

## **Chemical observations on sugar.**

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C H E M I C A L  
O B S E R V A T I O N S  
O N  
S U G A R.

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By EDWARD RIGBY.

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# CHEMICAL OBSERVATIONS

O N

## S U G A R.

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### S E C T I O N I.

#### *INTRODUCTORY.*

SUGAR has so long been an important and extensive article of commerce, that its natural history, the mode of its culture, and the various processes, by which it is purified, and otherwise prepared, are very well known. It is, likewise, so universally made use of, for a variety of æconomical purposes, that its general properties are sufficiently understood. But until very lately, little progress has been  
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made in the chemical investigation of its constituent principles; the various accounts of the chemical nature of sugar, given by different writers, being sufficient proofs of its true analysis being unknown to them.

By some it has been described as the native salt of a vegetable, rendered inflammable by the mixture of a certain portion of oil.—By others it has been called an essential salt, consisting of an acid united with a large quantity of a very attenuated and mucilaginous earth, and with a certain quantity of sweet and not volatile oil. And by others it has been said to be a native soap, consisting of an oil rendered miscible with water, by means of a saline substance.

THESE accounts are, obviously, too vague and indeterminate, not to say unintelligible, to be admitted as chemical definitions, and they appear, evidently, to have been derived



rived from experiments which were too imperfect to exhibit a true analysis of this substance. For until the experiments which were made on sugar, a very few years ago, by those celebrated and indefatigable chemists Bergman and Scheele, and which are, certainly, the only ones which lead to a rational conjecture respecting its composition, the only processes employed for this purpose were simple distillations, without addition, by different degrees of heat.

FROM the experiments of Scheele and Bergman, which have been alluded to, it is, however, probable, that sugar is composed of a peculiar acid and phlogiston, and the process by which a separation of these principles may be effected, is as follows.

To one part of pure refined sugar, finely powdered, add three parts of nitrous acid; expose this mixture in a glass alembic, to a very gentle heat; a violent effervescence will ensue, and phlogisticated nitrous acid

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will



will be condensed in the head of the alembic. When nearly one-half of the nitrous acid is distilled, three additional parts of the nitrous acid should be mixed with the residuum in the alembic; a second distillation will now take place, and when the residuum begins to exchange its yellow for an orange hue, the vessel is to be removed from the heat, and exposed in a cold air, which will very soon produce the separation of crystals. The liquor in the vessel should be decanted, and the crystals should be well washed in warm distilled water. The crystals may then be considered as the pure acid of sugar. By adding three more parts of the nitrous acid to the remaining mixture, more crystals may be obtained.

THE acid obtained from sugar by the preceding operation, possesses many peculiar properties, which sufficiently distinguish it from all other acids. It would be superfluous, in this place, to enumerate these,

as



as they may be seen, with its affinities for other substances, in Bergman's Dissertations, and in his Essay on elective attractions.

ADMITTING the existence of such a principle as phlogiston and its various affinities, according to the present received doctrines of chemistry, there can be little doubt, from the result of the preceding experiment, but sugar really consists, as was before observed, of a peculiar acid and phlogiston; and that their separation, in this process, is effected by the greater affinity which the phlogiston has to the nitrous, than to the saccharine acid.

IT will be the object of the subsequent pages to enquire whether any of the facts and phenomena which respect the natural production of sugar, or any of the changes produced on this substance by other chemical operations, agree with the foregoing analysis.

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AND this enquiry, according to the rules of chemical investigation, obviously divides itself into three parts, comprehending three different states or circumstances respecting sugar.

I. ITS production or composition by natural processes.

II. ITS decomposition by art, and more especially by the most general operation to which it is subjected, namely, fermentation.

III. ITS revivification by the artificial reunion of its constituent parts. Which several states I shall endeavor to consider separately.

SECTION



## S E C T I O N II.

*Of the production or composition of sugar by  
natural processes.*

SUGAR is well known to be the inspissated, or crySTALLIZED juice of a vegetable, and it has been ascertained by the experiments of Margraaf and others, that it forms a part of a great variety of plants, though in most of them it is in such small quantities, and so closely combined with other matter, that its separation is too difficult, and the quantity obtainable, too inconsiderable, to make the process worth carrying on as a manufacture: The plant from which it is obtained in the greatest abundance, and which is at present alone cultivated for this production, is the sugar cane, a native of tropical climates.

ITS



ITS existence in the fruits and seeds of many plants, is, likewise obvious, from their sweet taste, and from their juices or infusions being capable of the fermentatory process.

THERE can be no doubt, therefore, but sugar is of vegetable origin, and our next enquiry must be, whether these two principles, the acid and phlogiston, of which it seems to consist, can be detected in a separate state in vegetables; or whether the experiments which have at present been made on vegetation, the food of plants, its assimilation, &c. render it probable that these principles are deposited during the growth of vegetables.

VEGETABLES receive food in two ways, by their roots, and by their leaves; by their roots, probably, water and some mineral substances are absorbed; by their leaves, it is supposed that water and the  
air



air of the atmosphere are taken in: Light too, both by the direct rays of the sun, and as it is reflected from other bodies, seems to furnish something salutary to vegetable life and increase.

It would, perhaps, be very difficult to ascertain the peculiar kind of matter, which plants take in by their roots, much less to prove that the acid of which we are speaking, is derived from the earth in which they grow. The existence of an acid in vegetables is, however, not the less certain; the sour taste of the leaves of some, of the stalks of others, and of the unripe fruits of many, sufficiently proves this; and that this acid is the same as that which is derived from sugar, is highly probable, from its having been obtained by Scheele, some time ago, from the juice of lemons, and, more lately, from the foot stalks of the rhubarb plant, in which it seems to exist very abundantly.



THE nature of the principle which plants derive from the surrounding air, has, however, been lately more satisfactorily demonstrated; and that this principle greatly contributes to the support of vegetable life, and to promote the growth of plants, is evident, from the large apparatus which nature has contrived for the purpose of its admission; an apparatus so admirably adapted, by the very extensive surface it affords, to receive a substance of such great rarity.

THE chemical reader need not be informed that this substance is phlogiston: From the ingenious experiments of Dr. Priestley, and Dr. Ingenhousz, it would seem, that the atmospheric air is received into vegetables by the medium of their leaves, that during its circulation through the plant, the phlogiston, which was combined with the air, is deposited in the plant, and that the air, when perfectly freed from this principle, is returned from the plant, through



through different vessels in the leaves, into the common mass of the atmosphere; the leaves of plants being, therefore, analogous, as performing a similar office, to the lungs of animals; with this obvious difference only, that plants return the air of the atmosphere depurated from phlogiston, and animals return it loaded with that principle.\*

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\* FROM some experiments which have been made by Dr. Priestley, since the publication of Dr. Ingenhoufs's Experiments on Vegetables, and, more especially, from the more recently published Experiments of Sir Benjamin Tompson on Dephlogistified Air, in the first part of the Philosophical Transactions for the year 1787; there seems some reason to believe, that the dephlogistified air, which is generated by putting the leaves and green stalks of vegetables into water, and exposing them, in glass vessels, to the light of the sun, does not issue from the vegetables, but that it is separated from the water,

THIS circumstance, however it may affect the particular system of Dr. Ingenhoufs respecting the respiration of plants (and which, I confess, I shall relinquish very reluctantly, it being at once so beautiful and simple) by no means disproves the general agency of vegetables in purifying the atmosphere, in some way or other; nor does it lessen the proofs that phlogiston forms a very material part of the food of plants.

THE



WE have in this, then, a sufficient proof of the admission of phlogiston into vegetables by one process; but it is not improbable that this principle may be also communicated by the sun's rays, which, as before observed, are concerned in promoting vegetable life and growth, in some other way than by producing a warmer temperature in the atmosphere; for, from

THE original experiments of Dr. Priestley on this subject, in which air rendered so foul as to be unfit for the support of animal life or combustion, was so far restored, by a sprig of mint growing in it, as to be fit for both purposes, is, certainly, an incontrovertible proof of the first; and the peculiarly vigorous manner in which the plants, which were the subjects of these experiments, flourished in the phlogisticated air, is, equally, a proof of the latter.

WHETHER, therefore, the air be purified by circulating through plants, and depositing its phlogiston in them, and it be afterwards expelled in a dephlogisticated state, as Dr. Ingenhousz has supposed; or whether the phlogiston be absorbed by vegetables from the surrounding air, without the air being admitted into the circulation, the two circumstances of the plants receiving the phlogiston, and the air parting with it, being equally the same, they equally apply to the general doctrine which I have advanced, all I maintain being simply the admission and retention of phlogiston in all vegetables.

some



some late experiments, there seems reason to believe that phlogiston and the matter of light, if not one and the same principle, are so intimately combined, that wherever the latter is received, the former accompanies it. Indeed, from some facts and experiments, which are related in the Memoirs of the Academy of Sciences of Paris, and particularly noticed in Dr. Black's Lectures, it seems very probable, that the principle of inflammability is communicated to the leaves of vegetables by the sun's light; for without exposure to light it seems impossible to produce the green colour of vegetables; and by separating this green matter by pressure, and afterwards evaporating the water in which it is diffused, the green matter is obtained pure, and it appears to be the most oily and inflammable part of leaves.

BUT whether this conjecture be true or not, it is probable that the process of phlogistication is greatly accelerated in vegetables



getables by the application of the sun's rays; for the same experiments of Dr. Ingenhousz, which I have before alluded to, prove that the excretion of dephlogisticated air, (and which, according to his system, obviously, must be in proportion to the separation of phlogiston from the air that has been admitted into the circulation of the plant,) is carried on only whilst vegetables are exposed to light, and that this process is proportioned to the degree of the sun's light: So that whether the rays of the sun contain phlogiston or not, whilst their influence quickens the process by which the deposition of this principle in vegetables is effected, their agency in phlogistication is the same.

THOUGH, as before observed, it may be difficult to prove, that the acid of plants is communicated to them by their roots, yet as far as probability goes, it seems likely that it should be so; and for the following reasons. The difference produced  
by



by climate seems but little to affect the soil, its influence being principally felt by the atmosphere, in a superior temperature respecting heat, and a greater degree of phlogistication: for, with regard to soil, the same general variety of strong and light, of argillaceous, mixed and sandy, occur, perhaps, alike in all climates. Now in all climates in which vegetables can exist with any degree of vigor, the acid of plants seems to be produced: Even the fruits of warm climates will be produced in cold ones, and they will differ from those which grow in warmer ones, in their having the acid principle only.

It may, possibly, be supposed that the atmosphere itself may furnish this acid, and the various suggestions of Dr. Priestley respecting the constitution of atmospheric air, and from which he is induced to suppose the air to be a kind of sulphur,\* would,

\* Experiments and observations on different kinds of air, vol. i. page 261, 263, 264, 265, and vol. ii. page 55.

But



would, perhaps, justify such a conjecture: But if it be admitted that this acid is produced in vegetables nearly alike in all climates, it will very little affect my reasoning, whether it be derived from the soil or the atmosphere; for with respect to the production of phlogiston, there can be no doubt but there must be a very great difference in climates. In hot climates, those processes which occasion phlogiston to be separated from different animal and vegetable bodies, which contain it, and to be diffused through the atmosphere, are, certainly, more constantly existing, and are carried on to a much greater extent, than in cold ones; nor can there be any doubt, but plants will take in phlogiston, in the greatest quantity, where the surrounding air imbibes most of it, and where, moreover, being more constantly under the influence of the sun's direct rays, their power of assimilating it appears to be so much increased.

But in the 17th section of his last volume he seems to have relinquished the idea of there being any acid whatever in the composition of air.

IF,



IF, therefore, the production of the acid principle in vegetables, whether derived from the earth or the air, be nearly alike, in all climates, in which vegetation can be carried on, and the production of the other principle which is necessary to convert this acid into a saccharine substance, be greatest in warm ones, we have a very striking reason, why the production of sugar, and of those fruits which most abound with saccharine juices, should, as is the fact, be greatest in warm countries.

IT can scarce be necessary to observe the difference between the same kinds of fruit which grow in warm and cold countries, in this characteristic circumstance of sweetness, as a proof of the foregoing remark; for every one knows that in cold climates they are harsh and sour, and in warm ones sweet; but it may be remarked, that even those fruits which are usually cultivated in warm countries, if cultivated in still warmer ones, seem likewise to ex-

D perience



perience a change which is conformable to these principles, becoming not only ripe in a shorter space of time, as might naturally be expected, but having their juices really more saccharized: The orange which seems to acquire proper maturity in Spain, and the latitude of 35—40, when growing nearer the line, as in Jamaica and the other West India Islands, is not only sweeter, but the sugar so much abounds, that it is often observed to ooze through the rind and chrystalize on the outside\*.

It may, however, be observed, that phlogiston being the general food of plants, and probably essential to their existence, it certainly is to be found in all climates where vegetable life is sustained: There can be little doubt but this must be true, and perhaps the great difference between warm and cold countries, respecting the phlogification of vegetables, lies

\* See Long's History of Jamaica.

chiefly



chiefly in this; in the latter, such a quantity only of this principle is obtained, as is equal to support the life of plants, and to impart to them the general character of vegetables; in the former, there is probably such an excess of phlogiston, as to admit such an extraordinary deposit of it in plants, as will be sufficient to neutralize, if I may so express myself, their acid juices, thereby producing their saccharine state, which may truly be considered as a peculiar character of vegetables.

AT the same time, though it is very obvious, that a much larger quantity of phlogiston must be set at liberty in hot climates than in cold ones, and in summer than in winter, from the greater putrefaction of animal and vegetable bodies, which takes place under those circumstances, yet it may still, perhaps, be objected to the preceding application of this, that the fact of a superior phlogistication of the air, in hot climates, has not yet been ascertained by the eudiometer, and that on the con-



trary, from the experiments of Drs. Priestley, Ingenhoufz, and the Abbe Fontana, the difference observeable by that instrument, between the air in hot countries and in cold ones, in summer and in winter, in crouded cities, and in the most open and exposed situations in the country, is not sufficient to account for that difference in vegetables and fruit which has been suggested.

THOUGH I am aware that the eudiometer is not, perhaps, under all circumstances, a sufficient test of the purity of the air, as Dr. Priestley has himself observed, that phlogiston may be so combined with it, as not to be detected by the admixture of nitrous air; yet I think it may even be admitted, that the air is not more phlogificated in hot climates than in cold ones, without its proving, that more phlogiston is not evolved in those countries, or that more of this principle is not absorbed by vegetables in those places: For, admitting that the process of dephlogistication goes  
on



on as rapidly and extensively by vegetation, as phlogistification goes on by putrefaction, it may easily be understood why the general mass of air does not, under those circumstances, contain a more than usual quantity of phlogiston: the difference between climates not being, probably, in the quantity of phlogiston retained in the atmosphere, but in the quantity, which in a given time is received by it and passes through it, and this will, obviously, depend upon the celerity with which these processes are carried on, and their relative proportion to each other. Indeed, were not a much larger quantity of phlogiston set at liberty in warm climates than in cold ones, and vegetation could, at the same time, be equally supported, it is evident that the air must be much purer there than in cold ones; for as experiment seems to prove that dephlogistified air is perpetually issuing from the leaves and green stalks of vegetables, while they are exposed to the light, or at least, that vegetables, by some process or other, effect the purification



cation of the air, it cannot be doubted, but, where the greatest number of vegetables exist, where they flourish in constant succession throughout the year, where those parts of each individual vegetable, which are most concerned in this process, are not only most numerous, but peculiarly large, as is most remarkably the case with the leaves of plants in tropical countries, and where, too, they are more than elsewhere exposed to a strong light, from the vertical situation of the sun, and the cloudless sky, which throughout the year is so peculiar to those climates, an immense quantity of dephlogisticated air must be produced, and doubtlessly the whole atmosphere, especially the lower strata of it, would be purer in those regions than in any other on the globe, were there not constantly rising from putrescent substances, a proportionate quantity of phlogiston to mix with it, and to supply fresh materials for the processes of vegetation.

I am



I am the more disposed to think this is really the case, and that the air is not more phlogisticated, though more phlogiston passes through it, in warm countries than in cold ones, because I believe it probable, that a much greater degree of phlogistication than is found in temperate climates, would render it unfit for the purposes of animal life, as even in cold climates, where the sources of phlogiston are certainly fewest, the pure, vital, dephlogisticated air, according to the experiments of Scheele and Bergman, scarcely constitutes one-fourth part of the atmosphere; and as the proportion of animals in different climates, is, perhaps, nearly alike, greater or smaller numbers, depending more upon artificial than natural causes, the same standard of purity seems alike necessary in all countries.

BUT to return more immediately to the subject—The different degrees or stages of ripeness which fruits pass through, before



fore they are perfectly mature, may, I think, be likewise explained on the same principle of a smaller and greater degree of phlogistification, compleat ripeness being, probably, the state in which the juices of the fruit are fully saturated with this principle. And in this, the influence of the sun's rays, either in immediately imparting phlogiston, or in accelerating the process by which it is separated from the fluid circulating in the vegetable, is very apparent; for every one knows the difference in the same kinds of fruits, and which grow in the same climate, if planted so as to have different exposures with regard to the sun, and that even on the same tree, the fruit on different parts of it, will, for a similar reason, experience the same difference.—And here the remark before made, that the sources from whence the acid of plants and phlogiston are obtained, are very different ones, obviously recurs, for it is evident, that this acid is produced as much in the shade as in the sun,

sun, and, indeed, on account of the absence of phlogiston its presence is, even there, most obvious.

ACCORDING to Dr. Ingenhoufz, plants and parts of plants, in very shady places, give out phlogisticated air; we have, then, a still further reason, conformable to the preceding general principles, why fruits, under those circumstances, should be sour; for, independent of there being less phlogiston absorbed by that part of the plant which is hidden from the sun's light, it seems not even to have the power of retaining that phlogiston, which admitted into it by some other part which may be exposed to the sun, is brought to this in the course of its circulation through the plant.

THE acid of fruits seems, also, to be more early deposited than the phlogiston, for when the fruit is first formed, at least when it has acquired some degree of bulk



as well as shape, this acid exists in them; the absorption of phlogiston, appearing, on the other hand, to be a more slow process, and requiring a much longer time in which to be compleated.

FRUITS, gathered while unripe, either from being prematurely pulled, or, from the climate in which they grow being incapable of further ripening them, may, in some degree, be improved by keeping, by being laid together in large heaps, so as to sweat, &c. but even the change produced by these means, seems to be of the same nature with that which takes place more perfectly on the tree. Fruit is composed of other parts besides the acid juice and phlogiston of which we have been treating, it consists of a kind of cellular substance, in which the juices are contained, of the cortical and other membranes. These being all vegetable matter, phlogiston, of course, enters into their composition, though it is not obvious until they  
undergo



undergo some degree of decomposition; and this evidently takes place when any degree of putrefaction comes on. Now the changes produced by the means before alluded to are, probably, of this kind; a degree of putrefaction is induced, not indeed so much as materially to change the texture and quality of the body, but sufficient, perhaps, to separate some phlogiston from the vegetable parts, (and that a degree of putrefaction may be induced in fruit, sufficient to set at liberty some phlogiston, without sensibly changing its form and texture, is evident, from the air which surrounds fruit being so soon rendered noxious), which uniting with the acid, which is in contact with it, and which has an affinity for it, renders it more saccharine. A striking example of this may be adduced in the bruised parts of fruits, in which the disunion of the vegetable matter being more compleat, putrefaction is advanced somewhat further, a greater quantity of phlogiston is set at liberty and absorbed by



the acid, and these parts become sweeter than the rest of the fruit; and from this circumstance there will appear a propriety in the common phrase applied to fruit under these circumstances, that it is *rotten* ripe.

IT may also be observed, that in some places, in order to anticipate ripeness, green fruit is buried for some time in stable dung when heating, in which situation not only is the process of putrefaction, in fruit, carried on to a greater extent, from the joint circumstances of heat and moisture, which are well known very much to promote that process, but very possibly some phlogiston may be absorbed by the fruit from the surrounding dung, which is, at that time, very largely parting with that principle. If this operation be managed with a tolerable attention to cleanliness, and the process be not carried on too far, the fruit will acquire a not unpleasant sweetness, as I have several times

times experienced in the instance of pears.

SOME of the late autumnal fruits, which, in this climate, seldom attain to maturity, on account of the approach of winter, acquire a sweetness from the influence of frost; the effect of which, as in the last recited instance, is to induce a degree of putrefaction, and, probably, to set at liberty some portion of phlogiston—Several kinds of plumbs, particularly the bullace and floe, are so well known to be mellowed by this cause, that they are usually suffered to remain on the tree, till there has been frosty weather.

IT is also a fact, that fruit even acquires sweetness by being cooked; and this, too, is probably also owing to the same circumstance, the evolution of phlogiston from its vegetable parts. Heat and moisture, which are the principal agents in cooking, evidently promote many of those processes  
by



by which the decomposition of bodies is effected, and, perhaps, in this operation, they produce some such change, though to a more limited extent. The texture of fruit is certainly rendered more soft and tender by cooking, and it may therefore be presumed that the different parts of which it is composed are not only held together more loosely than before, but that some principles, which were before so closely combined as to be concealed, are now evolved; nor can it, on this account, be unreasonable to suppose, that some phlogiston may be separated by this means, and enter into a new combination with the acid principle which it meets with in the fruit. In baking and roasting, which, being each a kind of combustion, may more particularly be considered as phlogistic operations, the separation of phlogiston is still more probable; and agreeably to this, it may be remarked, that when apples are roasted near a large fire so as to burn the outward skin, the effect of phlogification



gification is most apparent in the juice which lies in immediate contact with the burnt part, that being always the sweetest part of a roasted apple.

FROM some of the before-mentioned instances of fruit being ripened by other causes than the common processes which obtain in living vegetables, and more especially from the last recited fact, of sweetness being produced in fruit by the application of heat, in cooking, &c. it may possibly be imagined, that the difference in climates, respecting the saccharization of fruits, which I have before considered as effected by a greater quantity of phlogiston being admitted into vegetables in hot than in cold countries, may be produced, simply, by a superior degree of heat, independent of its being the principal agent in phlogisticating the air in those climates, or of a certain temperature being requisite for the life and vigor of plants; and the circumstance of the  
fruits



fruits of hot climates being ripened artificially in cold countries, by the application of heat in hot houses, nearly as well as in those climates in which they are indigenous, has been suggested to me as a proof of this.

I THINK it, indeed, very probable, that heat should be a considerable agent in ripening fruit, by its immediate influence upon it; for by expanding the several parts of the fruit, they are probably rendered more capable of receiving phlogiston, and its union with the acid may be thereby much facilitated. It appears, likewise, very possible, that the application of heat, may, in this, as in the other recited instances, become a means of saccharizing the acid principle, by setting at liberty some of the phlogiston which entered into the constitution of the vegetable part of the fruit.

THIS

THIS, indeed, is the more likely, because a certain limitation, with respect to heat, appears to be requisite to preserve the perfect union of the parts of living vegetable substance, an excess or deficiency of it equally disturbing the due arrangement of its constituent parts, and disposing them to disunite.

THE effects of the absence of heat in producing this change of arrangement in bullace, sloes, &c. have been already noticed, as, also, that in this instance, the change was favorable to the maturation of the fruit, probably by setting at liberty some phlogiston which before that change was latently combined with the vegetable parts of the fruit, as in every change of arrangement produced in bodies containing phlogiston, some of that principle is, probably, liberated: And admitting that a similar change is effected in the arrangement of the constituent parts of vegetables, by an excess of heat, the evolution of  
F phlogiston,



phlogiston, its union with the acid principle, and the saccharization of the fruit, become, equally, the probable consequences of its application.

PERHAPS, in the common process of nature, fruit is matured by these joint causes; by the immediate deposit of phlogiston which may have been absorbed from the surrounding air by the plant, and have circulated through it, and by the evolution of phlogiston from the vegetable part of the fruit, and which may have been effected, as before observed, by the immediate application of heat.

It has before been observed, that sugar has been obtained from a great variety of vegetables, and though the fruits of plants are the parts in which this substance is most generally obvious, and are those to which I have principally confined the foregoing observations, yet it is not limited to those parts of vegetables.—The sugar cane,  
the



the different kinds of ash, which produce manna, the sycamore maple, the birch, the cocoa tree, and many other trees, seem to have a saccharine juice circulating through them, which either naturally exuding, inspissates in the form of sugar, or being artificially drawn off in its fluid state, affords a sweet liquor capable of fermentation, and of which, in many places, wine is made.

THE remark which has been before made respecting the greater degree of saccharization which fruits obtain in warm than in cold climates, may be applied to the several trees now mentioned. The sugarcane being, indeed, of no other use as a vegetable, but as it produces sugar, is cultivated alone for that production, and is consequently confined to the warmest climates: but the other trees which have been alluded to, being in most places cultivated for timber, they grow in very different climates, and exhibit, in a very



striking manner, the difference of their production of sugar according to the climate in which they grow: and as the sugar, in this instance, is less combined with vegetable matter than the sugar of fruits, as it exists in parts of plants which differ very materially from fruit in their natural structure, and, as in many of these instances, it is contained in trees which are not subjected to the same annual decay which fruits undergo, the production of the sugar in them is less likely to be effected by any of those causes of the decomposition of their vegetable parts, which have before been enumerated, as probably aiding the maturation of fruit, and therefore, being, perhaps, less likely to be affected, in this way, by the immediate influence of heat, the difference of their saccharization according to the climate in which they grow, may with still more propriety be referred to the differences which those climates exhibit respecting the production of phlogiston.

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THE sycamore, or sugar-maple, produces very little saccharine matter in the northern countries of Europe, but in the warmer parts of America, it is so abundant in this tree, that the inhabitants collect it, and prepare from it a sugar which answers the purpose of the sugar obtained from the cane. The same may be remarked of the birch-tree when planted in a warm climate, for it has been observed by botanists, that the exudation of sugar from this tree, under these circumstances, is so great, as very soon to exhaust its vigor. The larch, too, which in cold countries is scarce ever observed to give out a saccharine fluid, has it in considerable quantity when growing nearer the sun; in the south of France a kind of manna is obtained from this tree, of a similar kind, but not of equal purity to that which is produced from the manna-ash.—And with regard to the manna-ash, this general difference of climate, as respecting its saccharine produce, is not only observable, in common  
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with the other trees before-mentioned, but another circumstance may be remarked concerning it, which seems very strikingly to agree with the preceding theory, and which is, that this tree produces the largest quantities of manna in the neighbourhood of volcanos, in which situation the supply of phlogiston must evidently be particularly abundant.—Calabria, in Sicily, and the neighbourhood of Naples, in Italy, are the places in which the manna-ash is cultivated to the greatest advantage, producing the manna there more abundantly, and of a more purely saccharine quality than even in the warmer countries of the east.

THE effect which vicinity to volcanos has on vegetation, has been well observed by Sir William Hamilton, Mr. Brydone, and other philosophic travellers; indeed, all accounts of these countries agree respecting the extraordinary vegetation which takes place in those situations, and which  
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it seems not unreasonable to attribute to the plentiful supply of phlogiston which such situations afford.

IN some other parts of plants, more especially in farinaceous seeds, sugar seems, moreover, to exist in a latent state, 'at least it is not obvious until some peculiar change in the arrangement of their component parts has been effected. The saccharine principle, in barley, may be adduced as an instance of this sort, and its evolution, by the operation of malting, may, I think, be sufficiently explained on the foregoing principles.

VEGETATION is one of the several processes by which a new arrangement of the component parts of certain bodies is effected, and to produce this, it seems probable, that some parts must be set at liberty and rendered obvious, which were before so closely combined as to be concealed from the senses.

BARLEY



BARLEY, in its natural state, discovers no mark either of acidity or sweetness, and like other vegetable matter gives no proof even of its possessing phlogiston until its decomposition take place by putrefaction, combustion, &c.—The existence of an acid and phlogiston are both, however, sufficiently obvious in some of the changes of arrangement wrought on this grain. Barley-meal, which is merely pulverized barley, if moistened and exposed to the air under a certain temperature, and for a given time, will become very sour; this mode of obtaining a very powerful acid both from barley and rye, having been long adopted by tanners, who apply it for some necessary purpose in their operations on leather.—And it is needless to observe, that barley grain, as well as all other vegetable matter, is inflammable, and consequently, according to the present doctrines of chemistry, it contains phlogiston.

THESE



THESE two principles, therefore, the vegetable acid and phlogiston, being component parts of this grain, it is not unreasonable to suppose that some of each should be set at liberty in the vegetative process of malting, and that, uniting with each other in the moment of their individual separation from the other ingredients which compose the barley, they should, in that union, assume the same new saccharine character, which their combination, in the several before-recited instances, appears to have produced.

THERE are some farinaceous roots, also, which, in their common state, exhibit no marks of sweetness, but which discover it by undergoing some change of the arrangement of their constituent parts, by putrefaction or vegetation ; and by which, probably, as in the last recited instance, the saccharine principles are evolved. Potatoes, which have been frozen, or which have began to sprout, always acquire a

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sweet



sweet taste. And if this sweet taste were not a sufficient test of the presence of sugar, there are other proofs of the principles of sugar being contained in potatoes; for it has been lately found that inflammable spirit may be obtained from them, and that very abundantly: and it will, I believe, be found, that inflammable spirit is produced by an operation, the only true subject of which is saccharine matter, namely, fermentation.

NOR is this union of phlogiston and this peculiar acid, and the consequent production of sugar, entirely confined to vegetable processes; in some instances, though the acid be of vegetable origin, the phlogiston appears to be derived from animals.

THE natural history of the puceron, or vine-fretter, affords a very striking instance of the production of a saccharine juice, and from the very singular manner in which



which it is obtained, it seems very probable that the process is a phlogistic one.

It appears, from observations made by an ingenious and attentive French naturalist, the Abbè Boiffier de Sauvages, that swarms of these little animals fix themselves, in the summer time, on the young and succulent branches of various trees, and that their food consists of the juice which they extract from the tree by piercing the bark of these young and slender branches.—This juice, in the green parts of most vegetables, is acidulous, and is peculiarly so in the green stalks of the tree on which these insects most abound, and from which they take their name, namely, the vine. At a certain period, after receiving this acid as food, they part with it as excrementitious, in the form of a gelatinous amber-coloured liquor, which is exquisitely sweet. It falls upon the neighbouring leaves, or upon stones or other bodies, which may be near or under the animals, at the time of



its being ejected, and produces one species of what is commonly called honey dew, and which is eagerly sought after by bees, ants, &c.

THE change which this vegetable acid juice undergoes, by passing the stomach and intestines of these animals, and which, to use the words of the Abbè Boissier, “ though at first hard and sour, “ becomes in the bowels of this insect, “ equal to the honey obtained from the “ flowers and leaves of vegetables,” may, I think, with great probability, be attributed to the phlogiston which it receives under these circumstances; for minute as these insects are, if we admit that they belong to the general class of animals, and are constituted like them, there can be little doubt of the existence of phlogiston in their intestines, which are well known, in all other animals to furnish this principle very largely; and from this circumstance, we may surely consider this as another instance of the  
production



production of sugar from a combination of the vegetable acid and phlogiston.

EVEN the sweetness of honey is probably increased, if not in many cases totally produced by phlogification in the body of the bee: for it appears from Reaumur's History of this extraordinary insect, that the vegetable juice which they collect from flowers, remains some time in their bodies before it is deposited in the cells of the hive, in which situation, it is probable, that it undergoes a similar change to that of the acid juice which passes through the vine fretter.—There can be no doubt of the difference between the taste of honey and of that fluid which is generated in the nectaria of most flowers, and particularly in the circumstance of sweetness; for though in the nectaria of some flowers this fluid is found very saccharine, yet bees collect juice from various flowers, in which no sweet liquor can be detected, and



and which, therefore, seems to require some addition of phlogiston before it can assume so saccharine a state as that of honey.

It is probable that there are other insects which also produce a saccharine substance in a similar manner.—In the Memoirs of the Royal Academy of Sciences at Stockholm, for the year 1785, there is a paper, by M. Bjerkauder, which gives an account of a kind of sugar or honey found in some parts of the red fir, which is derived from flies.

THESE are the principal facts which I shall notice respecting the natural production or composition of sugar: The naturalist who is more acquainted with plants and animals, and the practical chemist, who is better able to analyze the various bodies which may contain this substance, might undoubtedly much extend them. But even these appear to me sufficient for the purpose for which I have adduced them



them, namely, to shew the probability of all native saccharine substances being derived from the union of the two principles, which I have so often before mentioned, namely, phlogiston and a peculiar acid.

SECTION



## SECTION III.

*On the decomposition of sugar by art, and more especially by the most general operation to which it is subjected, namely, fermentation.*

THE decomposition of sugar seems to be effected by three different processes, by combustion, by the application of the nitrous acid, and by fermentation.

THE operation of combustion upon sugar is, probably, the same as on all other inflammable substances, the constituent parts of which are unable to resist the effects of a certain degree of heat, and are not only separated from each other, but are volatilized and dissipated in the surrounding air, and thereby totally lost to the senses. Not being able, therefore,  
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to trace the principles of sugar as they are disunited by this process, the consideration of it would, in no respect, tend to elucidate the present enquiry, and I shall only observe, that sugar burns at a moderate degree of heat, and, therefore, if the present opinions respecting inflammable substances be just, this process proves that it certainly contains a considerable portion of phlogiston.

By the application of the nitrous acid, I allude to the process related in the first section, and which, as having been before mentioned, it would be superfluous to repeat in this place.

BUT fermentation is the process to which sugar is most generally subjected, the several results of this operation being of the most extensive æconomical use, and forming very important articles of manufacture and commerce; for it is well known, that

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by fermentation, wine, vinegar, and ardent spirits are produced.

As in this process the decomposition of sugar is effected much more slowly than in either of the preceding ones, and as its constituent parts seem to be much less dissipated than in those processes, we may expect to be more able, in this, to trace the several changes effected on this substance; and if the preceding general doctrine be true, we may also expect that it will assist us in explaining the principles of fermentation, and in accounting for the several changes which are produced on the solutions of sugar by that very singular process, and which, I believe, have been hitherto very imperfectly explained.

I consider sugar, properly speaking, as the only true subject of the fermentatory change, for though, in common language, it has been said, that vegetables, in general,

ral, are the subjects of fermentation, and though many vegetable substances are in different acts exposed to this process, yet I believe it will be admitted, that it is from the saccharine parts only of these substances, ~~that~~ the vinous and acetous results of fermentation are derived.

THE basis, therefore, of all liquors, capable of the vinous and acetous fermentation, is sugar, either naturally dissolved in a watery menstruum, as in the juice of the grape, and other saccharine fruits, or in artificial solutions of it in water; and as the great change produced by fermentation is the disposing the body, which is the subject of it, to assume a new arrangement of its constituent parts, it may be presumed that the first effect of this process on sugar, is the separation of its parts as primarily combined.

THE first object of many chemical operations is to enlarge the surface of the body



to be acted upon, and by dividing its integrant parts to diminish their attraction of cohesion; in hard bodies this is done by pulverization, and in soluble bodies by diffusion in a menstruum.

For the process of fermentation which is to effect a separation of the component parts of sugar, its solution in water seems first necessary for the above reason; for it is evident that sugar in its concrete state, even though its particles be ever so minutely divided by pulverization, is incapable of undergoing the fermentatory change.

NOR indeed is bare solution sufficient, it must be a dilute solution, for if such a quantity of sugar be mixed with the water as to give the compound the consistence of syrup, it will still resist fermentation.

AND



AND further, even this solution requires to be rendered still more rare, before the true process of fermentation can take place; and the matter of heat, whose tendency to separate the particles of bodies, in various processes, is so well known and established, seems to be the agent which effects this; for next to solution in a menstruum, a certain temperature respecting heat, appears requisite, before a true fermentation can be excited.

WHEN reduced by the joint powers of a dissolving menstruum and an expanding heat, to a state of extreme rarity, the surface of the sugar is so much extended, and the cohesion between its component parts is so much weakened, that they become liable to be acted upon by the surrounding medium, according to the general laws of chemical affinity, and such a change in the arrangement of the several parts of the compound takes place as may be explained to arise from the operation



tion of a superior attraction: fermentation seeming, therefore, to effect the decomposition of sugar upon the same principle as the decomposition of other bodies is effected by combustion, and of others by vegetation, &c. as may be instanced in the burning of all inflammable bodies, in the calcination of metals, in the malting of barley, &c.

INDEED the analogy between fermentation and combustion is very striking, as they both seem to produce a change of arrangement in the component particles of a body, in consequence of the body being brought into circumstances of such great rarity, or such weak cohesion that a superior affinity totally disunites them: thus a piece of coal, or any inflammable or metallic body, among other principles, consists of the matter of heat and phlogiston, but both these, during combination, are so closely united to the other parts of the coal as not to be obvious to our senses,



ses, and are not, under the common circumstances in which it is found, disposed to separate: but by the application of a certain degree of heat, acting in a sensible manner, the cohesion of the parts of the coal becomes so much lessened, that at this time the affinity of the particles for each other becomes less than their affinity for the surrounding medium, namely the atmospheric air, and they consequently, according to the great law of chemical attraction, separate from each other, and unite with the surrounding air.

IN the same manner, it may be presumed, the component parts of sugar, which appear to be principally phlogiston and a peculiar acid, when this substance is reduced to a certain degree of tenuity, by the means before mentioned, have the same tendency to separate from each other, and unite with the surrounding medium, which, in this instance, is water, and for which their attraction, under these



these circumstances, is superior to the attraction between each other.

ADMITTING, therefore, that fermentation is, as before suggested, a process by which the decomposition of sugar is effected, and that it is induced by the means and on the principles which have been mentioned, we must next advert to the effects produced by this operation on the fluid in which it is carried on, and which, if the preceding theory be a just one, we may expect will afford a further confirmation of it, as well as be another proof that the component parts of sugar are really such as have been all along supposed.

WHEN the process of fermentation has continued for some time, it may be supposed that the two ingredients, of which we imagine sugar to be principally composed, disunite from each other, mixing with the general menstruum as distinct bodies, and the peculiar properties belonging to each individually,



individually, being now no longer latent, communicate a new state and character to the liquor in which they are diffused, for instead of its being a saccharine liquor, we should now expect it to be a phlogisticated acid liquor; and this is obvious in the first change the liquor undergoes, for instead of its being sweet, as before, it immediately acquires an austere taste, which may be attributed to the acid, and at the same time exhibits the presence of a spirituous and inflammable principle, and which may be attributed to the phlogiston; both which evidently belong to the vinous character; so that the union of these three ingredients, namely, water, phlogiston, and the acid of sugar, appears, therefore, to constitute wine.

BUT though when these ingredients have separated from each other and united with the water, the operation of fermentation may be considered as compleated, as far as it relates to the decomposition of sugar,

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it is not perfected, if considered with respect to the new compound which is the result of the union of these ingredients with water, or, in other words, with respect to the production of wine; for there are some other substances, besides the acid and phlogiston, which are either combined with the sugar, as component parts of it, or which are adventitiously united to it, in the vegetable from which the sugar is derived, which as they do not contribute to the vinous character, must be separated, and these are known under the general name of *fæcula* or *lee*, and which are usually precipitated merely by the liquor remaining for a considerable length of time at rest.—The acid of sugar itself seems, also, too abundant, at first, for the true character of wine, and though soluble in water in a certain temperature, it seems not so perfectly so in the temperature under which wine is usually kept, as that a quantity, which is more than necessary for wine, can be held in permanent solution; and, therefore,



therefore, when the wine has been for some time kept at rest in casks, the superabundant acid separates, and chrystallizes on the sides of the vessel, and to this is given the name of tartar.

THIS acid, though thus evidently derived from sugar, seems, however, to be materially different to the acid of sugar; but this will not seem extraordinary, as probably, it has formed a combination with some other vegetable matter, which separates at the same time from the general mass. That the fixed vegetable alkali is united with it, though not to a degree of saturation, is well known by common chemical experiments, as it can be easily separated from it; and there can be no difficulty in tracing this, the lees of wine being evidently alkaline. The other materials with which the acid unites, may probably have such an affinity for it as not to be easily separated by any of the common processes of chemistry. But sup-



posing this even to be impracticable, there would still remain no doubt of the origin of the acid of tartar, as it is immediately derived from sugar. The industry of the celebrated Scheele has, however, removed all possible doubt on this subject, as he has actually produced the true acid of sugar from tartar; and from some other experiments of Scheele's and Dr. Crell's, the similarity of the acid of tartar to the acid of sugar is not only fully ascertained, but it seems probable that the acids of tartar, sugar and vinegar, which are all produced from sugar by different processes, are all modifications of the same acid, as it is united to more or less phlogiston, and that the acid of tartar has the greatest quantity combined with it, the acid of sugar has somewhat less, and the acetous acid has the smallest quantity\*.

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\* See Scheele's Essays—English Translation, page 388. See, also, Experiments and Observations on the Conversion of the acids of Sugar and of Tartar into Vinegar, by M. Hermstadt, in the Journal de Physique for September, 1787, from which it appears probable, that the acid  
of



THE vinous fermentation being thus perfected, by the separation of the superabundant acid and the other adventitious vegetable matter, the austere taste which it before had is now much lessened, and the wine is softer and more grateful to the palate, but retaining the phlogiston it is still inflammable, and has equally the power of producing intoxication, which it may reasonably be supposed is derived from that principle.

THAT the phlogiston is still in a state of combination with the liquor, is not only probable from the preceding circumstances, but its actual separation may be effected by art; for, by distillation, ardent spirit is obtained from wine; which has always been considered as phlogiston united to so much water as will fix it, thereby preventing its assuming that aerial form

of sugar, the acid of tartar, and the acetous acid, may each, by different processes, be obtained from various vegetable acid juices, as the acid of tamarinds, of lemons, the juice of plumbs, apples, pears, gooseberries, sorrel, berberis, &c.

which



which, with a smaller quantity of water, or with the surrounding air, it would probably put on.

THE acetous state which is brought on by fermentation in watery solutions of sugar, is evidently that state of it, in which, after the disunion of the two principles of sugar, the acid remains principally combined with the menstruum, in consequence of the escape of phlogiston.—This is effected by what is called the acetous fermentation, and which is in reality the same kind of process which produced the vinous state of the liquor, only extended somewhat further: and I think it may be thus explained.

IF, after the separation of the component parts of sugar, and their combination with the surrounding water, have been effected by what is properly called the vinous fermentation, a degree of heat be communicated to the new compound, more than was requisite for the before-mentioned



mentioned purposes, it will produce, upon the common principle of heat, a further rarefaction of the liquor, and the cohesion between its several parts will be proportionately diminished; and should either of the principles, which by the previous operation became united with the water, become by this means so loosely attached to it, as on the approach of another fluid to be sensible of a superior attraction, it will, as in the former process, quit that body to which it is attached by an inferior affinity, and unite with that to which it is attracted by a superior affinity. It is probable that the phlogiston, as the rarest and most volatile of the ingredients which enter into the composition of wine, will be most easily loosened from the medium in which it is diffused, by the application of heat, and if in this state of imperfect cohesion, the surface of the liquor be in contact with the atmospheric air, which has a well known and powerful affinity for phlogiston, it is highly probably that it should be so far attracted by it, as to quit the liquor, and  
uniting



uniting with the air, be dissipated; and it is evident that if this take place to such a degree as to dephlogisticate the liquor, it will remain composed only of the water and the acid, and consequently be four.

THE two circumstances of a superior temperature, with regard to heat, and the exposure to the surrounding air, being indispensably requisite to induce the acetous fermentation, certainly very much strengthen the above conjecture.—And it is rendered still more probable by another fact, in which the separation and removal of phlogiston from vinous liquors render them four.

AFTER the separation of phlogiston from wine has been effected by distillation, and which, as before noticed, takes place when ardent spirit is obtained, a four feculent liquor remains behind. Indeed this and the former operation by which a four residuum is produced, are very similar,  
both

both depending upon the same circumstance, the removal of phlogiston.

WHEN vinegar is produced by the acetous fermentation, just such a degree of heat is, probably, necessary as will volatilize the lightest part only of the compound, and which, as before observed, is most probably the phlogiston, this heat being found, by experiment, to be from 70 to 80 of Fahrenheit: and when, therefore, it escapes in this rare and light state, it may easily be imagined that it will unite with the surrounding air, and be soon lost to the senses in the general mass of the atmosphere. When wine is subjected to the process of distillation a much greater heat is applied, and it being more than sufficient to separate the phlogiston, a portion of water, with perhaps some other principle, is raised at the same time, which uniting with the phlogiston, the compound is rendered more obvious to our senses, than the phlogiston in its separate and more rare

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state, or when united only to air, can be supposed to be, and we are, consequently, able to collect it thus combined, in proper receivers.

VINEGAR is, moreover, produced from sugar by another process of dephlogistication, namely, by being placed in circumstances in which manganese can act upon it, by which it is soon deprived of its phlogiston; for, during the process, a sharp vapor arises, which, when collected in a receiver, appears to be true vinegar\*. The only difference between this operation and the fermentative process by which vinegar is produced, being that in the latter the phlogiston is volatilized and dissipated, and the acid is left behind united with the water, and in this the acid is raised in the form of vapor, and the phlogiston remains behind, being absorbed and fixed by the manganese.

\* See Scheele's Essays—Essay v. on Manganese—Section xxviii.

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I wish I could have added, in confirmation of the preceding theory of acetous fermentation, that experiment had proved that the air, which is in contact with the surface of the wine, when the process is going on, is phlogisticated, which it certainly must, if the foregoing conjecture, respecting the escape of phlogiston during that operation, be true.—I have never, myself, had an opportunity of observing this operation upon so large a scale as would probably be requisite to decide this circumstance, and I believe the air which rises from the surface of liquors undergoing the acetous fermentation has not yet been properly subjected to experiment. It would, however, be no difficult matter to ascertain this in places where wine and vinegar are articles of manufacture, more especially as the methods of discriminating between phlogisticated and other airs, and even of ascertaining the degree of phlogistication which the air may



have suffered, is at this time so well understood.

It must, at the same time, be admitted, that the general accounts of this process, which are found in books of chemistry, very much favour this opinion; as they all agree in these two circumstances, that heat and the free access of the external air are necessary to the acetous fermentation, and, moreover, that there really does arise from liquors, in this stage of fermentation, some principle which imparts a noxious quality to the surrounding air. It is, indeed, observed by Neumann, Macquer and Baumè, that the air which arises, during this operation, is not so noxious as that which is produced by the vinous fermentation. But at the time when these chemists wrote, the nature of this air, and of fixed air, or aerial acid being totally unknown, it is not to be wondered at, that they could distinguish them in no other way than as the one appeared more noxious than the other:



other: and though phlogisticated air be as incapable of sustaining animal life and combustion as fixed air is, yet a sufficient reason may be suggested why the latter must appear much more noxious than the former, if an experiment be made on both respecting their power of extinguishing life and combustion, as they are found on the surfaces of liquors undergoing the respective fermentations. For fixed air being heavier than atmospheric air, it must necessarily remain, as an increasing stratum on the liquor, and consequently be in as dense a state as it is capable of assuming: whereas the former, or phlogisticated air, having less specific gravity than the air of the atmosphere, cannot be stationary as fixed air is, but must constantly be quitting the surface of the wine, where it was generated, by its tendency upwards; so that unless it were detained on the surface by some mechanical contrivance, it could never be found but in so rare a state, that if subjected to the experiments before al-

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luded to, respecting the extinction of animal life and combustion, it must, from comparison, appear much less noxious than fixed air.—There is, however, an experiment of Dr. Crell's, related in Scheele's Essays, by which vinegar is produced from the acid of tartar and spirit of wine, (and which, when united, must evidently be similar to wine, at least must contain the same principles) in which the incumbent air became phlogisticated. It is thus related—"If acid of tartar and spirit of wine be digested together for several months, the whole is converted into vinegar, and the air in the vessel becomes partly fixed and partly phlogisticated\*."

FROM what has been said, I think it appears pretty evident, that wine is formed of phlogiston, a peculiar acid and water that vinegar is formed of this acid and water without the phlogiston, and that in-

\* See Scheele's Essays, page 387.

flammable

flammable spirit is produced by the union of the phlogiston with water without the acid; that the phlogiston and this peculiar acid are obtainable from sugar, being evidently produced by the decomposition of this substance, and that the process which disposes sugar to give out these principles to water is fermentation.

THE true vinous character and peculiar qualities of wine also depend upon the perfection of the decomposition of sugar, and upon the proper and proportionate combination of these principles with water: a variation in this respect, joined to the mixture of bodies which are adventitious to sugar, but produced with it in the vegetable body from which it is derived, constituting the difference between wines. Thus the saccharine principle in barley being closely united to the farinaceous part of the same grain, it is, perhaps, impracticable to make a perfect solution of the one in water, without imparting to it such  
a portion



a portion of the other, as will affect the process of fermentation, and give a peculiar character to the wine so produced. Hence the difference between ale, the vinous liquor produced from the saccharine part of barley, and wine produced from the juice of the grape.

IN wine, made from the juice of the grape, the separation of the phlogiston from the acid seems to be most perfectly effected, and the redundant acid being more completely done away, the wine thus produced is certainly the most perfect example of a vinous liquor. There is, however, an obvious difference in wines made from different grapes, and one of them is the unimportant one of colour, which seems to bear no relation to the act of fermentation, it being, probably, produced extractively from the skin of the grape, merely on the common principle of maceration.

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It may, perhaps, be remarked, that I have not mentioned fixed air as one of the constituent parts of sugar, though it is evidently produced during the vinous fermentation of all saccharine liquors, and it has generally been considered as derived from the sugar. I have not done this, because I believe it would be difficult to prove that it previously existed as an ingredient in the sugar; more especially as at this time chemists are not quite satisfied about the nature of this principle, and it is even contended, that it is composed of phlogiston and pure air. Should this be the case, it may evidently be produced by some redundant phlogiston which does not combine with the water, when the decomposition of sugar first takes place.

It may be right still further to observe, before I conclude the subject of fermentation, that in strict chemical truth, all the liquors derived from the decomposition of sugar in water, by the several processes of

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the vinous and acetous fermentation, and distillation, are composed of those principles which, in common language, may be said to belong peculiarly to wine; for, from some late experiments related by Dr. Crell\*, it appears that they all contain phlogiston, the acid of sugar, and water; and that the peculiar character of each liquor is owing to the predominance only of the one or other of these principles; thus, in ardent spirit, the phlogiston predominates; in vinegar the acid prevails; and in wine they are combined so equally, as, if I may use the expression, to neutralize the liquor. This circumstance, however, though it was right to notice it for sake of accuracy, can, obviously, make no difference in the general principles of the preceding theory of fermentation†.

FROM

\* See Scheele's Essays—page 386.

† SINCE I wrote the above I have read Mr. Henry's paper on Fermentation, &c. in the second volume of the Manchester Memoirs, and I am much pleased to find my sentiments,



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FROM the two natural processes which have been related, the one synthetic, and the other analytic, the first approximating and uniting the principles of which sugar is composed, in the acts of vegetation and animalization, and the other disuniting them in

ments, on this subject, accord, so much as they do, with those of so respectable a Chemist. Being each of us led by very different circumstances to consider the principles of fermentation, a similarity of sentiment may certainly be considered as reciprocally strengthening both our opinions.

Mr. Henry considers the knowledge of the constituent parts of sugar, as I have done, to be most likely to lead to a knowledge of the true principles on which this process is effected, and to account for the several changes which are produced by it. He differs, however, in one respect from me, in supposing the decomposition of water to take place during the act of fermentation, whereas I have considered the water merely as a menstruum in which the principles of sugar are diffused, upon being separated from each other in the fermentatory operation. And I cannot help still adhering to the same opinion, and for the following reasons, 1st. because the phlogiston obtained from the sugar seems sufficient to account for that which exists in wine: 2d. because I think it improbable that the water

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should



in the act of fermentation, there is certainly the utmost reason to believe that these constituent parts of sugar are really phlogiston and a peculiar acid, agreeably to the first-mentioned experiment of the dephlogistication of sugar by the nitrous acid.

THE experimentum crucis is, however, still wanted, fully to establish this theory, namely, the artificial synthesis of sugar, or its revivification by the application of phlogiston to its acid, on the same principle as metals are revived from

should be decomposed under so low a temperature as that in which fermentation takes place : 3dly. because if it did take place, at least to any considerable extent, it is evident that a great part of the water would be dissipated in the phlogiston and dephlogisticated air which would be liberated by its decomposition ; and lastly, because I have even my doubts respecting the conversion of water into air under any circumstances ; at least the experiments which have been hitherto made, do not appear to me to be sufficient to admit it as an established chemical fact. See Dr. Priestley's Experiments on this subject in his sixth volume of Experiments on Air, &c. and the Experiments of M. De la Metherie, in the Journal de Physique.

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their calces by the same means, or as sulphur is produced by the union of phlogiston with the vitriolic acid, the consideration of which will be the subject of the next section.

## SECTION



## SECTION IV.

*On the Revivification of Sugar.*

HOWEVER probable it may appear, from a consideration of the preceding facts and observations, that sugar would be produced by bringing the saccharine acid into circumstances in which it could absorb and saturate itself with phlogiston, yet I fear there would be great difficulty in effecting this union by any common chemical operation; at least there appears to be an insuperable obstacle to it, in the way in which this process is usually carried on in the instance of metals; for the degree of heat which is requisite to disengage phlogiston from common inflammable substances, would, even supposing the phlogiston to be attracted by the acid, be sufficient to decompose and dissipate the principles of the new formed sugar  
by



by combustion: this circumstance being in metals of no consequence, as a greater and longer continued heat is requisite to calcine metals, than to burn vegetable or animal matter.

WERE the attempt made, it is obvious that it should be with those bodies to which phlogiston is most loosely attached, and which would, probably, part with this principle under a lower degree of heat than that which would produce the combustion of sugar, as phosphorus, ardent spirit, sulphur, the electric spark, inflammable air, &c. and possibly, if it be admitted that the rays of the sun contain phlogiston, the acid might absorb some of this principle, if exposed a long time to its rays strongly condensed by a lens: indeed this will appear the less improbable, if we advert to the phlogistication of another acid, which is unquestionably effected by the solar rays, namely, the nitrous, which Scheele has found by repeated



peated experiments to acquire a yellow colour, and to emit yellow fumes by mere exposure to the sun's light; and it need not be observed. that the yellow colour of nitrous acid is acknowledged by chemists to be characteristic of its having imbibed phlogiston.—Dr. Priestley has also found that a metallic calx may be restored to a metal, not only by being exposed to the flame of inflammable air, but by the rays of the sun being thrown upon it by a lens, when surrounded by inflammable air confined in a close vessel.

NOTWITHSTANDING, however, the seeming difficulty of restoring phlogiston to the acid of sugar, and thereby reproducing its saccharine state, there are some common processes which seem, in some degree, to effect it.

ACETATED lead, which is usually called sugar of lead, and obviously so from its sweet taste, may, I think, be considered



dered as a true sugar produced by the phlogification of the vegetable acid. This substance is the chryſtallized ſolution of white lead in vinegar. The ceruſe being an imperfect calx of lead, muſt contain ſome phlogiſton, though, evidently, not enough to make it aſſume the metallic character. The ſalt thus produced ſeems then to be compoſed of the calx of lead, of phlogiſton, and of the acid of ſugar contained in the vinegar. By the union of the two latter, ſugar is produced upon the general principles already advanced; and though, in this inſtance, it is ſo much impregnated with lead that it would be unfit for any of the purpoſes, for which ſugar is uſed, yet its ſweet taſte and another property which it poſſeſſes, ſufficiently evince its truly ſaccharine ſtate; for it is well known to Chemiſts, though it has hitherto been very difficult to explain, that by diſtillation an inflammable ſpirit may be obtained from ſugar of lead, and though, from the adventitious circumſtance of a

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metallic



metallic combination, it may differ, in some of its principles, from ardent spirit obtained from pure sugar, by the double operations of fermentation and distillation, yet agreeing with it in the chief characteristic of that fluid, inflammability, there can be little doubt of its being in itself similar, as well as derived from a similar source, more especially as it is well known that inflammable spirit cannot be obtained from a solution of lead in the vitriolic acid, or any other than the vegetable\*.

THE revivification of perfectly metallic lead from the sugar of lead by heat alone, which is a well established chemical fact, is another proof that the compound contains phlogiston, and consequently still more strongly favours the preceding conjecture, that the sugar is produced by its union with the vegetable acid of the vinegar.

\* Neumann's Chemistry—vol. i, page 86.



It may indeed, at first, appear paradoxical that the salt of lead, obtained from a solution of calx of lead, which obviously could not contain, in its calciform state, a sufficient quantity of phlogiston to put on the metallic character, should be capable of producing true lead by heat alone; yet, if it be considered that the purest vinegar contains phlogiston, it may reasonably be supposed that the deficiency of phlogiston is supplied from thence. For though the vinegar be evidently combined with too small a quantity of phlogiston for it to assume the saccharine character, and the ceruse be combined with too small a quantity of phlogiston to assume the metallic character, yet when they are both united, the sum of phlogiston in the whole, appears to be sufficient in one process, by a union with the acid, to produce a sugar, and in the other, by a union with the metallic calx, to produce a metal; and the different modes in which the two operations are conducted, may, perhaps, ex-



plain, why in the first the result should be the sugar, and in the latter the metal.

IN the first, which is merely a solution of the ceruse in vinegar by digestion, a very gentle heat is applied, much below that which is ever made use of in revivifying metals from their calces, and therefore it may be presumed not sufficient to effect the union of the phlogiston and the calx in this instance, it not being even sufficient to dissipate the acid by evaporation. At the same time, as a moderate heat will enable vinegar to separate phlogiston from lead, as may be instanced in the production of ceruse, in which the heat applied is only that of a dunghill, it is probable that the heat made use of in this operation is sufficient to disengage the remaining phlogiston from the ceruse, and its union with the acid, with which it has a stronger affinity, follows.

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IN the second operation, the degree of heat applied is precisely the same as in that of smelting; the acid is therefore immediately separated and dissipated, and the calx and phlogiston uniting, the revivification of the metal is effected in the same manner as when a metallic calx is in contact with any other phlogistic body undergoing combustion.

SHOULD the foregoing conjecture, respecting the sweetness of acetated lead, be admitted, it follows, that the effect of lead, in sweetening four wines, does not depend upon this substance as a metallic but simply as a phlogistic body; and should further experiments prove this, some processes may, probably, be adopted, by means of which an equal portion of phlogiston may be imparted to the liquor uncombined with so noxious a metal.

THIS, evidently, throws a new light upon the subject of recovering four wines,  
and



and a conviction of this, among manufacturers and venders of wine, with the knowledge of some other equally cheap and easy method of imparting phlogiston to sour wine, would go further to prevent the use of lead, in sweetening wine, than the most severe prohibitory edicts. And this, important as it undoubtedly is, certainly cannot be very improbable, because even now there is a process used by makers of wine which is truly phlogistic, and is that which I proposed to mention as another instance of the revivification of sugar from its acid.

It is a common practice with manufacturers of wine, to burn common matches, or rags impregnated with sulphur, over the surface of wine which has discovered any marks of sourness, and if continued for some time, it never fails to diminish the acidity of the liquor. In making cyder, in which liquor the acid is usually too abundant, the effect of this mode of phlogistication,  
in



in sweetening it, is so certain and considerable, as to make it almost universally a part of the common process of cyder-making, at least in those parts of the kingdom, where apples do not obtain perfect maturity.

FRONTIGNAC wine, which is very sweet, is frequently imitated by dealers in wine, and I am told that this is principally done by impregnating some of the weak and acidulous wines very powerfully with sulphur; and, indeed, the sulphureous impregnation of this wine may often be detected by the taste and smell.—These kinds of factitious wines are chiefly manufactured in Holland, and I have been informed by an intelligent traveller, that large quantities of weak and sour wine are annually exported from Nantz and sold to the Dutch, where they are, probably, changed into sweet wine by the forementioned or some similar process.

NOR



NOR is this merely a modern practice, for the use of phlogistic fumes, in lessening the acidity of vinous liquors, and of the total exclusion of air in preventing a further disposition to sourness, was well known to the ancients; for, whenever signs of this began to appear, the wine was immediately poured off into fresh casks, impregnated with the *vapor of sulphur*, they were removed into a cooler situation, and the new casks were so constructed as totally to prevent the access of the external air\*.

THE influence of the vapor of sulphur thus applied, has, however, been very differently explained by chemical writers, as they have supposed that it serves no other purpose than simply to check the fermentation, by preventing the further escape of those principles, which, during

\* Barry on the Wines of the Ancients—pages 8, 46 and 47.

the

the process, are attracted by the air, in the same manner as the respiration of animals, and the combustion of inflammable substances, are instantly stopped by their being respectively surrounded with an atmosphere which is saturated with phlogiston.

THAT this must be one effect of a stratum of phlogistic vapor covering the surface of a vinous liquor when fermenting, is very certain; but it is at the same time as certain, that the mere exclusion of the external air, and the removal of the liquor into a cooler situation, would equally put a stop to the operation, and as this would be a more simple and much less troublesome method of effecting this purpose than the application of the sulphureous fumes, it is not probable that the latter mode would be preferred to the former, unless some other effect were produced on the wine, more than the suppression of the fermentation; and surely if the preceding general principles be admitted,

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that



that effect on the wine which has been suggested, is the most likely to take place under such circumstances.

ANOTHER instance, in which it appears to me very probable, that the revivification of sugar from its acid is effected by its union with phlogiston, is in the calcination of cream of tartar: for during this operation it never fails to emit a smell perfectly resembling that of burnt sugar; and when it is acted upon by some other chemical operations, a residuum is produced which much resembles treacle in color, odor and consistence. Dr. Priestley has particularly noticed this fact in the relation of the experiments he made with calcined tartar, in order to discover the kind of air it gave out\*.

THERE can be no difficulty in accounting for this seeming production of

\* Vol. iv. pages 109, 402 and 403.

sugar,

sugar, in the calcination of tartar, on the foregoing principles ; for as, according to the common chemical analysis of tartar, it seems to consist of an acid, the vegetable alkali, an oil and an earth, it is evident that during its combustion, phlogiston may be set at liberty from the oil, and of course may form an union with the acid, which has before been ascertained to be similar to the acid of sugar. But the sugar thus produced being destructible by fire, it is obvious that none of it can remain when the calcination of the tartar is compleat, the only fixed parts which are left, being the alkali, and the earth. The time, therefore, at which we might most expect to discover it, will be, when the combustion of the tartar is only partial; for when some phlogiston has escaped from that part which is burnt, and some acid remains in that which is not burnt, it may be supposed that an union between these principles may be effected, and that by it a new compound of sugar may be pro-



duced. Experiment very well accords with this, for when the tartar is but little calcined, the saccharine smell is very striking, the whole substance is moist and of a reddish brown colour; but when more calcined it becomes perfectly dry, is of a deep black, and has no smell. When mixed with water, in the first stage of calcination, it communicates a tinge, which the water retains after filtration; but when more completely calcined, the black matter of the calx being incapable of solution, if put into water, it soon precipitates, leaving the liquor a colorless solution of the alkali: If nitrous acid be added to this and the whole be evaporated, common nitre is formed; but if nitrous acid be added to the colored solution of the imperfectly calcined tartar, not only are crystals of nitre formed, but another brown saline deposit is produced, which very much resembles sugar; though it appears too moist to crystallize into grains, and  
too



too acid to resemble sugar in taste, both which circumstances may, possibly, be owing to the same superabundance of acid, which is ever observed in native sugar, before the admixture of lime; for it may be remarked, that sugar, as a natural product, seems to be supersaturated with acid, in the same manner as tartar, which, though a saline compound of an acid and an alkali, is, in its natural state, as first deposited, supersaturated with the acid.

It may, perhaps, be urged, that the mere smell of sugar is, in the preceding process, too imperfect a test of its presence. This odor is, however, so peculiarly characteristic of sugar, that I doubt not but those who will make the experiment will readily allow its similarity; and I think it may be as readily admitted to be, in this instance of the calcination of tartar, derived from sugar, as the sulphureous smell which arises in the burning of common gypsum, is admitted  
to



to be derived from sulphur. In the latter case the sulphur is said to be produced by the union of the vitriolic acid of the felenite, with the phlogiston contained in some of the animal or vegetable substance, which is usually combined with gypsum, as found in the earth\*: and it is, surely, equally as reasonable to suppose, that in the former case sugar should be produced by the union of the saccharine acid and phlogiston, it being no more difficult to prove the previous existence of both these in tartar, than it is to prove the previous existence of the vitriolic acid and phlogiston in gypsum.

It has already been observed that, in the malting of barley, it is probable sugar is produced by the evolution of phlogiston and the requisite acid, which takes place during the vegetation of the grain, and both which previously existed in a con-

\* See Fourcroy's Chemistry.—Article Gypsum.

cealed



cealed state in barley. I am, however, inclined to think that the saccharization of all the acid which is evolved by this process, cannot be effected without the application of more phlogiston than seems to be produced from the grain, during its vegetation\*, and that this is, probably, effected in the subsequent part of the process of malting; in which it will appear, that the grain is a long time exposed to phlogistic fumes; and which, therefore, may, perhaps, be considered as another instance of the revivification of sugar from the acid by the union of phlogiston.

It has, indeed, been commonly understood, that the malt, when sufficiently

\* AND agreeably to this conjecture, it may be remarked, that when the malt lies upon the floor, and even when the germination has proceeded as far as is thought proper, a sour smell may usually be perceived. Indeed my observing this circumstance in a late visit to a malting office, first led me to suppose that the saccharization was not completed in the vegetative part of the process, and that a further phlogistication was, therefore, necessary.

sprouted



sprouted by the first part of the operation, is laid upon the kiln, merely that it may be quickly and perfectly dried, and that the germination may be thereby effectually stopped; but if the mode, in which this is accomplished, be duly considered, it will be found that something more than heat is applied; and it is, moreover, a fact, ascertained by repeated experiments, that drying the grain, in any other way, as respecting the application of heat, than in that which is commonly made use of, though it may equally deprive it of moisture, will not produce perfect malt.

THE operation of kiln drying the malt, as it is called, is as follows; the grain is spread thick upon a floor made of flat bricks, or iron plates, which are full of perforations; immediately under this floor is the oven or furnace, in which is a large fire made of coaks, cinders, or in some places, billet wood; a current of air, at the mouth of the furnace, keeps up the combustion



bustion of the coaks, and the air which is phlogisticated by their burning, and which, in a common fire-place, rises up the chimney, passes, in this instance, through the apertures in the floor, and penetrates the whole stratum of malt, before it can pass into the external air. Under these circumstances, it is evident, that the interstices of the malt must be filled with phlogistic air, and as the grain usually remains in this situation about two days, it is obvious, that if it have the power of absorbing phlogiston, it certainly must do it, when so long in contact with it. And that the malt does really imbibe some of this principle, is not only probable on the general ground of the truth of the preceding theory, but, I believe, it will be found, that the phlogisticated air which rises from the burning substances underneath, is corrected in passing through the malt: for without its being meliorated by this or some other cause, it is evident that the air in the kiln-chamber, more especially



cially the lower strata of it, must be noxious, and, probably, even so much so as to be unfit for respiration and combustion. But so far from this being the case, I am informed that workmen will frequently lie and sleep many hours on the malt in this situation, without suffering any inconvenience: And after mentioning this, it is scarcely necessary to add, that I find also, by experiment, that a candle will burn perfectly well in the air which is immediately on the surface of the malt.

WERE heat alone sufficient for the purpose of completing the operation of malting, it certainly might be applied in a much more cheap way than is at present done; for the floor on which the grain is laid might, unquestionably, be heated equally without there being perforations in it, as with them; in which case one kind of fuel would be as good as another, and, consequently, the present expence of previously burning the coals  
to



to convert them into coaks or cinders might be saved.

BUT, admitting, that the application of phlogiston to the malt, as well as heat, is requisite in this operation, the necessity of these perforations becomes evident, and, also, the propriety of previously burning the coals in such a way that all the water and those other heterogeneous particles which compose smoke and soot may be dissipated; for these, merely as such, would, obviously, contribute little to the phlogistication of the malt, and would, evidently, impart some offensive flavor, if not some noxious quality to it\*.

## SECTION

\* REASONING from the above premises, it would seem that as all the farinaceous part of the barley is seldom dissolved in brewing, and the grains which are left have usually the disposition to become sour, thereby manifesting some of the acid principle to be still existing in them, it is not improbable, but some further saccharine matter might be obtained from the grain, by another exposure to phlogisticated air, or, in other words, by being once more laid on the kiln; I have much wished to make this experiment,



## SECTION V.

*Conclusion.*

**I**N recapitulating the several facts and observations which have occurred in the preceding enquiry, under the respective heads of the natural production of sugar, the separation of its component parts by fermentation and some other operations, and its revivification or reduction by the artificial reunion of those parts, however imperfect the chemical reader may consider some of the examples, which have been adduced, and however defective the experimental part must be acknowledged to

ment, but having no opportunity at present of doing it in a way that would, in my opinion, be sufficiently decisive, I must be satisfied with merely mentioning my conjecture, trusting that I may one time or other have an opportunity of fully ascertaining it by experiment, or that some other person profiting by the above hint, may make the trial, and perhaps in a way more likely to answer the purpose than any I could suggest.

to be, yet, as they all, as far as they go, very uniformly and strikingly agree in proving the same general principles, and as, moreover, there are no facts which have occurred in the course of the enquiry, which contradict the above general theory, I think we may surely be permitted to adopt it, and to consider sugar, therefore, as another of the sulphurs.

AT the same time, it is much to be wished, that the practical chemist would prosecute experiments on this substance, and particularly on the acid of sugar, endeavouring to compleat those which have already been made by Scheele and Bergman, and which seem to be principally defective, in their not having, among the various combinations they made with this acid and earth, alkalis, other acids, and metals, united it with phlogiston.

IT may, indeed, be said, that this has, in some measure, been done by Bergman, in  
the



combination of the acid of sugar with the metals, which are phlogistic bodies; but if this be admitted, the accounts he has given of the results, afford no information respecting the effects of the metals in saccharizing the acid, if I may so express myself. In its combination with iron, however, this circumstance is casually mentioned, and it seems, as far as it goes, to favour this hypothesis; for he says, “the acid of sugar attracts iron with effervescence, which is occasioned by the extrication of its *phlogiston*; the solution has an astringent *sweetness*\*.”

I CANNOT, indeed, help urging a further experimental prosecution of this subject, to those who have more opportunities and are better able to make chemical experiments than myself, and not merely with a view to the extension of chemical facts, or the proving a philosophi-

\* Bergman's Essays, vol. page i. 323.



cal theory, but as it may possibly be applied to the improvement of some important art or manufacture; for, in consequence of further chemical attainments, and which the united and well-directed labors of so many ingenious men, at this time, lead us, not unreasonably, to expect, should we become better acquainted with that extraordinary principle, phlogiston, and be more able to detect its presence and to transfer it from one body to another, it would be hazarding very little to predict that the processes of wine-making, brewing, &c. and of all others in which either the separation or combination of phlogiston is effected, would be much benefited by such a circumstance. Perhaps, even sugar itself might become a subject of manufacture, and by the requisite application of phlogiston, it might be obtained from many vegetables, which in their natural state, contain only the acid principle of that substance.

WERE



WERE there, indeed, no other reason to encourage a further investigation of this subject, that which was suggested in considering the nature of wine, would, surely, be sufficient, as it seems from thence not unreasonable to expect that it may lead to the discovery of some method of sweetening four wine by the application of phlogiston, unattended with any of the pernicious effects of saturnine solutions, which notwithstanding the present laws in force against their use, in all countries where wine is drank, will probably continue to be mixed with it, by makers and venders of wine, whilst they have no other method of restoring an unsaleable article.

THE importance of such a circumstance to society need not be insisted upon, more especially to the medical reader, who cannot be ignorant of the very dreadful diseases which are produced by the admission of this metal into the stomach and intestines, and of the very extensive mischief,



mischief which has already been occasioned by its introduction into the constitution, through the medium of wine, cyder, &c.

The very classical and elaborate enquiry of Sir George Baker into the cause of the Cholica Pictonum, and his other excellent observations on the Poison of Lead, in the London Medical Transactions, will fully justify the preceding remark, and afford the most ample information on this head.

It would be superfluous to enumerate the various experiments which would be necessary in further pursuing this subject, as they must obviously occur to every chemist, who considers it with attention. I am aware, however, that there are many difficulties which would probably arise, and more especially to those who, like myself, have not had much experience in chemical processes; and there is one circumstance which appears likely to be, at present at least, a source of no small uncertainty in ascertain-

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ing with accuracy the results of many of these operations; and this is the want of a proper test of the presence of sugar.

IN the simple and uncombined state of sugar, the taste would be sufficient for this purpose, as sweetness, properly speaking, belongs alone to saccharine matter: but when it is either very much diluted in any liquid, or when its peculiar taste is covered by the predominant taste of some other substance, with which it may be united, this can, evidently, be no longer relied upon to discover its presence.

NOR is it difficult merely to discover the presence of sugar when much involved in other matter; it is also very difficult to ascertain the quantity of sugar which may be dissolved in any simple menstruum, in which the presence of sugar may be sufficiently obvious to the taste. A want of a method of effecting this has long been complained of by brewers, makers of wine, cyder, &c.  
and



and it has lately so much engaged the attention of those who are interested in this subject, that it is, this year, the subject of one of the premiums offered by the Society for the Encouragement of Arts, Manufactures, and Commerce, in London, a silver medal being proposed as an honorary reward “for discovering a practicable method of ascertaining the degree of sweetness in saccharine substances.”

ATTEMPTS have, indeed, been lately made to ascertain the quantity of sugar contained in malt worts; at least this would seem to be the case, from the name which has been given to the instruments which are employed for this purpose, namely, *saccharometers*\*. But however useful those instruments may be in pointing out the addition of matter which the liquor, in which

\* THE application of an instrument of this kind is fully explained in a work of considerable ingenuity, on the subject of brewing, lately published by Mr. J. Richardson, of Hull.



malt has been infused, may have acquired, yet as they effect this merely by shewing the increased density of the fluid, and do not, on any chemical principle, discover of what nature the adventitious matter is which is diffused in the water, and to which it owes its increase of density, and which, even in the instance recited, may be in part farinaceous as well as saccharine, it is evident that they must be inadequate to the detection of sugar merely as such, and, consequently, are not likely to obviate the difficulty which has been suggested.

COULD the process of fermentation be easily induced on substances which may be suspected to contain sugar, notwithstanding their being involved in other matter, the result being a vinous liquor, would be an unequivocal proof, that sugar had previously existed in them: but, (not to mention the very great improbability of effecting this on sugar under such circumstances, and more especially on such small specimens



specimens of such substances as might, perhaps, be the subject of investigation) if it even were effected, it could scarcely be considered as a test of the presence of sugar, as this proof could not be exhibited until, by a decomposition of the sugar, it might properly be considered as no longer existing in the substance.

WHEN sugar is simply combined with vegetable mucilage, or with any other substance which is insoluble in spirit, it certainly may be separated by digesting the compound in that fluid, and afterwards evaporating the spirit, in the way in which Magraaf obtained sugar from such a variety of vegetables, and in which way I have been informed, by a gentleman lately returned from the Continent, that some attempts are prosecuting, at this time, in France, with the prospect of obtaining sugar from many different vegetables which are cultivated in that country, and in such quantities as may make it become an object of mercantile advantage.

BUT



BUT even this will scarcely obviate the difficulty suggested, being rather calculated to separate sugar from such substances which exhibit some marks of its presence by their sweet taste, and which separation they, obviously, cannot effect, if the adventitious matter, with which it is united, be also soluble in spirit of wine.

THE application of the nitrous acid to substances which may be supposed to contain sugar, may, perhaps, be thought to be another means of detecting it; but this, like the process of fermentation, as it decomposes the sugar, and dissipates the phlogistic part of it, could, at most, only render it probable that some sugar had been contained in them; and as the saccharine acid would be the only principle remaining, this process must be rather considered as discovering that than sugar.

COMBUSTION, for the same reason, would seem, likewise, to be unequal to the detection of sugar under these circumstances,



stances, more especially as all its component parts are dissipated by the application of much heat. There is, however, one circumstance attending this operation, which, I think, may be considered as affording a tolerable criterion of its presence; and this is the characteristic odor emitted by sugar during burning.

It was this circumstance which led me, as before observed, to suppose that the principles of sugar existed in tartar; and as its presence was evidently betrayed by the peculiar saccharine smell emitted during its combustion, it may, probably, in some other instances, where it is so much covered by adventitious matter as to be concealed from the sense of taste, be rendered obvious to another sense by the operation of burning.

IMPERFECT as this test of the presence of sugar undoubtedly is, it appears to be the most likely, of any which have been mentioned



tioned, to assist us in discovering it when much involved in foreign matter.

It will, however, probably, be the business of future experimenters to enquire whether sugar has any peculiar affinities; and should these be known, they will obviously lead to more accurate methods of detecting its presence, and ascertaining its quantity under its different combinations, as also to the improvement of the several processes of separating it from different substances, and of refining it for use.

F I N I S.



E R R A T A.

Page 9 line 17 for *as*, read *with*.

— 39 — 17 for *sufficiently*, read *in some degree*.

— 50 — 17 for *explained*, read *understood*.

— 51 — 6 dele *that*.

— 63 — 8 for *this*, read *these*.

— 66 — 15 after *being*, insert a *comma*.

— 67 — 7 after *must*, insert *be*.



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