

On the origin, nature, and uses of Liebig's Extract of Meat : with an analytical comparison of other essences and preparations of meat / by J.L.W. Thudichum.

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Thudichum, J. L. W. 1829-1901.
Royal College of Surgeons of England

Publication/Creation

London : John Churchill & Sons, 1869.

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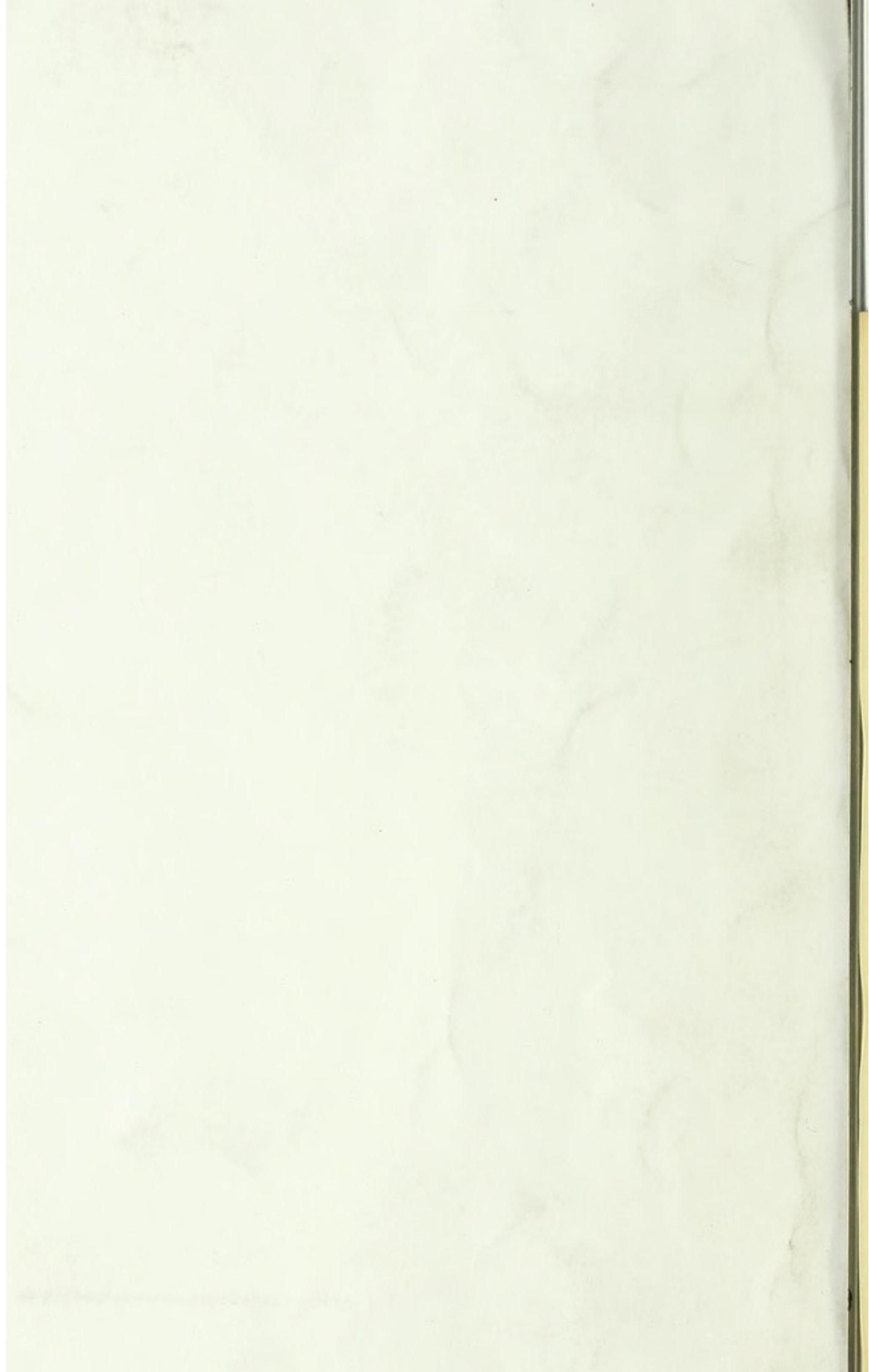
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ON THE

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ORIGIN, NATURE, AND USES

OF

LIEBIG'S

EXTRACT OF MEAT;

WITH

AN ANALYTICAL COMPARISON OF OTHER ESSENCES
AND PREPARATIONS OF MEAT.

BY

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LONDON:

JOHN CHURCHILL & SONS, NEW BURLINGTON STREET.

1869.

ON THE
ORIGIN, NATURE, AND USES
OF
LIEBIG'S
EXTRACT OF MEAT;

AN ANALYTICAL INVESTIGATION OF THE PRINCIPLES
AND PREPARATION OF THE
EXTRACT

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LONDON:
PRINTED BY
J. E. ADLARD, BARTHOLOMEW CLOSE.

PREFACE.

AT several periods of the present century various preparations and extracts of meat have been introduced to the attention of the medical profession and the public. Amongst these none have achieved such a genuine scientific, social, and commercial success as the extract which bears the illustrious name of Liebig. It was natural, therefore, that general attention should be directed upon it, and that a body of gentlemen, specially entrusted by a most influential and beneficent Society with an inquiry into the nature of the food of the people and the means of its increase and improvement, should desire to obtain more complete and certain information about it than that which had existed previously. As I had for years given attention to and been deeply impressed with the importance to society of the question of the meat supply, including the extraction as well as preservation of meat, it was not unnatural that I should be honoured with the request of the Food Committee of the Society of Arts to afford them some information more particularly on Liebig's Extract of Meat, and the scientific issues and dietetic questions raised by this new article. The results of my interview with that Committee, whose counsels were guided by the now Home Secretary, Mr. Bruce, were published in the 'Journal of the Society of Arts,' March 8 and 15, 1867. During the time which has elapsed since then my opinions have been freely canvassed, adopted by many, and been assented to by those who followed lines of inquiry similar to my own. The medical profession, as well as the public, seemed to have adopted the commodity itself as the best argument in its favour, so that in 1868 its consumption in this country experienced a great increase. A short time ago, however, there appeared in certain medical and belletristic periodicals, a succession of articles, which, by affecting

a scientific basis which they did not possess, and *pro tanto* imposing upon the credulity or good nature of a portion of the public, deterred many from the further use of extract of meat, and put others in a state of uncertainty and doubt. As a consequence, I had inquiries addressed to me concerning these sensational publications, and my opinion as expressed before the Food Committee of the Society of Arts, which induced me to institute a critical review of the entire subject. In this endeavour I was most kindly assisted by communications from Baron Liebig, from his son, M. Hermann von Liebig, by authentic information obtained from various correspondents abroad, and by the co-operation (in several important analytical inquiries to be related in the text) of Augustus Dupré, Esq., Ph.D., Professor of Chemistry to the Westminster Hospital, and J. Alfred Wanklyn, Esq., Professor of Chemistry to the London Institution. I now beg to lay before the medical profession and the general public the result of these studies and communications in the shape of the following essay.

THE
ORIGIN, NATURE, AND USES
OF
LIEBIG'S EXTRACT OF MEAT.

THE discovery of pure extract of meat, such as we know it now, was the result of abstract scientific researches into the nature of meat, which Baron Liebig published in the year 1847 ('Annalen der Chemie und Pharmacie,' 62, 257). They were republished in London under the title 'Researches on the Chemistry of Food.' They excited universal interest, and justly enhanced the reputation of their author as a chemist and philosopher. During the ten years succeeding this publication, the attention of many men of science, but more particularly of the medical profession in Germany, was directed upon this subject, and it was ascertained that extract of meat was of great usefulness in medical cases. In consequence, the "Extractum Carnis" was, without Baron Liebig's privity or assistance, introduced into the Bavarian Pharmacopœia of 1856, and from that time all Bavarian apothecaries were legally bound to keep the extract in stock, or to make it when required, just as any other drug. From Bavaria the knowledge and medical use of the extract spread over the whole of Germany, but its manufacture remained confined to pharmaceutical chemists, and its use to the sick chamber. Baron Liebig, on the other hand, while fully appreciating the clinical importance of the extract, and further endeavouring to improve the alimentation of sick persons by various modifications of this invention, such as the "extractum carnis frigide paratum," and the concentrated cooked beef-tea, endeavours in which during the whole of that period I have taken an active interest, as shown by the fact that I drew the attention of the Medical Society of London to several of these inventions at the time they were made, proposed to bring meat extract into commerce as an article of food, and to make its manufacture the object of industrial enterprise on a large scale. But his endeavours were without success, until

History.

Extract invented, 1847.

Extractum carnis official in Bavaria, 1856.

Spreads in Germany.

Other preparations of meat by Baron Liebig.

Proposal to make extract an object of industrial enterprise.

M. Giebert carries out Liebig's plan, 1862.

Giebert's Manufactory at Fray Bentos, Uruguay, South America.

First South American Extract arrives at Munich, 1864.

Conditions of Liebig's name being attached to Extract.

Establishment of Liebig's Extract of Meat Company, Limited.

New Manufactory at Fray Bentos, completed in 1868.

General features of process of preparation.

early in 1862, M. George Christian Giebert, an enterprising engineer, well acquainted with the meat-producing districts of South America, having read Baron Liebig's 'Letters on Chemistry,' and in them the passages relating to extract of meat, and the feasibility of producing it cheaply from the meat so deplorably wasted in South America, went to Munich to receive instruction in the method of preparing the extract by Baron Liebig himself, aided by Prof. M. von Pettenkofer, and then returned to Uruguay, and established a manufactory on a considerable scale. In November, 1864, the first samples of M. Giebert's manufacture, produced in connection with a company at Fray Bentos, and consisting of eighty pounds of extract of beef and thirty pounds of extract of mutton, arrived at Munich, and their quality far exceeded the expectation of Baron Liebig. He consented to M. Giebert's proposition that the extract should bear the name of the inventor, on condition that it should always be free from fat and gelatine, that each consignment should be subjected to a gratuitous analysis by him or his delegate, and that it should be sold at one third of the price for which it could be produced in Europe. These circumstances were detailed by Baron Liebig in an article in the 'Annalen' for 1865. The new extract met at once with a rapid sale, and the "Fray Bentos Company," requiring more capital, was shortly afterwards merged in the "Liebig's Extract of Meat Company, Limited." This latter company, like their predecessors, accepted the scientific direction and control of Baron Liebig, and received by him the exclusive right of using his name in connection with their manufacture.¹

The Company at once proceeded to erect a new manufactory on the largest scale, which was completed in 1868. A sketch and description of these works has been published in one of the Company's fly-sheets, and it is, therefore, not necessary for me to dilate on this subject. Suffice it to say that the whole of the arrangements are of gigantic dimensions, and the apparatus is the best known to science, all evaporation, *e. g.*, being effected in so-called vacuum pans, or closed boilers, from which the air, and subsequently steam-gas, are removed by air-pumps. The general features of the process by which the extract is obtained are not by any means a secret, but the special rules by which extract of the quality, constancy of composition, and durability of that of Liebig's Company is obtained, have never been published by the inventor. Indeed, such rules could hardly be given, inasmuch as the varying circumstances of the manufacture, the season of the year, and the qualities of the raw

¹ No other person or society has ever received Baron Liebig's permission to use his name in connection with their manufacture, and any persons so using his name do so not only without his permission and control, but contrary to his clearly expressed desire.

material, require a continuous scientific supervision on the part of a thoroughly skilled chemist, and eventually a change of the process in emergencies. This function is performed at Fray Bentos by Dr. Seekamp, a former assistant and now deputy of Baron Liebig. The material from which the extract is made is the flesh of the best cattle, not less than four years old, which have been reared and grown up in the pampas. These grassy plains of the Uruguay are subdivided in "estancias" or separately owned estates. Their climate is so mild that the animals live in the open air all their lives without any kind of shelter except that afforded by some exceptional trees and shrubs, particularly the poplar trees with which the estancias are enclosed. The cattle is originally of the Spanish long-horned breed, but has been much improved during several generations by the importation of and crossing with English animals. Wild oxen or buffaloes do not exist in the Uruguay,¹ as is testified by Martin de Moussy, "La Confédération Argentine." The herds are most healthy, have for a long time been free from cattle plague or any other epidemic disease, and do not suffer from the effects of those droughts which often deteriorate and not rarely destroy² the herds of Australia. The pampas have another advantage over the grass-fields of Australia in this, that besides being much better watered so as to produce grasses of the finest feeding qualities, they are quite free from noxious herbs, particularly from the gum-tree (Eucalyptus), by browsing on which at times of drought the Australian cattle acquire a peculiar flavour in their meat, which is resinous or drugged, and variously described as the "turpentine" or "laurel flavour." Calves, heifers, and animals under four years are not used at Fray Bentos, as their extract tastes flat, and has other drawbacks, *e. g.* pappyness or viscosity. The extract from oxen between four and six years of age is best and of the finest flavour; it is darker than that from cows, which, however, is milder in flavour; a full-grown ox yields from eight to ten pounds of extract of standard composition. It is to the interest of the Company to use the best beef only in their manufacture, as a deteriorated animal yields much less extract than a healthy and strong well-fed one, in the proportion of seven to ten. In fact, to work up inferior beef would result in a loss rather than a gain. The Company have in consideration of this fact enclosed large spaces of selected grass land in the neighbourhood of their manufactory, where all animals which come from a

Materials—the best Cattle of Spanish breed, improved by English. Pampas, Estancias.

No buffaloes in Uruguay.

Pampas better watered than Australian runs, and free from noxious trees.

No Extract from animals below four years made.

Extract from oxen, best beef only used.

Enclosed grass land for resting of driven cattle.

¹ "There are nowadays no wild oxen or 'alzados' met with in the Argentine Confederation, and if any should exist, they are exceptional and accidental. All the cattle is broken in, imperfectly no doubt, but so as to be accustomed to the presence of man, and to allow itself to be directed by him."

² One of the agents of the Australian preserved meat movement, who is now on business in this country, has lost his entire property to the value of sixty thousand pounds, by such a calamity.

Inferior, bad, or diseased meat excluded.

distance are kept, until they are in a proper condition for being slaughtered. Thus it is quite clear that the Company have no inducement by way of gain to use inferior, bad, or diseased meat in their manufacture, as is sometimes disingenuously insinuated by ignorant sensation writers. But even were it otherwise, the Company would, I am sure, unreservedly repudiate the calumnious suggestion of their using bad meat, or of their permitting any even by inadvertence to be mixed up with the materials of their manufacture. Such a proceeding they would consider as a fraud upon the public, equalled in immorality only by the want of honour in those persons who falsely suggest that such a fraud was of common occurrence.

Horseflesh too dear and useless for Extract.

It is also sometimes suggested that horseflesh might be used for making extract, but the insinuation only reflects the ignorance of those who put it forth. Horses are much scarcer in Uruguay than oxen, and in every sense far too valuable for slaughtering. But independently of that, even if they could be had, their flesh would not give a satisfactory extract. For, during evaporation, it constantly forms skins on the surface, which make the condensation to extract consistence almost impossible. Moreover, the extract from horseflesh greatly varies in composition, being sometimes rich in dextrine, at others destitute of it.

Guarantee of genuineness of Liebig's Extract of Meat.

The genuineness of the extract, that is to say, the guarantee that the extract of meat sold by the Company is actually extract made according to Liebig's plan, and is pure and of uniform composition, is most perfect and complete. M. Seekamp superintends the chemical part of the manufacture at Fray Bentos. Another of Baron Liebig's trusted assistants, an equally reliable and honorable man, is attached to the general depôt of the Company at Antwerp. He receives the whole of the extract on its arrival from South America, and it is his duty to take a sample of every one of the packages (tin boxes containing from seventy to eighty-five pounds of extract each) and send it to Munich. There in Baron Liebig's laboratory each sample is examined as regards the amount of moisture, of ash, and of matter soluble in spirit of wine of 80 per cent. strength contained in it, and care is taken to ascertain the complete freedom from fat and gelatine. No extract is allowed to be sold which has not thus been examined and approved by Baron Liebig. Every manufacturer knows that it is at least exceedingly difficult, and, if not impossible, at least impracticable, to produce extracts of any organic substances of ever uniform condition, colour, and composition. Various preparations of extract of meat must, therefore, be allowed to vary in composition within certain well-ascertained limits, which have been fixed at an early date of the manufacture by Baron Liebig, as follows:

Chemical superintendence at Fray Bentos.

Sample-taking at Antwerp.

Analysis of samples in Liebig's Laboratory at Munich.

Limits of variation of extract fixed by the inventor.

The amount of water or moisture in the extract may vary between 16 and 21 per cent.

The ash may fluctuate between 18 and 22 per cent.

The amount of extract soluble in alcohol of 80 per cent. must amount to from 56 to 60 per cent.

In case the extract, on arrival at Antwerp, is found to contain more than 21 per cent. of water, it is there made more concentrated. Only two packages have hitherto required such treatment. As a rule, the extract contains less than 17 per cent. of water, and more than 56 per cent. of matter soluble in alcohol of 80 per cent. strength. Extract containing gelatine, or of gelatinous or pappy, viscous quality, is not allowed to be sold at all from the Company's depôt, and, in fact, has never arrived there.

Limits of water contained in extract.

From the foregoing it is evident that some explanation is required of the statement of Dr. Letheby, that analyses of the "extractum carnis" of Liebig, "as found in commerce," have furnished from 41 to 60 per cent. of water, from 22 to 41 per cent. of organic matter, and from 8 to 16 per cent. of saline matter ('Journal of the Society of Arts,' vol. xvi, p. 733, Sept. 11, 1868). I was so much struck with the peculiarity of the foregoing figures, and with the fact, on the other hand, that not one of the extracts which were examined either by Baron Liebig, M. H. von Liebig, or Prof. Wanklyn, Dr. Dupré, or myself, had shown a composition in any sense similar to that given as usual by Dr. Letheby, that I inquired of him the names of the makers and sellers of the extracts referred to by him. To this inquiry Dr. Letheby replied, that, as the extract was made by many persons (!), it would not be proper, nor would it be prudent, for him to specify the names of the parties to whom he referred. In his certificate on Whitehead's solid essence of beef Dr. Letheby gives the water "generally" contained in Liebig's extract as from 40 to 49 per cent., which differs greatly from the above 41 to 60 per cent. The "extract of meat" in this essence he gives as 61.7 per cent. It appears from Dr. Dupré's analysis that Whitehead's essence contains 53 per cent. of gelatine. Five sixths of this "extract of meat," therefore, is extract of bone. Whatever may have been the nature and origin of the extracts referred to by the food-analysist of the City of London, it is certain that they were not Liebig's extracts, and it is evidently his duty to the public (particularly in his capacity of guardian appointed by law to protect the public from adulterations of food) to state where and under what circumstances he obtained these spurious and falsely so-called Liebig's extracts, in order that the imposture committed by their sale may be immediately exposed. No sample of extract made in Germany for trade purposes (excepting always the officinal preparation in Bavaria) has as yet been found to contain less than 24 per cent. of water; some, however,

Dr. Letheby's peculiar statements concerning extract of meat.

Dr. Letheby's Report on Whitehead's Solid Essence

German Extracts.

contained up to 28, and one 36 per cent. of water, being the maximum amount ever observed by Baron Liebig in any extract bought in the market. Only one of these extracts pretended to be made by Liebig's process, an assumption which was quickly stopped by the publicity given to the circumstance. The others were sold, as they had a perfect right and liberty to be, as "Extractum Carnis Germanicum."

Adulteration with, or admixture of salt, actual and erroneously alleged.

An admixture which actually occurred in the case of an unauthorised product, but was falsely attributed abroad and in this country¹ to be made with Liebig's extract, was that of common salt. The wholesale druggist firm of Gehe and Co., of Dresden, published in one of their trade reports that the genuine South American extract of meat obtained from the depôt of the Fray Bentos Company, of Antwerp, was strongly mixed with salt. This statement was completely unfounded, and it is almost incomprehensible how this firm should have come to commit such a grave error. Perhaps their examiner only tasted the extract, which is always salty on the tongue, or mistook a few crystals of creatine or acid phosphate of potassium for common salt. The exposure by Baron Liebig of this grave mistake has led this firm to espouse strongly the cause of a competing extract, which, but for the artifice of using Baron Liebig's name contrary to his wish, and without his permission, and by means of a licence of which we cannot distinguish the honorable origin, would by dint of its own merits have no chance of existence.

Salty taste of, and crystals in, true extract.

Necessity of preventing spurious articles from being sold under the title of the genuine extract.

The whole of these transactions and statements of strange analyses, be they founded or unfounded, show the absolute necessity which there is for the greatest watchfulness on the part of the inventor and the public as well to prevent spurious articles from being sold under the title of the genuine extract, as also to prevent spurious analyses and disingenuous editorial articles from damaging the real extract in the eyes of the public. In this endeavour the medical profession will be the best and most competent judges.

Materials—their quantity and yield of extract.

At Fray Bentos every thirty-four pounds of pure flesh (muscular tissue), corresponding to forty-five pounds of meat as obtained from the butcher, including fat, tendons, ligaments, cellular or connective tissue, and bones, yield on an average one pound of extract, so that an ox yields seldom more than eight or nine, in the best case ten, pounds of extract. All the meat is weighed before going to the mincing machines, and the extract obtained being again weighed when of standard concentration, it is clear that no one can have more certain data to arrive at a correct conclusion concerning this matter than the officers of the company.

It is clear that, as against their positive experience, the mere statements *extempore* of writers in periodicals with a tendency

¹ See Dr. Hassall's statements in the 'Lancet.' Though challenged, Dr. Hassall has never stated where he obtained the adulterated article. Sapiienti sat.

or motive for detraction, are not to be trusted. These writers, however, make the most of an alleged discrepancy in the statements of various authors regarding the point. It is amusing to see how they either fall into mistakes or accept the mistakes of their prototypes.

Explanation
of alleged
discrepancies
concerning
yield of
extract.

The officers of the company say that on an average thirty-four pounds of muscle yield one pound of extract. A M. Ford says thirty-three pounds of meat yield one of extract, which is almost the same as thirty-four. In fact, we know that M. Ford was told by M. Giebert that the quantity of muscle required was from thirty-three to thirty-four pounds.

A Mr. Hutchinson, who has published a work entitled 'The Parana and South American Recollections,' also gathered his information at Fray Bentos. But he forgot the distinction between butchers' meat and muscular tissue, if he had ever taken it in, between the time of his visit and the writing of his notes, and stated that forty-five pounds of meat are required to yield one pound of extract. However, in the sense defined above, this may be said to be perfectly correct. The discrepancy between Ford and Hutchinson is only this: that the former implies muscular tissue, without fat, bones, &c., while the latter includes all these anatomical parts, and implies butchers' meat in toto.

The estimates of Professors Poggiale and Payen ('*Révue des deux Mondes*,' Décembre, 1867) involve, however, a mere error. They mistook the figures thirty-five (indicating muscle only) and forty-five (indicating muscle, bones, fat, and tissue) as applying to homogeneous matters, and indicating extremes of fluctuation, and stated the mean of these numbers, namely forty, implying forty pounds of beef of some kind or other to be required on an average for the production of one pound of extract. But, even if their statements were not based upon mere mistakes, they would have no validity as concerns the company's extract, and it is the merest suppression of the truth and adoption of the false to use them for controverting the scientific expositions of Baron Liebig and his collaborators. There is the incontrovertible fact, which the balance proves upon the flesh and extract from many hundred oxen at Fray Bentos daily, that thirty-four pounds of muscle on an average yield one pound of extract. There is further the incontrovertible fact of the great uniformity of strength and composition of the company's extract,—a uniformity which actually keeps considerably within the limits of fluctuation allowed by the inventor,—and yet there can be found persons, such as "Dr. de Beaumont,"¹ and his adherents,

¹ Frère Ephrém," who ministers to the medical wants of his fellow-monks in the Trappist Convent of Aiguebelle near Lyons, owns and manufactures on behalf of the Abbey of the Dombes the "Musculine Guichon," and writes in the '*Medical Gazette of Lyons*' under the pseudonyme of "Dr. Charles de Beaumont."

Errors of
M. de Beau-
mont, Dr. R.
Druitt, and
M. E. S.
Dallas.

Dr. R. Druitt, and M. E. S. Dallas, who, by admitting every possible exploded fallacy into their argument, endeavour to discredit the true Liebig's extract of meat with the public on this allegation, shown to be quite contrary to fact that the composition of the extract was not nearly constant, and that one pound of extract might represent quantities of meat varying between thirty-three and ninety pounds.

Such simplicity is only surpassed by the repetition and unreserved acceptance by the editor of the 'Medical Times and Gazette' of the absurd assertion of the monk of Lyons, "that 'un bouillon de cuisine,' or 'pot-au-feu ordinaire,' independently of its possessing valuable nutritive ingredients which are removed from the extract, yields on evaporation considerably more of the ingredients contained in the extract than Liebig's beef-tea contains even on the highest estimate."

It would be difficult to crowd into one sentence a greater amount of fallacy than is here contained with apparent ease. What quantities of meat, with or without bones, &c., does "un bouillon de cuisine" or the classic "pot-au-feu" represent? Have the French abbott or his English followers ever analysed that shadow "bouillon de cuisine?" If not, why do not they supply the want of chemical qualification by some metaphysical analysis, *vulgo* common sense? It is lamentable to behold such ignorance detracting from useful inventions while, at the same time, giving testimonials to Australian disks of glue, to real size of a pliability akin to india rubber.¹

Gelatine is
the greatest
enemy of the
true extract
of meat.

"The extract," says Baron Liebig, "must not contain any gelatine. It is clear that if we consider an amount of even $\frac{1}{2}$ or 1 per cent. as admissible in its composition, we cannot consider $1\frac{1}{2}$ or even 2 per cent. as a great fault, certainly not as an adulteration." From this point of view glue has to be considered as the true enemy of the real extract of meat. For if it is admitted at all, the door is open to deterioration and adulteration, and it can be foreseen and predicted that the extract will in a short time sink to the low estimation of the tablets of "consommé" or of bouillon, which are a coloured carpenter's glue, or painter's size. This does not by any means imply that ready made bouillon or beef tea (or soup) ought not to contain any gelatine. A decoction of bone may have its uses by giving body to a broth, but gelatine can be bought at the price of pence, while true meat extract, weight for weight, costs shillings; therefore, to sell gelatine to the public in meat extract, is the same as selling chicory to the public in coffee. It is a wrong whenever the fact of there being this ingredient and its

¹ The success and scale of manufacture of this solid extract may be judged from the following fact. We called at a wholesale depôt to buy a number of boxes; but only one was forthcoming, and no time could be given at which we might obtain a second one.

amount are not stated to the purchaser. The presence of gelatine in extract of meat diminishes greatly its quality of remaining unchanged in varying seasons, climates, and conditions; it becomes thereby liable to be mouldy, which, in its pure state, it never is.

The solution of extract of meat gives a precipitate with tannic acid, a circumstance which might mislead the inexperienced into the belief that, after all, gelatine was a common ingredient of all meat extract.¹ But this is not the case; for the extract, prepared with cold water, according to Liebig's original prescription, from which albumen and myochrome are removed by boiling, gives a precipitate with tannic acid, which has adhesive properties. But neither this nor the precipitate in the company's extract contains any gelatine, *i. e.*, do not yield any gelatinising body, and do not, on combustion, give out a disagreeable smell of burning glue.

Particular ingredient not to be confounded with gelatine.

One pound of the company's extract is sufficient to produce seventy pints of good beef-tea, of which each pint contains the soluble ingredients of half a pound of beef. By no culinary method other than the process of Liebig can any half pound of beef be made to yield a pint of beef-tea of the same strength and quality as any of these seventy pints. Half a pound of beef as ordinarily treated in kitchens for the purpose of extracting beef-tea, must necessarily yield a lesser quantity of extract to the pint. No culinary operation can equal the established methods for preparing pharmaceutical and chemical extracts, such as are used at Fray Bentos.

Extract yields best beef-tea.

Frère Ephrém of the Dombes and his disciples wanted to be severe and epigrammatic, but, attempting the pathetic, they became ridiculous. "This new and audacious product," says the proprietor of 'Musculine Guichon' (think of poor beef-tea being called new and audacious!), "claims to dethrone the classic pot-au-feu of our households, and to relegate to the position of antiquated formulæ preparations of raw meat from which therapeutics derive such advantages."

Errors of the advocate of "Musculine Guichon."

This claim exists only in the fancy of the vain pompous monk, or his instrument, the apothecary M. Guichon. The extract claims to enable a man to have the equivalent of a good pot-au-feu where ordinarily there is none, and to have it cheaply, quickly, and certainly. It does not intend to supplant anything, but to supplement much that is wanted. It leaves the raw meat preparations, their trichinæ, their cysticeri tæniæ grandis, and

¹ Thus an analyst who published in the 'Lancet' for January 9th, 1869, his comparison of the composition of three different extracts from as many makers, found in one 7.87 per cent., in another 9.63 per cent., and in a third 8.56 per cent. of "gelatine." It is suggestive of much consideration that the analyst also determined the nitrogen in the extract, and calculated from its per-centage the amount of albuminous matter to which it corresponded.

solium, the germs of tapeworms, quite undiscussed, and does not compete with them. The raw meat therapeutics have the freest scope, independently of and without any interference on the part of the advocates, the inventor, or the manufacturers of the extract.

Liebig's extract used in St. Thomas's Hospital and elsewhere.

In St. Thomas's Hospital the ordinary beef-tea, which is made fresh daily for the use of the patients, is now strengthened with advantage and perfect success by the addition of a certain quantity of Liebig's extract of meat. Many other establishments, to the knowledge of the writer, do the same.

It is, perhaps, partly on account of this aggravating success of the extract that the advocates of muscine, the backers of painter's size and carpenter's glue, spare no means of discrediting Liebig's extract with the public and the profession.

Dr. Druitt's æsthetics and facts.

Thus Dr. Druitt, forgetful of æsthetical feeling, and of that honorable regard to facts which is the duty of every public writer, says ('*Med. Times and Gazette*,' January 23, 1869, p. 94): "A pot of evaporated urine bears a painfully close resemblance to a pot of extract of meat, and both extracts have many constituents in common." In a foot-note patients are said sometimes to have objected to taking beef-tea prepared with the extract, on the ground that it sometimes bears an unpleasant urinous odour.

It is simply not the fact that evaporated urine, or extract of urine, has any resemblance in odour, colour, taste, composition, or properties, with concentrated beef-tea or extract of meat of almost any kind, even the worst included. In evaporated urine there are urea, urochrome, and the emetic products of its decomposition; there are volatile alkalies, and a great amount of common salt. The "extractum saponaceum" of Rouelle and Boerhaave is nauseous at once to smell and taste, quite independently of the idea of excrement. None of its constituents except the small amount of creatine which it contains, and phosphate of potassium are present in meat extract. In fact, the comparison is a very coarse attempt to disgust people with the extract, and must be visited with the contemptuous reprobation of every decent person.

Composition of fresh muscles.

The fresh muscle of young, well-fed oxen contains—water, 74 to 80 per cent., and solids, 26 to 20 per cent. Of these from 15·4 to 17·7 per cent. are insoluble in cold water, and consist of myosine or fibrine, sarcolemmata, nuclei, blood-vessels, and elastic fibres. The connective or gelatine-forming tissue is also insoluble in cold water, but gradually dissolves in hot water, giving gelatine; it amounts to from 0·6 to 1·9 per cent. The matters soluble in water are myochrome, or hematocrystalline, the red colouring matter, albuminate of potassium, coagulating at 45° C., and serum-albumen, amounting together to from 2·2 to 3·5 per cent. The fat amounts to 1·5 to 2·3 per cent.;

lactic acid, 1.5 to 2.3 per cent.; the quantities of dextrine, glycogen, inosite, sarkine, xanthine, taurine and inosinic acid (this last being perhaps an ingredient peculiar to the flesh of fowls), have never been determined, and are exceedingly small.

Of inorganic ingredients the flesh contains, phosphate of potassium 1.1 to 1.24 per cent.; traces only of sodium salts, and a little phosphate of calcium and magnesium.

It is doubtful whether creatinine naturally occurs in muscle, or is a product from the creatine. The quantity of creatine obtainable from the meat of different animals varies somewhat. Thus by a careful method from 0.07 to 0.14 per cent. are obtained from young beef, 0.189 per cent. from mutton. Such a quantity as 0.7 per cent. of creatine, which is put forth as the average by the editor of the 'Medical Times,' has never been obtained. It must be remarked that the numbers expressing creatine are still 12.1 per cent. too high; this being the amount of water which crystallises with it from its solution. Now, as 1000 pounds of meat contain on an average, say two pounds of creatinine and creatine, and as 1000 pounds of meat yield about thirty pounds of extract, it is clear that every fifteen pounds of extract contain one pound of creatinine and creatine (7.5 per cent.). It is therefore not the fact what Dr. Druitt says, namely, that the extract contains 97 per cent. of creatine; it is not the fact when he says that Liebig had found that the flesh of the ox contains 0.7 per cent. of creatine. Dr. Druitt has evidently stated the quantity of creatine found by Liebig ten times too high. From 100 pounds of lean horseflesh Liebig obtained 0.072 per cent. or a total of thirty-six grammes of creatine; from fifty-six pounds of young ox beef he obtained thirty grammes, or 0.07 per cent.; from forty-seven pounds of lean flesh from fowls he obtained seventy-two grammes, or 0.32 per cent. It is therefore not the fact when Dr. Druitt states that the flesh of the common fowl yields 3.7 per cent. of creatine. With this demonstration of the errors in his alleged data fall the whole of the speculations of this editor; they are reduced to an absurdity.

Of the 60 per cent. of organic solids in the extract only $\frac{1}{6}$ is qualitatively known, $\frac{5}{6}$ are as yet unknown. Perhaps the most active ingredient has yet to be found here. The body which can be precipitated by tannic acid is an albuminous substance resembling the peptones, or matters which have become soluble by stomach and duodenal digestion. There is contained in the extract a body possessing the remarkable property of fluorescence. None of the isolated and ascertained substances hitherto mentioned possess this property. In the purest state in which as yet I have been able to obtain it, it fluoresces violet, and owing to the remarkable pertinacity with which it preserves its optical property, I have termed it *fluorescentine*. It seems

Inorganic salts in flesh.

Quantity of creatine contained in different descriptions of meat.

Organic matters in extract only partially known.

Fluorescentine.

to possess the properties of an alkaloid, and may possibly in that capacity have important effects upon the nervous system, resembling quinine and other organic bases. On this part of the extractum carnis active researches will yet have to be made, in order that we may be enabled to know the *rationale* of the actions of beef-tea as well as we know that of tea and coffee, of opium and tobacco. But we need not for that arrest our enjoyment of soup and beef-tea, and disdain that which is naturally agreeable to our taste.

Mr. Dallas's
fancies and
gyrations.

Mr. E. S. Dallas, who, while he shows such desire to know what he is swallowing, strains at gnats and swallows elephants of errors,¹ thinks that a watery solution of creatine from codfish, salted with phosphate and common salt, would be a more agreeable drink than we now possess in the solution of the extract. He has dropped the "caution-to-cooks" sensation-style, and in order to let himself down easy, now denounces the same experiments which before he had held up as having saved the world from destruction. He affects even to have read the account of these experiments, but it is evident that he merely stammers the apology in the words of the castigation which was administered to him in the 'Lancet' by Baron Liebig. The experiments of Kemmerich and the conclusions drawn from them are quite trustworthy, and there is no flaw in them; but what is not trustworthy is the use which Mr. E. S. Dallas has now on two occasions made of them. The public must be warned of such pseudo-scientific literature, which is not worth the paper on which it is printed.

Peculiar
value of meat
extract ascer-
tained by
chemistry
and taste.

If beef-tea is considered as agreeably flavoured phosphate only, a pint would certainly be worth twopence. For potassium-phosphate is necessary food. But the savoury quality of flavour, the meaty taste, no "penny-a-liner's" swaggering can impart to a creatine and alkali solution, to extract of cod or herring. They are the property of meat extract only, and are an inseparable part of its value.

Australian,
American,
and European
extracts—
differences in
their flavour.

The chemical analysis of extract gives a certain basis for judging of its value, but, as in wines, it is not alone decisive as to quality; taste and flavour and odour have to be consulted. I have tasted many extracts, of European, Australian, and American origin; they all more or less approached the chemical requirements, but in taste and odour were very different. Some were brown, viscous, or pappy, and of a strong flavour of over-done meat, with some disagreeable heavy odour attached;

¹ Thus he erroneously repeats that Liebig fixed (! *sic*) the average amount of ash in extract at 25 per cent. (p. 128 of 'Once a Week'), while, in reality, Liebig allows it to fluctuate between 18 and 22 per cent. He says that creatine, lactic acid, and the salts of certain fatty acids in the extract are insoluble in alcohol, while actually they are soluble, &c. This article is a *rechauffee* of that in the 'Medical Times and Gazette,' flavoured with the same animus, but spiced with more elaborate chemistry.

others, also over-heated, and too brown, were yet too watery, and not keeping in hot weather; others, again, were much too brown, blistery, not of extract consistence, but of the consistence of electuary, with a heavy strong odour. The Fray Bentos alone has a pale brown colour, a faint odour of roast-beef gravy, and a *fine* flavour, as distinguished from a coarse one. With water and salt alone it yields a fluid which tastes and smells like roast-beef gravy. There is no suspicion of strange taste about it; it leaves the tongue free; it does not make the lips sticky; it perfectly amalgamates with the finest and simplest cookery. It keeps perfectly in any climate. I have in these days examined and tasted an extract which had been sent to China and back in the usual pots. It was perfectly good, although it had passed the equator five times.

Distin-
guished fine
quality of
Fray Bentos
Extract.

I had formerly made the experience that some extract did not keep well in hot weather. But I have reason to believe that this extract was not of the Company's, but of another manufacture. At all events, I have lately subjected the Company's extract to severe trials with regard to its keeping qualities, and can say that they are perfect. The only changes I observed were, that the extract fused, when it became warm, and assumed a slightly darker colour on its surface than in its interior. Odour, flavour, and taste remained perfectly unchanged.

The main use¹ of the extract is of course dietetical, in the form of beef-tea. Its solution may be substituted for or used in conjunction with beef-tea in the following manner:—One ounce of the extract, containing the soluble constituents of two pounds and two ounces of fresh meat, when dissolved in three pints of boiling water, makes good strong beef-tea. A less strong but still excellent beef-tea is obtained by dissolving one ounce of the extract in four pints of water, or smaller quantities in proportion, when each pint contains the extract of half a pound of beef. Salt has to be added to taste. Flavouring ingredients and spices may also be added with advantage.

Uses of ex-
tract of meat.

$\frac{1 \text{ oz} - 4 \text{ lb}}{2}$
 $1 \text{ oz} : \frac{1}{2} \text{ lb}$

Beef-tea is ordinarily made thus: a quantity of meat, mostly from the leg of the ox, say two pounds, is minced or cut small, and put on with five pints of cold water. It is then heated to boiling and the scum which rises taken off. It is further boiled down to three pints, and the liquid strained from the meat residues. This boiling down is not necessary when Papin's digester is used. In that case the exact amount of water is added and the pot closed. The residues after straining are in such a condition that human beings refuse to eat them, and cats and dogs will eat them only under the compulsion of great hunger, or with the addition of some salt or fat. If two pounds of beef or their soluble constituents in the shape of Liebig's

Ordinary
culinary
mode of
making beef-
tea.

¹ Compare my Memorandum in 'Journ. of the Soc. of Arts,' March 15, 1867.

extract are used to make three pints of broth, a beef-tea results which is as strong as ought ever to be used. For some persons and some purposes the three pints may with advantage be diluted to four. Liebig's extract is free from fat and gelatine; the beef-tea made in our kitchens contains both. Careful cookery prescribes the removal of the fat from beef-tea or gravy soup, but the gelatine is not by any means excluded. On the contrary, much of our gravy soup, or light thin soup so called, consists of stock which is mainly a decoction of all kinds of bones resulting from culinary operations. This gelatine adds a trifle to the nutritive value of the gravy, but when it amounts to any quantity injures its taste; it hangs gluey or sticky about the lips. It is the less objectionable, the larger the proportion of actual extract of meat, or decoction of meat (real beef-tea), that is mixed with it; it is by no means a necessary ingredient of good beef-tea or gravy soup.

Nevertheless, habit or idiosyncrasy may cause persons to like this addition. These may dissolve a little white gelatine or isinglass in the hot beef-tea, or proceed as follows. A quantity, say a pound of porous bone, with some marrow, is obtained from the butcher, pounded coarsely and boiled in water for at least an hour. Towards the end of the boiling, vegetables such as celery, endive, carrot, parsley, leek, &c., are added. When all is done, the broth is strained and the necessary amount of extract is added, together with spices. If it be desired to leave the vegetables in the soup, then the broth has to be strained from the broken bones previously to adding the vegetables. In this way, recommended by Liebig, both gelatine and a little fat are added to the soup. There is a clear gravy soup, containing gelatine only, known in the art of cooking, namely, the "soupe maigre" from the drumsticks or tarsal bones of fowls, so pathetically described by Beauvilliers in 'L'Art du Cuisinier;' this is very much improved by the addition of the minimum of extract of meat. In my opinion, Liebig's extract will be generally useful, as an aid for cookery in all households managed with intelligence, and in hotels and eating-houses of all descriptions. It will be specially useful as a ready means for producing quickly a nutritive, easily digestible, and tasty soup for great numbers of persons, under circumstances where elaborate cookery is impossible. Thus, for soldiers on the march, in camp, or in barracks,¹ for mariners on board ship, for patients in hospitals, for the recipients of charity in soup kitchens; for the poor in workhouses and asylums; for prisoners in jails, and for children in schools, orphanages, and refuges, &c., good soup can be prepared quickly by the above-described process; or, more simply still, by dissolving the

¹ See Dr. Boudens, 'Une Mission Médicale dans la Crimée, Revue des deux Mondes,' tom. vii, 1857, "La soupe fait le soldat."

Stock and soup contain gelatine, and are freed from fat.

Gelatine may be added to extract in cooking.

Recipe for soup.

Soupe maigre of Beauvilliers.

General usefulness of extract of meat.

necessary quantity of the extract and salt in boiling water, and pouring this over bread or toasted bread.

Any ordinary soup made with water and with ingredients such as peas, rice, potatoes, &c., and even with lumps of meat, may be greatly improved by the addition of a suitable quantity of the extract. One teaspoonful of the extract dissolved in a quart of the ready-made soup would make it of the same beef-tea strength as is ordinarily used in good household soups of the middle classes. The extract is in fact already in use in hundreds of large establishments. The case of St. Thomas's Hospital I have already alluded to. The invalids, sick soldiers, women and children of the British army, consume 12,000 little pots of the extract per annum. It is about to be introduced into the Prussian army as an article of diet in the daily cookery of the regiments.

Experiments have been made in all army corps of the North German Confederation, in which upwards of 3000 pounds of extract were employed. They were all successful, as I know from official documents of the Prussian Ministry of War. The Magdeburg Regiment of Infantry, No. 26, uses at the rate of 100 pounds of extract per month; the Westphalian Battalion of Pioneers, No. 7, 60 pounds per month, and other corps use large quantities. Of the 300,000 men of the standing army of the Confederation 270,000 are regularly using the extract of meat in their cookery. Only the governments of a few small states, counting one tenth of the population of the Confederation, remain behind in this particular subject of meat-extract as in many other matters of human progress.

From a letter of Colonel von Schmeling, commanding the 26th Magdeburg Regiment, I quote the following passage: "If there is a necessity of giving some cooked food to the soldier in the evening, the following soup may be made:—Boil the bones which remain from several meals once more in hermetically closed cauldrons; add to the decoction a liberal quantity of onions, green vegetables, and spice, and boil the whole once more in the large kettle, adding at the same time the extract of meat. In this manner I have obtained from 400 quarts of decoction and four pounds of extract, with the vegetables, a tolerably good soup, of which each man (of 800) received half a quart for supper, which half-quart cost the mess one third of a penny. If the mess can expend more, a few gallons of haricot beans, boiled very tender, may be added with advantage."

From an oral communication of the gallant colonel it appears that meat extract is of advantage even where meat is to be had in abundance. Soldiers in the field have mostly fresh meat in plenty, but they soon come to dislike it, perhaps because it is so very fresh. If to such meat which has to be used immediately or shortly after killing, extract of meat is added in cooking or

Liebig's extract introduced into constant use in the army of the North German Confederation.

How to make a soup for the supper of a regiment.

Extract improves very fresh meat.

roasting, the disagreeable flavour disappears to the senses, and no repugnance of the taste is excited. The extract supplies the effect which hanging of the meat has in the butcher's shop or the private larder.

Subdivision
and distribu-
tion in rations

The very greatly improved nature of the extract, its nice consistency like ointment, make it now much more easy of distribution in small quantities adapted for daily wants, than its formerly more viscid quality allowed it to be. This will allow even the very poorest to participate in its benefits by their fetching a small supply in a cup or even in a paper from the retailing grocers. It will thereby be possible to avoid the greatly increased cost of small packages. But it should be stated that it bears well to be put up in small packages, in little jars containing a quantity enough for making one pint of good beef-tea. It can also be put into tin bottles, the same as are used for keeping oil-paints, and the desired quantity may be squeezed out each time that it may be wanted. It can, therefore, with facility be sent and distributed in certain rations. In 1866 the Bavarian soldiers had such rations dealt out to them for a considerable period during the campaign. The system has also been tried in the camp at Châlons, and been found to be quite practicable.¹

Experience in
German war,
1866, and in
French camp
at Châlons.

Use of Ex-
tract in the
alimentation
of the sick.

As an agent for the alimentation of the sick the extract is unsurpassed. It is suitable in all stages of illness and convalescence. It stimulates the heart, vessels, and kidneys, and supplies a certain very small amount of light nutriment (the peptones alluded to, gelatine if added), and useful materials to the muscles through the blood. But it would be a mistake to believe that it possessed by itself the properties of a complete nutriment. Its effects are, perhaps, in part, analogous to those of tea, though dependent upon different chemical agents. The effects of tea would be mainly due to the theine which it contains, and would consist in an acceleration of the heart's action and greater vivacity of the mental powers. A similar effect would be produced by beef-tea, but not so much through its influence upon the heart as through its influence upon the nerves of taste and digestion, and upon the muscular sense or sense of strength.

Comparison
of beef-tea
with Chinese
tea.

Beef-tea for the patient has this advantage over tea, that it has no tendency to make him sleepless, and acts against prostration of the muscles directly. The action of the creatine seems, to some degree, to resemble that of theobromine, found in cocoa. Beef-tea is acid, and the acids which it contains are phosphoric, lactic, and perhaps inosinic. Of these, the former is mostly com-

Comparison
of creatine
with theobro-
mine.

¹ It is related that the Emperor Napoleon, some time after an animated conversation which he had with Baron Liebig one day during dinner at the Tuileries, experimentalised with the extract at Châlons. He took his whole staff into the kitchen, saying, "Nous allons faire la soupe nous mêmes;" and made the soup with his own hands. The company ate it, and probably did not forget the lesson.

bined with the potassium, but the latter are free. If we look at the history of food among men, we find that they have at all times made provision for particular acids in their food. The ancient Romans were acquainted with "sauerkraut," or fermented cabbage. In Russia and many parts of Germany they have a food made of fermented beans; and in Holland and many parts of southern Europe they have a preparation of fermented cucumber, and many other vegetables are used in an acid state. These various foods contain lactic acid. This acid, or one identical with it in composition, though differing slightly in other properties—paralactic acid—is contained in meat, and that the more the longer the meat has hung. There is no question that the fine flavour of meat—the osmazome—which provokes appetite, is due in part to the action of this lactic acid. If there is an absence of flavour in any kind of meat, lactic acid, if mixed with the gravy during preparation, acts as a substitute, and produces a relishing flavour. We find, besides, that lactic acid is useful for digestion. Of the inosinic acid less is known, but it cannot be doubted that it acts similarly to lactic. These agents are all very beneficial to sick persons. The beef-tea may be beaten up with the yolks of eggs or other soup-making ingredients. With eggs the beef-extract would be equally nutritive as meat. I have kept patients suffering from typhus or typhoid fever for weeks upon such food, giving them wine at frequent intervals.

Acid articles of food of many nations contain lactic acid.

Para-lactic acid in flesh and extract.

Beef-tea from extract, with yolk of egg in severe febrile diseases.

Extract in a too concentrated form has a strong taste, which may cause patients to become impatient of its use.

The extract of meat is sometimes mixed with wine (Parmentier), sherry, or brandy, and in that form may have its uses in cases of sinking from failure of nervous influence or loss of blood. A French correspondent writes that he has found the extract in that form, and even by itself, produce "a quick recrudescence of the vital powers," as he terms it, so that the influence of the foregoing mixture is by no means to be put on account of the alcohol only.

Extract mixed with alcoholic liquid.

Baron Liebig informs me that many German physicians prescribe the extract to be eaten spread upon bread. I find it a great improvement to mix the extract with butter previously to using it with bread. One part of extract of meat and two or three parts of butter are placed in a cup, and stirred while the cup is placed in hot water, sufficient to soften and mix, but not to oil, butter and extract. The homogeneous mass is spread upon slices of bread adapted to the occasion. Spread upon thin slices of toast, and eaten after the soup, the mixture of butter and extract has the effect of exciting the appetite and nerves of gustation in the same manner as caviare.

Extract eaten upon bread.

Extract mixed with butter.

The extract has also been made into biscuits in a peculiar manner. As the biscuits could not easily be baked, the flour-paste was baked first by itself, then powdered, impregnated with

Extract baked into biscuits and made into lozenges.

the extract, and then pressed into the shape of the little cakes without application of heat. This form is, theoretically, not objectionable, but does not appear to be attractive. Its only use will, perhaps, be for travellers, to whom these biscuits afford a ready means of, with hot water only, making quickly a good soup. But it appears safer that travellers should have the extract and the biscuits each by themselves, as they are in that case certain of what they have. In a similar manner those who want to suck a little extract had better take it with a spoon out of a pot than take the lozenges, of which they do not know the composition, and may dislike the smell.

Extract enclosed in capsules.

The French enterprise of enclosing the extract in capsules, and letting the patient swallow them like specific medicines, may be noted. But the extract is not to be considered as a medicine in any sense, and has no specific properties against any particular disease.

Great success of the new manufacture, and habit.

It has been said that the introduction of a new habit amongst men was more difficult than the conquest of an empire. Be the comparison true or not, the difficulty of introducing the extract into habitual use has been enormous, and it has lasted twenty years, until the work of the philosopher's closet had taken hold upon society. Now the manufacturers receive honours of all kinds, particularly prize-medals at exhibitions, for excellent quality of their product, and for establishing a new branch of industry. Thus it appears that the original idea of Baron Liebig of increasing the wellbeing and food resources of the people permanently are about to be realised. The sale was greatest on the continent at first, where the name of the inventor was more immediately relied upon. But the English people in 1868 fetched up what they had missed, and doubled their consumption in that year. It is still rapidly increasing, and no one can tell its limits. All nations are underfed as regards meat. "Extract combined with vegetable albumen," says Baron Liebig, "enables us to make up the deficiency, and that combination is the only one at our disposal." The European nations may partially supplement their faulty food by making the most of the herds of grass-producing countries, in transforming their flesh into meat extract, and by importing corn from the western states of the American union. But all the cattle now produced and killed for its hides and horns, if transformed into extract, would only give a small supply if spread over large populations. "For, supposing ten manufactories to produce together ten millions of pounds of extract of meat from a million oxen or ten millions of sheep, that entire quantity would provide the population of Great Britain with only one pound yearly for every three persons, or one pound a day for every 1100 persons."

Quick increase of consumption of extract.

Extract a remedy for faulty food of European nations.

Possible supply of extract.

Success excited competition.

So great a success excited, of course, competition. But the

products of rivals, particularly those of South America, were so inferior that of sixteen establishments which I could name only three now continue to compete at all. And they are obliged to arrogate to their product Baron Liebig's name, though they and their products are emphatically repudiated by him. I have sufficiently shown the necessity of this repudiation by the relation of facts in the foregoing. It is of the utmost consequence for the security of the public. In fact, the entire movement is endangered by these persons, who, whatever may be the legal formal quibble by which they are permitted to do so, have no moral right to use the name of the man who objects to their doing so, and protests against it. If there are persons so desirous to utilise their beef for extract let them join the Liebig's Company. The true manufacture admits of any amount of extension; it is only known to the company's agents, and already their article is the cheapest and best, and will, of necessity, remain so. But a persistent competition, based upon a depreciation of the Fray Bentos extract, appears to me quite useless and hopeless. It has been Baron Liebig, and he alone, who made the extract cheap for the people, and it is to him that the people must look for the preservation as well as the extension of this boon.

Advice to competitors.

In Australia, a quantity of the glue-broth (see 'Household Words,' 1868), which remains when the carcasses of sheep and oxen and cows are boiled for the fat, is evaporated, and brought into the English market. The people will be easily able to distinguish from the true Liebig's extract these products, particularly the so-called solid extracts, which unite in themselves all the faults most to be deprecated, as shown above.¹

Inferior products of Australia.

I am happy to think that the detraction which the true preparation has here and there in exceptional cases experienced arose more from ignorance than from partisan motives. Some misunderstandings on the part of a certain portion of the popular press were thoroughly exposed by the scientific members of the medical journals, and failed in the effect which even mere misunderstandings might be able to produce. For a particular *medical defamation* which endeavours to lower the product by comparison with disgusting objects, the key of explanation would not be difficult to find; but it is best to cover it with contemptuous oblivion.

Detraction and defamation.

A boon to mankind; a waste recovered and turned to use; food augmented; a new industry, employing hundreds profitably, capable of great extension; a use for every household,

Peroration.

¹ Though *solid*, these extracts contain 18 per cent. of water, according to Dr. Dupré's analysis, given below (Dr. Letheby's analysis states 26 per cent.) They therefore contain as much or more water than any Liebig's extract; of their dry residue, 53 per cent. are gelatine, and only 9 per cent. ash.

every individual cupboard; a comfort to every sick person's bedside, particularly that of the poor and afflicted; a provision for ships on all voyages; for armies in the field, in camps, in barracks; traversing the seas or the deserts unchanged; one of the greatest achievements of Baron Liebig, and one of the finest proofs of the usefulness to man of abstract scientific researches:—such are the heads of the reflections which we leave to the earnest contemplation of the reader.

Analytical comparison of various essences and preparations of meat with Fray Bentos Extract.

In the following pages I give a series of important and interesting analyses of various products sold in the London markets, particularly for shipping purposes. The inquiry was originated by Baron Liebig, who communicated to me the results obtained by his son, M. H. von Liebig. Considering that several of the essences analysed by him had stood longer than probably they would be kept in ordinary life, or were intended to be kept, I thought it expedient to have these analyses repeated upon fresh essences as sold in trade; and I was happy to obtain for that purpose the co-operation of two distinguished chemists, Professor Wanklyn, of the London Institution, and Dr. Dupré, of the Westminster Hospital. There is thus an amount of independent evidence brought to bear upon this question which excludes every idea of personal partiality or unfair selection. Whatever may be the result of the following comparison, I strongly feel that the public owe a debt of gratitude to many of the manufacturers of preserved meats for having, in times gone by, without any scientific guidance, supplied a want in the shape of their meats not only, which will flourish for ever, but also in that of their essences. If I am correctly informed, most of these essences are not made expressly, but obtained as collateral products during the heating of meat in closed vessels, frequently under pressure, for the purpose of its preservation. During this process the meat (as during boiling in water) shrinks very much, and oozes out fluid to the amount of from 15 to 26 per cent. of its weight. This fluid, without any further preparation that I am aware of, constitutes the essence in question. It is simply enclosed, air-tight, in the vacuum boxes in which it is sold. The meat which has lost this essence is sold separately from the essence, and, of course, never comes in contact with it again. The meat therefore loses a great part of its nutritive value, and, as M. H. von Liebig correctly observes, in a physiological dietary must be ranked even after salt meat. The indication from this state of things is clear. The manufacturers, in any case, whether

or not they could sell their essence separately, ought to restore it to the meat; and they should do so by boiling it down to the consistence of extract, and putting the extract back into every tin with the meat whence it came. If the manufacturers will act upon this advice, they will not only experience no loss, but, on the contrary, gain an advantage in getting rid of a collateral product which is difficult of manipulation and bulky, and confer a benefit upon all persons who have to use their preserved meat, by keeping that meat at its full nutritive value. This applies to all meat, whether preserved in this country by private makers or in public (naval or military) victualling yards for the provisioning of ships or for exportation, or preserved abroad for importation into the countries of Europe.

I. *On the Composition of various Preparations of Meat, and of Essences of Meat.* By HERMANN VON LIEBIG.

By desire of my father I have analysed the following preparations of meat and essences of meat.

Dr. Hassall's Flour of Beef.

This is a yellowish-brown powder, of aromatic odour, and agreeable taste. The result of the analysis is as follows:

Water	.	.	.	.	8.04 per cent.
Albumen	.	.	.	.	2.84 "
Watery extract	.	.	.	.	19.00 "
Fibrine	.	.	.	.	57.06 "
Fat	.	.	.	.	12.06 "
					<hr/>
					100.00

Hassall's Flour of Beef is sold in small wooden boxes, holding, on the average, 115 grammes ($\frac{1}{4}$ lb.) of flour of beef. It is recommended for the production of beef-tea; it would, however, be a mistake to suppose that its value was limited to that particular purpose, and I think that its entire value is only obtained by its consumption as such. One box furnished about 27 grammes of extract of meat, computed to contain 20 per cent. of water; and the contents of nearly seventeen of these boxes would be required for producing one pound of Fray Bentos extract of meat; as the price of one box is 2s. 1 $\frac{1}{2}$ d. (8s. 6d. per lb.), one pound of extract would cost 36s., whereas the South American Fray Bentos extract is sold wholesale at only 8s. 3d. per lb. The dried watery extract yields 33 per cent. of ash, of which one third consists of chloride of potassium and of chloride of sodium (common salt), whilst extract of meat contains about 20 per cent. of ash.

In the following I give the results of the analysis of a number of essences of meat, which represent concentrated broths of very

varying value; they are generally prepared by subjecting meat to a temperature of from 212° to 250° Fahr., in closed vessels, either with a small addition of water or without water. The liquid which issues from the meat produces the essence. All these essences contain the constituents of extract of meat, together with a certain quantity of gelatine, which latter, as is well-known, possesses none or very little nutritive value. I have evaporated these essences to dryness, and treated the residue with alcohol of 80 per cent. calculating from the weight of the alcoholic extract its amount of extract of meat. The South American Fray Bentos extract yields in minimo 60 per cent. of extract soluble in alcohol of 80 per cent. I have analysed essences of meat of John Gillon & Co., of Leith, of McCall and Co., John Moir & Son, Alexander Forbes, Marshall & Co., all of Aberdeen.

Of JOHN GILLON & Co's essences I have examined three, viz., Essence of Fowl, of Beef, and of Mutton.

When holes were pierced into several of the tins, compressed gas was expelled therefrom, a sign of partial decomposition, which was further proved by the disagreeable odour and the turbid appearance of the yellowish-brown liquids. Their taste was still like that of a strong meat broth, and not unpleasant. The essence of fowl had the lightest colour. The essences of meat of Gillon & Co. analysed by me had been kept for eighteen months.

1. *Essence of Fowl.*—The tin contained 116 cubic centimeters of liquid, and yielded, after evaporation, 7.94 grammes of dry residue, containing 3.60 grammes of alcoholic extract, and 2.76 grammes of gelatine. This essence, like the other two, when reduced by evaporation to one fourth or one fifth of their original volume, coagulated into a jelly, which is never the case with pure extract of meat; and this sufficiently indicates the considerable amount of gelatine they contain. One pound of pure South American Fray Bentos extract of meat (453.6 grammes) contains, as before mentioned, 60 per cent., that is, 272 grammes of alcoholic extract (extract soluble in alcohol); and, as one tin of essence of fowl yielded in 116 cubic centimeters 3.6 grammes of alcoholic extract, it follows, therefore, that seventy-five of these tins contain only the equivalent of one pound of Fray Bentos extract of meat.

2. *Essence of Beef.*—The tin contained 114 cubic centimeters, and yielded dry residue 10.57 grammes, containing 4.509 grammes of alcoholic extract, and 2.395 grammes of gelatine. Sixty tins contain the equivalent of one pound Fray Bentos extract.

3. *Essence of Mutton.*—The tin contained 118 cubic centimeters of liquid, yielding 10.256 grammes of dry residue which

contained 5.402 grammes of alcoholic extract, and 2.342 grammes of gelatine. Fifty tins contain the equivalent of one pound Fray Bentos extract of meat.

According to the statement of Gillon & Co., these essences are prepared from pure meat, and it follows, therefore, that, under the influence of the high temperature, a portion of the connective tissue of the meat has become dissolved. The dry residue of the essence of fowl contains 34.7 per cent. of gelatine, that of the essence of beef 22 per cent., and that of the essence of mutton 22.7 per cent.

The *essences of beef* of John Moir & Son, and the *pure essence of beef* of McCall, are dark-brown, limpid fluids, of the same odour and taste as strong beef-tea.

The *essence of beef* of Alexander Forbes, and of Marshall and Co., were turbid liquids of a dull, light-brown colour, having all the appearance of a dirty broth of glue or size water.

On piercing a hole into a tin of essence of beef made by Marshall & Co., compressed gas issued from it; this no doubt owed its origin to partial decomposition, as in the case of the essences of Gillon & Co. The liquids evidently only began to decompose after the tins had been soldered. I ascribe this to the circumstance that the tins contained from 26 to 30 cubic centimeters of air, which, therefore, furnished a sufficient amount of oxygen to engender a partial decomposition.

On the essence of beef of Marshall & Co., there floated several small drops of congealed fat, and after the fluid had been allowed to stand for twelve hours in a closed vessel, this essence, as well as that made by Alexander Forbes, showed a flaky deposit.

In these four last-mentioned essences I have also determined the amount of ash, and therein the earthy phosphates and the common salt.

JOHN MOIR & SON'S *Essence of Beef* (Full strength).

The tin contained 112 cubic centimeters of liquid, of which

Dry residue	.	.	16.08	grammes.
Alcoholic extract	.	.	11.078	„ (inclusive of ash).
Ash	.	.	5.136	„

The ash amounted to 31.3 per cent. of the dry residue, and contained

Common salt	.	.	.	42.498	per cent.
Earthy phosphates	.	.	.	5.940	„

This essence is not free from gelatine. 245 tins contain the constituents of one pound of extract of meat (Fray Bentos).

J. McCALL & Co's *Pure Essence of Beef.*

The tin contained 114 cubic centimeters of liquid, of which

Dry residue	.	.	.	8.740 grammes.
Alcoholic extract	:	:	:	5.412 "
Ash	.	.	.	2.483 "

Consequently, the ash forms 28.4 per cent. of the dry residue, and contains

Common salt	.	.	.	18.26 per cent.
Earthy phosphates	:	:	:	8.901 "

Fifty of these tins are equivalent to one pound of Fray Bentos extract of meat.

ALEXANDER FORBES' *Essence of Beef.*

The tin contained 115 cubic centimeters of liquid, and yielded—

Dry residue	.	.	.	16.870 grammes.
Alcoholic extract	:	:	:	9.468 "
Ash	.	.	.	4.134 "

The ash represents 25 per cent. of the dry residue, and contains—

Common salt	.	.	.	17 per cent.
Earthy phosphates	.	.	.	7 "

The dry residue yielded 4.27 grammes of gelatine. About twenty-nine tins of this essence contain the equivalent of one pound Fray Bentos extract of meat.

MARSHALL & SON'S *Essence of Beef.*

The tin held 108 cubic centimeters of liquid, yielding—

Dry residue	.	.	.	20.010 grammes (of which 13 grs. gelatine).
Alcoholic extract	.	.	.	5.298 "
Ash	.	.	.	2.063 "

In this essence the gelatine amounts to 65 per cent., the ash only to 10 per cent. of the dry residue, owing to its consisting to the extent of more than two thirds of gelatine, which contains only a small amount of salts; the ash yielded 23 per cent. of common salt, and 6.932 per cent. of earthy phosphates; the remainder consists, as in the other essences, of phosphate of potassium. Fifty-one tins contain the equivalent of one pound of Fray Bentos extract of meat.

As the composition of these essences is exactly known, and as they differ from beef-tea or a solution of extract of meat only in

this particular, that they contain, besides the ingredients of the extract, a variable amount of gelatine, their commercial value can be accurately determined.

When we dissolve in $1\frac{1}{2}$ gallons of boiling water (= 6815 cubic centimeters),

	<i>s.</i>	<i>d.</i>
4 oz. of pure gelatine	0	9
16 oz. Fray Bentos extract of meat	8	3
<hr/>		
we have exactly the contents of 60 tins of Gillon's Essence of Beef, the whole of which, therefore, will cost	9	0
or 1 tin	0	$1\frac{8}{10}$

The actual selling price of the latter is $5d.$ per tin, and exceeds, therefore, by $3\frac{2}{10}d.$, or 178 per cent., its commercial value, as determined in the foregoing.

If I am correctly informed, the meat from which these essences have been expelled by heat is not thrown away, but is packed into tin canisters and sold as a provision for ships. By the abstraction of its essence the meat loses a considerable proportion of its nutritive value, and, in a physiological dietary, must therefore be ranked even after salt meat.

II. Report of Analyses of Extracts and Essences of Meat. By AUGUSTUS DUPRÉ, Ph.D.

I have examined the under-mentioned essences and extracts :

1. JOHN McCALL & Co., *Houndsditch*. Gravy Soup.—In tin canisters hermetically closed. Canister held $17\frac{1}{2}$ oz., and contained 16 oz. of the gravy. Empty space $1\frac{1}{2}$ oz.; vacuum absolutely perfect. Gravy gelatinized, of light brown colour, slightly turbid, no fat visible; taste and flavour good, spiced. To be used without the addition of water. Price, retail, 1s. per tin.

2. JOHN RITCHIE & SON, *Peterhead*. Essence of Beef.—In tin canisters holding $4\frac{1}{2}$ oz., and containing 4 oz. of essence; vacuum good. Essence gelatinized completely when only $\frac{1}{6}$ th of its bulk was evaporated, but little taste and flavour; no fat. To be made into 40 oz. of beef-tea. Price, retail, $6d.$ per tin.

3. CROSSE & BLACKWELL, *London*. Beef-tea.—In tin canisters, holding 17 oz., and containing 16 oz. of beef-tea; vacuum good. Colour light brown; taste and flavour agreeable; a little fat floating on surface; did not gelatinize when evaporated down to $\frac{1}{3}$ th. To be used without the addition of water. Price, retail, 1s. $2d.$ per tin.

4. GILLON & Co., *Leith*. Essence of Beef, Fowl, and Mutton.—In tin canisters, holding $4\frac{1}{2}$ oz., and containing 4 oz. of the

essence each, leaving an empty space of $\frac{1}{2}$ oz.; vacuum tolerably good. The essences were all in good condition, of agreeable taste and flavour, light brown colour, slightly turbid, but without fat. They did not gelatinize when evaporated down to $\frac{1}{3}$ th. When used they are to be mixed with three times their weight of water. Price, retail, 1s. per tin.

5. MARSHALL & Co., *Aberdeen*. Pure Essence of Beef.—In tin canisters, holding $4\frac{3}{4}$ oz., and containing 4 oz. of essence; slight vacuum. Colour pale brown, of very agreeable taste, and good flavour; a very little fat. Gelatinized completely when only $\frac{1}{4}$ th was evaporated. To be mixed with from 8 to 12 times its bulk of water. Price, retail, 7d. per tin.

6. WHITEHEAD'S Solid Essence of Beef.—In flat elastic cakes, round, $2\frac{1}{8}$ inches diameter, weighing 0.447 oz. each. The cakes are packed in round boxes of pasteboard, with a little arrowroot between the cakes to prevent them from adhering to each other. Eight cakes in the box, weighing together 3.57 oz. Colour brown; taste and flavour good; $\frac{1}{4}$ lb. to make 1 gallon of beef-tea. Price, per box, retail, 2s. 6d.

7. DR. HASSALL'S Flour of Beef.—In round wooden box, lined with paper, lid pasted down. Box contained $\frac{1}{2}$ lb. of a coarse yellow powder, little taste, spiced. 1 oz. to make 10 oz. of beef-tea. Price, per box, retail, 5s.

The analytical results obtained are given in Table 1. The total residue is estimated by drying the extract for some hours at the temperature of 100° C. The results, thus obtained, although not absolutely exact, are quite sufficiently so to give reliable comparative results.

The portion soluble in ether contains only a small proportion of fat, inasmuch as the greater part of it is soluble also in water and in spirit; it is therefore included in the portion soluble in spirit of 80 per cent., which latter also contains the greater part of the mineral constituents of the essence. The far greater part of the phosphoric acid in the ash is present as potassic phosphate, and therefore soluble in water; part, however, generally less than $\frac{1}{10}$ th, is present as calcic phosphate, insoluble in water, but dissolved in the essence by the lactic acid contained in it.

In the table the essences are arranged in the order of their increasing per-centage of alcoholic extract, and it will be observed that, with one or two exceptions, this is also the order in which the amount of ash and phosphoric acid increase. In the pure essences these three characters evidently go hand in hand.

In estimating the value of an essence or extract, it must be remembered that no essence, &c., whatever, when taken by itself, is, strictly speaking, a food, *i. e.* capable of sustaining life, but that it becomes one of the highest value when mixed in proper proportions with certain other substances, such as in meat are represented by albumen, fat, fibrine, &c. These latter may, however, be replaced by vegetable substances, and these when added in the right proportion to the extract, &c., produce a food little, if at all, inferior to meat itself. *The specific value of an essence or extract thus depends chiefly on the presence of those constituents of the meat which cannot be otherwise replaced, and is not enhanced by the presence of the others, nay, it is rather diminished, inasmuch as their presence impairs the keeping quality of the extract, and unnecessarily increases its bulk and weight.* The constituents to which the extract, &c., of meat thus owes its specific value are soluble in spirit of 80 per cent., and the value of such extract, is therefore given by the proportion of matter soluble in spirit which it contains. Water, of course, excluded. The stimulating and medicinal value of the pure extract are here entirely left out of consideration, for, although very considerable, they do not admit of comparison with other articles of food. Applying the foregoing valuation to the above essences, &c., in comparison to Fray Bentos extract, we arrive at the following results, set forth in Table II :

Fray Bentos extract contains on an average 17·5 per cent. of water, 22 per cent. of ash, and 82·5 per cent. of total dry residue, of which latter at least 60 per cent. are soluble in spirit of 80 per cent. strength. Price, per lb., retail, 11s.

It will be seen from column 4 of Table II that, to produce one pound of Fray Bentos extract, it requires rather more than 2 lb. of the richest and more than 34 lb. of the poorest of the other essences; whilst from column 5 it appears that the price of 1 lb. of Fray Bentos extract is less than half that of a corresponding quantity of the cheapest, and less than $\frac{1}{8}$ th of the dearest. Lastly, it may be seen from column 6, that whereas 1 lb. Fray Bentos extract contains the extractives of 35 lbs. of beef, the richest of the others is equivalent to little less than 16 lbs., and the poorest to 1 lb. only.

(Signed)

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Feb. 27, 1869.*

TABLE I.

NAMES OF MAKERS AND TITLES OF PRODUCTS.	Water.	Total Dry Residue.	Proportion soluble in Spirit of 80 per cent.	Proportion soluble in Ether.	Gelatin, &c.	Ash.	Total Phosphoric Acid.	Chlorine.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
M'Call's Gravy Soup .	86.97	13.03	1.73	0.06	11.30	0.74	0.02	0.228
Ritchie's Essence of Beef	74.36	25.64	1.87	0.20	23.77	0.78	0.01	0.252
Crosse and Blackwell's Beef-tea	96.04	3.96	2.31	0.06	1.65	0.98	0.17	0.194
Gillon's Essence of Beef	92.75	7.25	3.06	1.03	4.19	1.32	0.29	0.094
Gillon's Essence of Fowl	94.05	5.95	3.21	0.62	2.74	1.17	0.24	0.105
Gillon's Essence of Mutton	93.45	6.55	3.44	0.81	3.11	1.49	0.27	0.099
Marshall and Co.'s Essence of Beef	83.55	16.45	6.54	0.09	9.91	2.49	0.60	0.211
Whitehead's Solid Essence of Beef	18.16	81.84	27.75	7.60	53.09	9.00	2.35	0.708
None of the Essences contains more than a trace of Chloride of sodium.								
Hassall's Flour of Beef			Per cent.				Per cent.	
	Water	15.53	Soluble albumen	3.81				
	Total Dry Residue	84.47	Fibrine, &c.	63.88				
	Aqueous Extract	16.78	Ash	4.81				
	Proportion soluble in Spirit	9.17	Total Phosphoric Acid	0.79				
	Ether Extract	4.50	Chlorine	0.704				

TABLE II.

NAMES OF MAKERS AND TITLES OF PRODUCTS.	Quantity in each Tin or Box.	Price per Tin or Box Retail.	Calculated price per lb.	Number of lbs. required to make 1 lb. of Fray Bentos Extract.	Quantity required for 1 lb. of Fray Bentos Extract Costs	1 lb. of the Essence, &c., contains Extract from lbs. of Beef.
		<i>s. d.</i>	<i>s. d.</i>		<i>s. d.</i>	
M'Call's Gravy Soup .	16 oz.	1 0	1 0	34·6 lbs.	34 6	1·01 lb.
Ritchie's Essence of Beef	4 „	0 6	2 0	32·0 „	64 0	1·10 „
Crosse and Blackwell's Beef-tea	16 „	1 2	1 2	26·0 „	30 4	1·34 „
Gillon's Essence of Beef	4 „	1 0	4 0	19·6 „	78 5	1·78 „
Gillon's Essence of Fowl	4 „	1 0	4 0	18·7 „	74 9	1·87 „
Gillon's Essence of Mutton	4 „	1 0	4 0	17·4 „	71 9	2·01 „
Marshall and Co.'s Essence of Beef . .	4 „	0 7	2 4	9·1 „	22 2	3·84 „
Whitehead's Solid Essence of Beef . .	3·57 „	2 6	11 5	2·2 „	25 0	15·91 „
Hassall's Flour of Beef	8 „	5 0	10 0	6·5 „	65 0	5·38 „
Fray Bentos Extract .	...	...	11 0	1 „	11 0	35 „

III. Report of Analysis of Essences and Preparations of Meat. By Prof. WANKLYN.

Dr. HASSALL'S *Flour of Beef* is sold packed in round boxes of thin wood lined with paper. Price of a boxful (containing 109·0 grammes, being little short of a quarter of pound), 2s. 6d. The flour of beef is a light powder, of about the colour of hay. It is slightly flavoured with some kind of spice. Warmed with a moderate quantity of water it enters partially into solution, and on cooling forms a very pale-coloured jelly. On analysis it yielded—

Organic matter	80·02 per cent.
Water	14·17 „
Ash	5·87 „
	100·00

The organic matter is very mixed in character. A considerable proportion of it is *non-nitrogenous*. There appears, however, to be absence of fat.

One hundred parts of the flour of beef contain 15·6 parts, soluble in water. Of this a certain quantity is albumen. One

hundred parts of the flour contain 11.21 parts, soluble in alcohol of 80 per cent. Calculating on the assumption that the portion soluble in alcohol represents "Fray Bentos Extract," then 11.25 parts soluble in alcohol are equal to 18.75 parts of Fray Bentos extract; 5.33 lbs. of flour of beef will be equal to 1 lb. of Fray Bentos extract. The box of flour of beef being $\frac{1}{4}$ lb. at 2s. 6d., the price of 5.33 lbs. will be 53s. 4d. Fray Bentos extract, therefore, bought retail, in the shape of Hassall's flour of beef, costs 53s. 4d. per lb., as against 11s., the retail price of the extract bought as such.

JOHN GILLON & SON'S Essence of Beef, Mutton, and Fowl.—These were in quarter-pound tins, very well packed, air rushing in on opening the package in every case.

The Essence of Beef.—A tin, price 9d. retail, contained 114.5 grammes of the essence, being about $\frac{1}{4}$ lb. The air space in the tin measured 30.7 cub. cent., and was $\frac{3.07}{1.4270}$ of the entire capacity of the tin. The essence was of a light brown colour, very fluid, very pleasant to the taste. Its specific gravity at 14° C. was 1.029 (water being 1.000). On analysis it contained—

Water	92.51 per cent.
Organic matter, soluble in alcohol of 80 per cent.	3.69 "
Ditto insoluble in alcohol of 80 per cent.	2.37 "
NaCl	0.175 "
Phosphates, &c.	1.255 "
	<hr/>
	100.000

Essence of Mutton. In tins holding a quarter of a pound at 9d. per tin. Contents of a tin = 119.0 grammes of essence. Air space = 27.2 cub. cent., equal to $\frac{2.72}{1.4320}$ of the entire capacity. This essence was slightly turbid, of a light brown colour, pleasant taste. Its specific gravity at 14° C. = 1.027. It was analysed:

Water	93.67 per cent.
Organic matter dissolved by alcohol of 80 per cent.	3.58 "
Ditto not soluble in alcohol of 80 per cent.	1.37 "
Chloride of sodium	0.24 "
Phosphates	1.14 "
	<hr/>
	100.00

Essence of Fowl, also in $\frac{1}{4}$ lb. tins. Price, per tin, 1s. Contents of a tin 120 grammes of the essence. Air space = 22.6 cub. cent., or $\frac{2.26}{1.4060}$ of the entire capacity of the tin. The essence was very pale in colour. Specific gravity at 13° C., = 1.022. Analysis:—

Water	94.56 per cent.
Organic matter soluble in alcohol of 80 per cent.	2.74 "
Ditto insoluble in alcohol of 80 per cent.	1.76 "
Chloride of sodium	0.17 "
Phosphates	0.77 "
	100.00

Essence of Beef from other makers. From the agents of Messrs. John Moir and Sons it was not possible to procure their essence of beef. They would not sell it retail, and would not give a sample for analysis.

McCALL'S *Essence of Beef*.—In $\frac{1}{4}$ lb. tins, well packed, price 9d. per tin. Examined a tin. Contents = 125.3 grammes of essence. Air space = 13.9 cub. cents., or $\frac{13.9}{136.0}$ of the entire capacity. The essence was much deeper in colour than Messrs. Gillon's essence of beef. Specific gravity at 13° C. = 1.027.

Water	93.40 per cent.
Organic matter soluble in alcohol of 80 per cent.	4.30 "
Ditto insoluble in alcohol of 80 per cent.	0.67 "
Chloride of Sodium	0.22 "
Phosphates	1.41 "
	100.00

ALEXANDER FORBES' *Essence of Beef*.—In $\frac{1}{4}$ lb. tins, well soldered up, price 9d. per tin. Contents of a tin = 130.7 grammes of essence. Air space = to 9.2 cub. cent., or $\frac{9.2}{134.0}$ of the entire capacity. Analysis: Specific gravity at 15° 1.043.

Water	90.38 per cent.
Organic matter soluble in alcohol of 80 per cent.	6.17 "
Ditto insoluble in alcohol of 80 per cent.	1.03 "
Chloride of Sodium	0.40 "
Phosphates	2.02 "
	100.00

MARSHALL & Co's. *Essence of Beef*.—In $\frac{1}{4}$ lb. tins, well soldered up, price 9d. per tin. Contents of a tin = 113.2 grammes of essence. Air space equal to 27.8 cub. cents., or $\frac{27.8}{134.0}$ of the entire capacity of tin. Very brown and turbid; deposited much on standing. Specific gravity at 14° = 1.066. Analysis:

Water	82.17 per cent.
Organic matter soluble in alcohol of 80 per cent.	4.21 "
Ditto insoluble in alcohol of 80 per cent.	11.65 "
Chloride of sodium } Phosphates }	1.97 "
	100.00

Tabular Summary of Report on Essence of Meat, and on Dr. Hassall's Flour of Beef.

The Essences of Meat were packed in tins, which were well soldered up, there being a rush inwards of air on opening the tin. Dr. Hassall's Flour of Beef, however, was in a round box of thin wood, lined with paper. The weight of essence in each tin was approximately a quarter of a pound, the exact weight being given in grammes in the following table. Dr. Hassall's powder was also approximately a quarter of a pound. In estimating the prices, the tin or box has been taken as a quarter of a pound.

	JOHN GILLON & SON'S				M'CALL'S ESSENCE OF BEEF.	ALEX. FORBES'S ESSENCE OF BEEF.	MARSHALL & CO'S ESSENCE OF BEEF.	DR. HASSALL'S FLOUR OF BEEF.
	ESSENCE OF BEEF.	ESSENCE OF MUTTON.	ESSENCE OF FOWL.					
Water	92.51	93.67	94.56	93.40	90.38	82.17	14.17	
Organic matter soluble in alcohol of 80 per cent.	3.69	3.58	2.74	4.30	6.17	4.21	11.25	
Organic matter insoluble in ditto	2.37	1.37	1.76	0.67	1.03	11.65	68.77	
Chloride of sodium	0.175	0.24	0.17	0.22	0.40	} 1.97	} 5.81	
Phosphates	1.255	1.14	0.77	1.41	2.02			
Specific gravity (water = 1.000 at 15° C.)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Contents of tin in grammes	1.029	1.027	1.022	1.027	1.043	1.066	...	
Air space in tin expressed in cubic cents.	at 14° C. 114.5	at 14° C. 119.	at 13° C. 120.	at 13° C. 125.3	at 15° C. 130.7	at 14° C. 113.2	...	
Fraction of entire capacity of tin occupied by air space	{ 30.7 142.	27.2 143.	22.6 22.6 140.	13.9 13.9 136.	9.2 9.2 134.	27.8 27.8 134.	...	
Price per quarter of a pound retail	0s. 9d.	0s. 9d.	1s. 0d.	0s. 9d.	0s. 9d.	0s. 9d.	2s. 6d.	
Quantity in pounds of each which is equivalent to one pound of Fray Bentos Extract	16.3	16.7	21.9	14.0	9.7	14.2	5.33	
Price in shillings paid (retail) for an equivalent of Fray Bentos Extract, valued at 8s. 3d. wholesale	48.9	50.1	87.6	42.0	29.1	42.6	53.3	

Remarks.—ALEX. FORBES'S ESSENCE OF BEEF deposited an abundant sediment on standing. None of the Essences of Meat showed any sign of containing fat. DR. HASSALL'S FLOUR OF BEEF also contained no fat. 100 parts of it contained 15.6 parts, soluble in cold water.

LONDON INSTITUTION; 17th March, 1869.

(Signed) J. ALFRED WANKLYN, *Prof. of Chemistry.*



