposed, in fact, changing its colour from a blueish-green to a bright and lively yellow, or brownish-yellow tint, and I found that with care it could be re-dried at a temperature below 212°, without even uncurling the leaf, and without apparent loss of any of its characteristic qualities. When the drying was completed, the sample appeared nearly as dark as the ordinary black teas, and when examined by the microscope, presented a smooth surface, perfectly free from the previously observed facing, and having all the characters of black tea, with the exception of the corrugated aspect, which is common to the greater part of the teas of the latter variety, and which evidently arises from their

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* In determining the amount of nitrogen in glazed teas, it will be necessary to operate upon them in some such manner as described by Mr. Warrington. If this be rapidly executed, the tea may be dried, and the operation proceeded with as usual.

having been exposed in the operation of drying to a much higher temperature. The greenish coloured turbid liquid, which passed through the meshes of the muslin filter, was allowed to deposit the matter suspended in it, which was then washed and collected. These sediments, obtained from various samples, were submitted to the following course of chemical examination. They were in the first instance tested with a solution of chlorine gas, in water, to ascertain if the colouring matter, were indigo or other vegetable colouring matter—this substance, as we shall presently see, having been supposed by some persons, to be the one employed by the Chinese for the purpose of imparting the blue tint to some of their green teas. In no case, however, that I have yet examined, have I found this to be the case, but the colouring agent has invariably proved to be the ferrocyanide of iron or Prussian blue.* The presence of this compound was next evidenced by adding a small drop of caustic potash to a little of the sediment under examination, when the green hue was instantly converted to a bright reddish-brown, the original blue appearance being again restored by the subsequent addition of a little diluted sulphuric acid. The other ingredients of the facing were sought for in the manner stated in the previous part of this paper, and also by heating a part of the sediment after calcination, and free exposure to the air with carbonate of soda to fusion, which in the case of sulphate of lime being present, formed sulphate of soda, and carbonate of lime, and these were each subsequently tested for.

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* In some cases I have, however, found Indigo as well as Prussian blue, sometimes the former and sometimes the latter, at others a mixture of both.

"By these means Nos. 5, 8, 10, and 11, were found to be faced with Prussian blue, and sulphate of lime. Nos. 6, and 7, gave no indication of Prussian blue, but of sulphate of lime only. The sulphate of lime from some samples, appeared to be crystallized gypsum reduced to a fine powder, the coarser particles still exhibiting a crystalline structure.

"Through the kindness of Mr. Greene, of the East India House, I was enabled to obtain samples of the Assam teas in a genuine condition; No. 12, Imperial; No. 13, Gunpowder; No. 14, Hyson. They had none of the blue granules, were very filamentous, and presented the same appearance as the unglazed varieties, but brighter in colour; the facing was apparently sulphate of lime. No. 15, Assam Hyson of the last importation, it was of the unglazed variety, with the superficial white powder, having a slight brown tint, and consisting of a minute quantity of sulphate of lime, with a little alumina.

"It appears, therefore, from these examinations, that all the green teas that are imported into this country, are faced, or covered, superficially with a powder, consisting of either Prussian blue and sulphate of lime, or gypsum, as in the majority of samples examined, with occasionally a yellow or orange-coloured vegetable substance, or of sulphate of lime, previously stained with Prussian blue, as in Nos. 8 and 9; and one of those first investigated, or of Prussian blue, the orange-coloured substance, with sulphate of lime and a material supposed to be kaolin, as in the original sample, or of sulphate of lime alone, as in the unglazed varieties. It is a curious question, what the object for the employment of this facing can be? Is it simply added as an absorbent of the last portion of moisture which cannot be entirely dissipated in the process of drying? or, whether is it only, as I believe, to give that peculiar bloom and colour so characteristic of the varieties of green tea, and which is so generally looked for by the consumer, that the want of the green colour, as in the unglazed variety, I am informed, affects the selling prices most materially. This surely can only arise from the want of the above facts being generally known, as it would be ridiculous to imagine that a painted and adulterated article, for such it must really be considered, should maintain a preference over a more genuine one."

Mr. Warrington further remarks:—

"That in looking over the various authors who have written on the subject of tea, I observe the following curious statements bearing on the above subject, and which fully confirm many of its results."

I shall, therefore, follow the example, and give them, as he has done, inasmuch as they are especially interesting, in proving the correctness of Mr. Warrington's views.

In Dr. Horsfield's valuable translation* on the subject of the manufacture of Tea in Java, we find, at page 36, the following dialogue:—

"*Visitor.*—Is it, indeed, the case that tea is so much adulterated in *China?*

"*Superintendent.*—Unquestionably! but not in the interior provinces, for there exist rigid laws against the adulteration of tea; and all teas as they come out of the plantations, are examined on the part of Government, to

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* Essay on the Cultivation and Manufacture of Tea in Java, translated from the Dutch, by Thomas Horsfield, M.D., F.R.S.

determine whether they are genuine, but in Canton, which is the emporium of teas, and especially at Honân, many sorts, indeed, most teas are greatly adulterated, and that with ingredients injurious to health, especially if too much of these ingredients be added. This is especially the case with the *green* tea, in order to improve the colour, and in this manner to add to the value of teas in the eyes of the common consumers.

" *Visitor.*—Are these ingredients known ?

" *Superintendent.*—Most of them are certainly known, they have been communicated to government (we presume the Dutch government), while, at the same time, the privilege has been requested that they might not be employed here, and although this occasions loss, the request has been granted, and it has been ordered by government, that not the least admixture should take place, either to improve the colour or taste of the tea, even in such cases where this might be desirable."

Dr. Royle* states, " The Chinese, in the neighbourhood of Canton, are able to prepare a tea which can be coloured and made up to imitate various qualities of green tea, and large quantities are thus yearly made up," and Dr. Dickson,† " The Chinese annually dry many millions of pounds of the leaves of different plants to mingle with the genuine, as those of the ash, plum, &c., so that all spurious leaves found in parcels of bad tea, must not be supposed to be introduced into them by dealers in this country. While the tea trade was entirely in the hands of the East India Company, few of these adulterated teas were shipped for this country, as ex-

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* Article " Tea," Medical and Dietetical, Penny Cyclopedia.

† Article "Tea" in the Penny Cyclopedia.

perienced and competent inspectors were kept at Canton to prevent the exportation of such in the Company's ships, but since the trade has been opened, all kinds find a ready outlet, and as the demand often exceeds the supply, a manufactured article is furnished to the rival crews."

Mr. Warrington says, "during these investigations, I have received samples of tea, both green and black, imported into this country from China, which are known by the most experienced brokers not to contain a single leaf of tea, and which were sold at public sale in bond at from 1¾d. to 2d. per pound."

Again, "The green tea for exportation, undergoes some process which changes its colour, giving it a bluish-green hue."

Mr. Davis gives the following important information on this subject: "The tea farmers* who are small proprietors, or cultivators, give the tea a rough preparation, and then take it to the contractors, whose business it is to adapt its further preparation to the existing nature of the demand.

"Young Hyson,† until spoiled by the large demand of the Americans, was a delicate genuine leaf." As it could not be fairly produced in any large quantities, the call for it on the part of the Americans was answered by cutting up and sifting *other* green teas through sieves of a certain size, and as the Company's inspectors detected the imposture, it formed no portion of their London importation. But the abuse became still worse of late, for the coarsest *black* tea-leaves have been cut up, and then

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* Davis's "Chinese," Vol. II, p. 458.

† Ibid., Vol. II, p. 464.

coloured with a preparation resembling the hue of green teas." At page 466, Mr. Davis, continues, after speaking of the frauds with spurious and adulterated teas which the Chinese had endeavoured to practice: "But this was nothing in comparison with the effrontery which the Chinese displayed in carrying on an extensive manufactory of *green teas* from *damaged black leaves*, at a village or suburb called Honân."

"The remission of the tea duties in the United States, occasioned in the years 1832 and 1833, a demand for green teas at Canton, which could not be supplied by arrivals from the provinces. The Americans, however, were obliged to sail with cargoes of green teas within the favourable season, they were determined to have the teas, and the Chinese were determined that they should be supplied. Certain rumours being afloat concerning the manufacture of green tea from old black leaves; the writer of this became curious to ascertain the truth, and with some difficulty persuaded a Hong merchant to conduct him, accompanied by one of the inspectors, to the place where the operations were carried on. Entering one of these laboratories of fictitious Hyson, the parties were witnesses to a strange scene." The damaged black tea-leaves, after being dried, were transferred to a cast-iron pan placed over a furnace, and stirred rapidly with the hand. A small quantity of turmeric, in powder, having been previously introduced; this gives the leaves a yellowish or orange tinge, but they were still to be made green. For this purpose, some lumps of a fine blue were produced, together with a substance in powder, which from the names given to them by the workmen, as well as their appearance, were known at once to be *Prussian blue* and *gypsum*. These were triturated finely together with a small pestle, in such proportions as reduced the dark colour of the blue to a light shade, and a quantity equal to a teaspoonful of the powder being added to the yellowish leaves, these were stirred as before, over the fire, until the tea had taken the fine bloom colour of Hyson, with very much the *same scent*. To prevent all possibility of error regarding the substances employed, samples of them were carried away from the place. The Chinese seemed quite conscious of the real character of the occupation in which they were engaged, for on attempting to enter several other places where the same process was going on, the doors were speedily closed upon the party; indeed, had it not been for the influence of the Hongist who conducted them, there would have been little chance of seeing as much as they did."* It is an interesting and important question to determine, whether the same system of artificial colouring enters at all into the manufacture of the more genuine teas brought to this country. "One fact is well ascertained and undeniable, that the Chinese themselves do not consume those kinds of green teas which are prepared for exportation.† The young Hyson and Pekoe teas made from the green-tea plant, have a yellower, and, as it were, a more *natural* hue, than the blueish green which distinguishes the elaborated teas imported to us." Mr. Bruce, states,‡ That in the last operation for colouring the green teas, "a mixture of sulphate of lime and indigo, very finely pulverized and sifted through fine muslin, in the propor-

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* Davis's "Chinese," Vol. II, p. 468.

† Ibid., Vol. II, p. 469.

‡ Report on the Manufacture of Tea, and on the extent and produce of the Tea plantations in Assam, by C. A. Bruce, Superintendent of Tea Culture, presented to the Tea Committee.—August 16, 1839.

tion of three of the former to one of the latter is added; to a pan of tea containing about 7 lbs., about half a teaspoonful of this mixture is put, and rubbed and rolled along with the tea in the pan for about an hour. The above mixture is merely to give it a uniform colour and appearance. The indigo gives it the colour, and the sulphate of lime fixes it. The Chinese call the former *youngtin*, the latter *acco*."

Mr. Warrington, here observes, that "Indigo, however, as previously stated, has never yet been met with in any of the green teas of commerce that have fallen under my notice."

The following curious observation occurs in Maculloch's "Commercial Dictionary," "Blue is a favourite colour with the Chinese, and in 1810-11, the imports of Prussian blue into Canton from England, amounted to 253,200 pounds. But for some years past, the Chinese have not imported a single pound weight. The cause of the cessation of the trade deserves to be mentioned. A common Chinese sailor, who came to England in an East Indiaman, having frequented a manufactory where the drug was prepared, learned the art of making it, and on his return to China, he established a similar work there with such success, that the whole empire is now supplied with native Prussian blue."

On the determination of Nitrogen in Tea.—The process of determining nitrogen, which was contrived by Will and Varrentrap, is too well known to chemists to need description here. A modification of this plan, however, due to Peligot, deserves a somewhat detailed account, as it is much more rapid and less expensive than the method in general use.

M. Peligot burns the substance with soda-lime in the usual manner, but instead of collecting the ammoniacal products in hydrochloric acid, he employs in lieu, sulphuric acid of a known strength and in known quantity. After the operation, he determines the amount of sulphuric acid remaining, *i. e.* not neutralized by the evolved ammonia, by means of a solution of sugar-lime, and from the amount of sulphuric acid which has disappeared during the process, is calculated the quantity of nitrogen present in the substance examined. This process is tolerably exact, but is still susceptible of some decided improvement—which I have thus effected. The following is the substance of a paper read at the Chemical Society, November 15.

I found that the process, as planned by Peligot, was liable to error from several causes. The first was the alterable nature of the sugar-lime solution; the second, the use of the burette, or dropping tube; and, thirdly and lastly, the difficulty of finding the exact point of neutralization in the determination of the amount of acid left intact after the operation.

The first difficulty was removed by the use of a solution of caustic soda, specific gravity 1018. The second, by the substitution of a Schuster's alkalimeter for the burette; and lastly, the employment of a decoction of logwood instead of litmus, the former being very much more delicate in its operation than the latter. While an excess of acid remains in the liquid under examination, the logwood merely turns yellowish-brown, but when the slightest possible excess of alkali is added, it becomes a deep blueish-black.

ON THE USE OF THE FLESH OF DISEASED ANIMALS AS AN ARTICLE OF FOOD.

From the public papers, and from other sources, I have been enabled to ascertain that cattle in a frightfully diseased state are continually sold for the purpose of forming an article of food. Cheap sausages are thus manufactured, and the best-looking part of the meat sold in the usual manner. It is also an extraordinary thing, that horses' tongues are never found with that portion of the flesh in use for canine and feline consumption; they are commonly salted and sold as neats' tongues; now such a procedure as this must be prejudicial in the greatest degree to the public health, for horses are seldom killed until they are in such a state of disease as to be totally unfit for further employment in the usual manner.

Having thus cursorily reviewed the subject of flesh, I will now pass on to fish. A great quantity of the fish sold to the humbler classes of society, is in a totally unfit state for use, more especially the salted or dried portion. Herrings, haddock, &c., having partially undergone decomposition before the salting process has been commenced, are unfit for use as articles of food, and the greater portion of very cheap dried fish is in this predicament. In fact, I have no doubt that many distressing ailments have arisen from this source, in the same manner as from the celebrated "sausage poison" mentioned by Leibig.

Dr. Weiss, of Bacnang, in Wurtemberg, has observed twenty-nine cases of poisoning of this class, out of which number there were six deaths. Smoked meats, as before observed, are not the only animal matters that undergo an alteration which will transform them into an essentially poisonous substance. Pork is especially prone to undergo this peculiar change. The nature, however, of the substance formed is not at all known, although many experimenters have published their researches on the nature of this poisonous principle, which is developed spontaneously, more especially in smoked meats.

Emmert thought that the poison was hydrocyanic acid; but on after experiment, it was found that not a trace of this substance could be separated from the altered meat.

Others have thought it has been pyroligneous, and others again, some peculiar fatty matter, but each experimenter has left as much to do as there was before he commenced his researches, for the nature of the substance is still as unknown as ever.

Many persons have stated that the meat of diseased cattle is not at all unhealthy as food; this position, however, cannot, I think, be maintained. Again, the milk of diseased cows is eminently injurious, and I have no doubt that butter and cheese manufactured from such an article has a decidedly injurious tendency.

Table for ascertaining the per centage strength of sulphuric acid by its specific gravity for alkalimetrical purposes, by Dr. Ure:—

Specific gravity.	Per centage.
1·8485	81·54
1·8475	80·72
1·8460	79·90

Specific gravity.	Per centage.
1·8439	79·09
1·8410	78·28
1·8376	77·46
1·8336	76·65
1·8290	75·83
1·8233	75·02
1·8179	74·20
1·8115	73·39
1·8043	72·57
1·7962	71·75
1·7870	70·94
1·7774	70·12
1·7673	69·31
1·7570	68·49
1·7465	67·68
1·7360	66·86
1·7245	66·05
1·7100	65·23
1·6993	64·42
1·6870	63·60
1·6750	62·78
1·6630	61·97
1·6520	61·15
1·6415	60·34
1·6321	59·52
1·6204	58·71
1·6090	57·89
1·5975	57·08
1·5868	56·26
1·5760	55·45
1·5648	54·63

Specific gravity.	Per centage.
1·5503	53·82
1·5390	53·00
1·5280	52·18
1·5170	51·37
1·5066	50·55
1·4960	49·74
1·4860	48·92
1·4760	48·11
1·4660	47·29
1·4560	46·48
1·4460	45·66
1·4360	44·85
1·4265	44·03
1·4170	43·22
1·4073	42·40
1·3977	41·58
1·3884	40·77
1·3788	39·95
1·3697	39·14
1·3612	38·32
1·3530	37·51
1·3440	36·69
1·3345	35·88
1·3255	35·06
1·3165	34·25
1·3080	33·43
1·2999	32·61
1·2913	31·80
1·2826	30·98
1·2740	30·17
1·2654	29·35

Specific gravity.	Per centage.
1·2572	28·54
1·2490	27·72
1·2409	26·91
1·2334	26·09
1·2260	25·28
1·2184	24·46
1·2108	23·65
1·2032	22·83
1·1956	22·01
1·1876	21·20
1·1792	20·38
1·1706	19·57
1·1626	18·75
1·1549	17·94
1·1480	17·12
1·1410	16·31
1·1330	15·49
1·1246	14·68
1·1165	13·86
1·1090	13·05
1·1019	12·23
1·0953	11·41
1·0887	10·60
1·0809	9·78
1·0743	8·97
1·0682	8·15
1·0614	7·34
1·0544	6·52
1·0477	5·71
1·0405	4·89
1·0336	4·08

Specific gravity.	Per centage.
1·0268	3·260
1·0206	2·446
1·0140	1·6300
1·0074	0·8154

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