ON THE NATURE OF FOOD;

WITH SOME REMARKS ON THE VARIETIES OF ALIMENTS TO BE
SUPPLIED TO THE ARMY OR NAVY.

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It is perhaps in the present day too exclusively, at least for practical purposes, assumed that, in the process of digestion, food, whether animal or vegetable, is merely dissolved and reduced to its proximate elements, and at once appropriated by the system. The beautiful exemplification of this law afforded by Liebig's discovery of analogous compounds in the vegetable to those formed in the animal, would appear to have been too rigorously applied in practice. It was rational to conclude, from such a fact, that while the carnivorous animals obtained the proximate elements of their organisms from the herbivorous, on whom they preyed, the latter did not convert, as formerly supposed, the vegetables on which they fed into their ultimate elements, prior to their re-formation into the proximate elements of their own bodies, but by a simple solution analogous to that effected in the digestion of carnivora. Thus their fat was procured from the oily matters of plants; the fibrine, albumen, casein, etc., in their tissues, from vegetable fibrine, albumen, and casein. These are no doubt the principal sources whence these substances are procured; but not by any means *the exclusive sources*.

It may, thus, be advisable shortly to sketch the process of digestion in its alimentary bearings, so as to bring the whole subject into something like a connected form, to enable me to apply the conclusions deduced from facts, and to refute objections. In this sketch, I have adopted Bernard's views, from a belief that the extended nature of his experiments, and the very careful manner in which they were conducted, fully authorise the conclusions to which he has arrived. In doing so, however, I cannot forbear acknowledging the obligations due to Professor Donaldson, for the very lucid and intelligible manner in which he has set forth these views in his late admirable papers on this subject, and from which I have largely drawn. (*American Journal of Medical Science*, vol. xliii.)

The food first masticated in the mouth, is moistened with saliva. The saliva is not the same fluid, as it emanates from each of the salivary glands. The secretion of the parotid and sublingual glands is clear and limpid, poured out at the moment of, and assists, mastication. The secretion of the submaxillary gland is thick and glutinous, secreted during, and assisting, deglutition. Nor do the secretions of either of these glands, separately or conjointly, exercise any influence upon food, even of the amylaceous variety, other than the mere mechanical one of facilitating its transit down the œsophagus into the stomach. When combined, however, with the fluid from the *buccal* glands, amylaceous food, kept long enough in contact with it, is converted entirely into grape sugar, dextrine, lactic, and butyric acids. In ordinary digestion, however, as the food is not kept long enough in contact with it, this change is but very imperfectly carried on. The peculiar

principle in the saliva on which this change depends is *ptyaline*, or *animal diastase*. It exists in many other fluids of the body; in the serum of blood, in mucus from inflamed or irritated mucous surfaces, in the serum of cysts of the liver, all of which will produce a like change on amylaceous food.

Arrived into the stomach, the food comes in contact with the *gastric juice*. This gastric juice is made up of free acid, namely, the *lactic*, (and not the hydrochloric or acetic, as formerly supposed,) chlorides of lime and ammonia, phosphate of lime, an aromatic principle, and an animal matter called by some *pepsin*, by others *chymosine* or *gasterase*. The action of the gastric juice is limited to the nitrogenous and mineral aliments. Fatty matters and amylaceous aliments pass through unchanged. Meat, kept long enough in contact with it, is completely dissolved by it; as also albumen, casein, and fibrine. The former is not coagulated by it, but merely rendered opalescent. The casein is coagulated by it prior to solution. The third is with most difficulty digested; indeed, the muscular fibres are generally, in ordinary digestion, never more than partially dissolved, and the greater part of the fibrine passing out by the pylorus, is little more than softened; this solution constituting the chyme. Although lactic acid is the acid of gastric juice, still any dilute acid, when mixed with pepsin, will dissolve food in like manner. There is this difference, however: that whereas the solution in ordinary gastric juice is perfectly assimilable, and may be injected in the veins without injury, that dissolved by the artificial juice prepared with any other acid, will generally prove fatal to the animal.

The chyme passes onwards into the duodenum and small intestines. This chyme consists of amylaceous food partially changed in sugar, dextrine, lactic and butyric acid; nitrogenised food partially dissolved; a large quantity of amylaceous, fatty, and nitrogenous food, merely moistened, or mechanically mixed with the watery portions of the saliva and gastric juice; and the whole has an acid reaction.

On reaching the duodenum, the chyme is mixed with the bile. The changes effected by this agent are numerous. The whole fluid is rendered *alkaline*; the nitrogenous aliments are rendered *soluble*; the chyme is rendered *indestructible* and *imputrefactive*; all kind of fermentation is stopped. The saccharine and amylaceous aliments are untouched; the fatty likewise, unless they are rancid, in which case a sort of saponification takes place by mixture with the bile. With fresh oils it is only a mechanical mixture. This mixture is called the "*chyle brut*."

This chyle brut in its progress comes in contact with the *pancreatic fluid*, and by it is effected the saponification of the fatty matters. This saponification is not due to alkalies, as the pancreatic fluid will saponify fats in acid mixtures, but to an active principle in the pancreatic fluid, called *chyloposine*, which resembles albumen in most of its chemical characters, yet differs from it in being redissoluble, after coagulation, in water.

The universal solvent of food is thus not the gastric juice, as has been generally supposed, but the combination of saliva, gastric juice, bile, pancreatic fluid, and the secretion of Brunner's glands. This is the veritable dissolving and digesting fluid. Neither the saliva, how-

ever, nor even gastric juice, are essential; as food in a liquid state will, if injected into the duodenum, be digested. The intestinal fluid will equally dissolve out of the body all kinds of food.

The various aliments having been dissolved by the intestinal fluid, the digested or assimilated are taken up by the lacteals and veins, and mixing with the general mass of the blood, are severally apportioned to nourish the different parts of the system, and for the purposes of respiration; the former consisting of the nitrogenous or azotised portions; the latter, of the hydrocarbons.

In so far, then, as regards the formation of some portion of the fat, of the albumen, fibrine, or casein, sugar, and the mineral ingredients of the body, it is readily seen how these may be directly derived, as proximate substances, by the mere solution of the food.

Apart, however, from this source, there is no doubt that some of these substances are *elsewhere manufactured* in the body. Not to speak of the cerebral matter, which is admitted by all to be the result of a purely animal change, there is evidence to warrant the belief that sugar, fat, and fibrine, are likewise formed by the liver; as shewn, especially in reference to the two former, by Bernard.

1. *Sugar* is secreted by the liver. In cases of diabetes, in which all substances capable of direct conversion into sugar were carefully excluded, such as the three varieties of sugar usually taken as aliments, cane, glucose and milk sugar, or amylaceous food of any kind, sugar was found in the hepatic veins. The same experiments repeated upon dogs, whether fed with such substances, or lean meat simply, gave a similar result. The parenchyma of the liver in man, oxen, dogs, cats, rabbits, horses, and even of the foetus, contained sugar. Again, irritation of the olivary bodies in the medulla oblongata, or the administration of narcotics, gave rise to it for a limited period in undue abundance, so that it was detectable in the urine.

2. *Fat*, very analogous to butter, is also secreted by the liver. The portal vein was tied, so as to prevent the absorption by it of any fatty matters taken with the food, and fat was detected in the hepatic vein. This fact affords a ready explanation of the fatty livers in some drunkards, where the organ is unduly stimulated. It explains the occurrence of fatty livers in animals kept quiet, and prevented from consuming their fatty tissues. It explains, probably, the examples of chylous urine or fatty diabetes, where it may be presumed the liver secretes an undue quantity of fat, which, like sugar, is excreted by the kidneys. It explains satisfactorily the formation of fat over and above what is taken *as such* in the stomach, in cases of corpulent persons, and in animals fed exclusively on nitrogenous matter. Thus Bous-singault fed geese on albumen and casein exclusively, and found they fattened upon it. A good instance, also, of the change of nitrogenous into fatty matter has been afforded by Playfair, in the fact that not only does the yield of milk, but also the amount of butter, increase with the amount of nitrogen in the food, *i.e.* with the quantity of plastic aliment taken: a fact the more remarkable, as the absence of nitrogen in butter would naturally have led to a different conclusion. (Knapp's *Chemistry applied to Art*, vol. iii, p. 45.) Lastly, as evidence of the production of fat, or rather the conversion of nitrogenous tissues into fat, we have the examples of fatty degeneration. Be this a pro-

cess of decay, or of diminished nervous energy, I do not pretend to say, but the fact is unquestionable.

3. *Fibrine* is probably also secreted by the liver. The *albuminose*, or solution of food in the *intestinal fluid*, is believed by Bernard to be transformed at once into fibrine in its course through the *vena porta*. The blood which enters the liver, even in an animal fed exclusively on meat, contains large quantities of azotised matter, but very little fibrine. The hepatic veins contain much fibrine, and but little albuminose; and further, this difference is only observed during digestion. The same change has been noticed in the chyle after its transit through the mesenteric glands. (See Professor Donaldson on Bernard's new discoveries, *American Journal of Medical Sciences*, vol. xlviii.)

Essentially, therefore, while it cannot be denied that nature will generally adopt the simplest method to nourish the body, we should not too exclusively direct attention to this means of nutrition, as has perhaps been done by Liebig, to the disregard of the other. It is philosophical, certainly, to admit that most of the fatty, saccharine, nitrogenous, and mineral elements, are often directly obtained from those substances, taken as food, and in which they already exist ready formed as such. But there can be no doubt, also, that these same substances may, under peculiar circumstances, be decomposed again into their ultimate elements, for subsequent appropriation after conversion into new alimentary compounds, by the economy. This change may be secondary to digestion, *i.e.* effected through a special organ, or the general capillary system, apart from any direct connexion with the intestinal tube, but it is not the less completely and certainly effected; whence it becomes important to estimate the value of aliments, rather in reference to their ultimate, than their proximate composition, so that while we do not lose sight of the latter, we can more certainly trace or explain the possible changes that may occur through the former.

Having thus prepared the ground upon which I purpose to tread, I proceed to speak of food in a more especial manner. In doing so, I may premise by stating that I availed myself of any information I have been able to collect from the French academicians, Dumas, Pereira, Proust, but especially Liebig and Knapp, and a few others; nor have I hesitated to quote largely from the works of these, when it appeared to me that a fact, conveyed in the expressions of such distinguished authorities, would carry more weight.

The food of man may be divided into two grand classes. 1. The *Combustible*; 2. The *Incombustible* aliments. The incombustible may be again divided into two important subclasses; 1. The nitrogenous or azotised aliments, or those serving especially for the nourishment of the body; the amount of nitrogen contained in a compound aliment being proportionate to its nutritive qualities. 2. The *mineral* aliments or salts, which by their chemical and physical properties, keep the nitrogenous and combustible aliments in that state of solution, or physical condition, in which they are best calculated to serve the purposes of the economy.

The *combustible* aliments, or compounds especially rich in hydrogen and carbon, are those serving for the purposes of respiration, and the maintenance of animal heat in the body.

There is one fact in connexion with these three classes of aliments, the nitrogenous, mineral, and combustible, which is of great interest. It is that the aliments of no one class, or even of any two, if perfectly pure, are capable of supporting life for any lengthened period. After a time varying on an average from one week to a month, animals so fed die with all the symptoms of starvation. It is true it was once believed that gluten was an exception, as it proved sufficient to maintain life even when given singly. Such was certainly the result aimed at by the French academicians—but gluten can scarcely be considered a simple aliment, since it may be looked upon as a compound of vegetable gelatin, vegetable fibre or fibrine, oil, and gluten. Moreover Magendie has since shown that the gluten used in the experiments before alluded to, was not pure, but, in fact, a very compound body, containing, besides gluten, a little albumen, gum, mucilage, starch, and even sugar. It becomes therefore most important that the food supplied should at all times contain a full proportion of each of these alimentary matters.

I. OF THE INCOMBUSTIBLE ALIMENTS.

1. *The Nitrogenous Ingredients.*

The nitrogenous sub-class may be divided into two groups. In the first, we have the proteinaceous aliments, in which we may include the proteinaceous compounds, or those derived from them.

In the second group, which for convenience I have called the *per-nitrogenous*, I would be understood to mean, not only those aliments which resemble creatine in some of their chemical properties, but also those which contain, like creatine, a very much larger quantity of nitrogen than the proteinaceous group, but which are also comparatively rich in hydrogen and carbon.

a. The Proteinaceous group. These compounds have been so named from their being all derived from proteine, and may be enumerated as follows: Proteine being, $C_{40} H_{31} N_5 O_{12} = Pr.$

Albumen of blood..	10 Pr.+S. ₂ P.	Arterial membrane ..	Pr.+2 HO.
Albumen of egg ..	10 Pr.+S. P.	Mucus	Pr.+3 HO.
Fibrine	ditto.	Chondrine	Pr.+4 HO.+2 O.
Casein	10 Pr.+S.	Horny tissue ..	Pr.+NH. ₃ +3 O.
Globulin	15 Pr.+S.	Gelatinous do...	2 Pr.+3 NH. ₃ + HO.+7 O.
Muscular flesh....	Pr.+HO.+H.		

These formulæ (taken from Simon) must not be looked upon as representing the actual constitution of these tissues respectively; but only the proportion of actual elements present, and as indicating the changes which may take place in the formation or alteration of each.

More lately Liebig, in his late work,¹ appears to doubt whether these tissues are in reality all protein compounds; he seems to regard them rather as metamorphoses one of another, taking place in connexion with other elements. Thus, if from the formula of casein we deduct that of blood, we have—

	S.	N.	C.	H.	O.
Formula of casein	2	36	288	228	90
Formula of blood	2	27	216	169	68
Subtracting one from the other, we have		9	72	59	22

¹ Liebig's Letters.

According to this view, it is evident certain proportions of carbon, hydrogen, oxygen, and nitrogen, must separate from casein, if it is to be converted into the albumen of blood; but what surprises us, when we observe these formulæ, is, that the eliminated elements, with the exception of a small amount of oxygen, are in the same proportion as in chondrine: so that if we add to the formula of casein, ten equivalents of oxygen, we obtain a formula which includes precisely those of albumen of blood and chondrine.

	S.	N.	C.	H.	O.
To formula of chondrine		9	72	59	32
Add that of albumen.....	2	27	216	169	68
Formula of casein + ten oxygen	2	36	288	228	100

In like manner the formula of albumen + 10 water, contains the elements of 2 gelatine + 1 choleic acid. Again, fibrine of blood + 8 water = 1 albumen of blood + 1 gelatine.¹

When changes of this kind are examined, we are enabled to trace the analogous relations of several aliments, apparently very different in nature, and yet capable of being grouped together in the same category. Between those named, for instance, though in the change the substances are not exactly reduced to the proximate substances to which they are closely related—*protein*, still there is a marked relationship. It is but a modification of what we have before noticed; but may lead to an easier explanation of those more complete changes, by which one aliment assumes the form of another aliment, before it is finally appropriated by the economy. Thus starch becomes converted into fat; flesh and blood into fat; perhaps fat again into grape sugar, etc.

Four only of these substances need occupy our consideration, namely, fibrine, albumen, casein, and gelatine.

1. *Fibrine*, the principal constituent of muscular flesh, or the shreds obtained from fresh blood when it is stirred up with fine rods, exists largely in the animal body; but it is also found in the vegetable kingdom, in *gluten*—the substance which is left behind when the starch of wheat flour has been separated, by washing the dough in water till the water is no longer milky; or *vegetable fibrine*, as the greenish-tinged precipitate deposited in the newly-expressed juices of vegetables, after they have stood a little while, duly freed from colouring matter.

2. *Albumen*, as it occurs in the white of eggs, or in the serum of blood. Its analogue in the vegetable world is *vegetable albumen*, obtained as a precipitate from certain vegetable juices, such as cauliflower, asparagus, mangel wurzel, or turnips when boiled.

3. *Casein*, or cheese as it exists in milk. Its analogue in the vegetable world is *legumin*, a vegetable casein, obtained from peas and other leguminous plants, such as beans and lentils, as a precipitate from the milky fluid remaining after the first subsidence of albumen.

These three substances, though differing in form, and in the functions which they perform in the animal economy, and adapted for special and distinct purposes, are yet essentially the same in their chemical composition, and readily convertible one into the other, both in the body, and by artificial processes out of the body.

¹ Liebig's Letters.

4. *Gelatine* does not exist in the body as such, but is the product of their alteration by boiling. It forms the basis of glue, size, etc. Though not properly a proteinaceous compound, it is evidently derived from them, as before seen.

b. The *pernitrogenous* group includes substances very much richer in *nitrogen* than any of those before alluded to. We may include in this group theine, caffeine, theobromine, the essential principles of tea, coffee, and cocoa; and, indeed, the active principles of many medicinal tonics, quinine, strychnine, etc., could as fairly be taken in it. This division is arbitrary; yet that some relation exists is evident, from the following formulæ, given by Liebig:—

	Carbon.	Nitrogen.	Hydrogen.	Oxygen.
Theine	8	2	5	3
Kreatinine	8	3	7	2
Glycicoll (anhydrous)	8	2	8	6
Kreatine	8	3	11	6
Theobromine	7	2	4	2
Caffeine	8	2	5	2

We see from these formulæ that kreatinine contains the elements of theine and those of amide (NH₂); and that glycicoll and kreatine differ in this, that the latter contains one equivalent of ammonia more than the former. Theine or caffeine, and the bodies resembling them, which may be taken without injury, all, on the other hand, contain for the same amount of nitrogen, eight equivalents of carbon, or less than the constituents of blood. Theine is related to no organic base more closely than to kreatinine.

Both kreatine and kreatinine are readily convertible into one another. They exist in all vertebrata hitherto examined. Human flesh is particularly rich in kreatine; and both are found in extract of flesh. As nitrogenous aliments, they contain very much more nitrogen than the proteinaceous; and if the amount of nitrogen present in an aliment be considered as the test of its nutritive value, they are much more nutritious than the proteinaceous.

Now it has been generally admitted, that the amount of nourishment in aliments is in proportion to the amount of *nitrogen* or *azote* contained in them. With the reservation, that this nitrogenous ingredient can only be looked upon as a measure of nutritive value in so far as it is really digestible, this may be stated to be generally true. In accordance with this notion, the following table, giving the equivalents for several alimentary substances, taken from Boussingault, Knapp, Horsford, Thomson, and Schlossberger, upon the scale of wheat as 100°, has been prepared.

Table of Nutritive Equivalents, corrected from recent analyses.

Wheat, 2·61=100. (n. s., natural state.)

	Amount of Nitrogen.	Equi- valent.		Amount of Nitrogen.	Equi- valent.
Rye straw, n. s.	·17	1535	Juice of potatoes	·37	705
Pure saw-dust, n. s.	·22	1186	Oat straw, dry	·4	652
Barley straw, n. s.	·23	1134	Wheat straw, dry	·4	652
Rye straw, dry	·25	1044	Red clover stalk, n. s.	·4	652
Barley straw, dry	·26	1003	Buck wheat straw, n. s.	·48	543
Husks of oats, n. s.	·30	870	Leaves of beet, n. s.	·5	522
Pure saw-dust, dry	·31	841	Pulp of potatoes, n. s.	·52	501

Table of Nutritive Equivalents, continued.

	Amount of Equi- Nitrogen. valent.		Amount of Equi- Nitrogen. valent.
Grass, n. s.	53 493	Wheaten flour, Vienna, No.	
Oak saw-dust, n. s.	54 483	1, and rye bread, made	
Buck wheat straw, dry	54 483	with upper malt dough	3 87
Stalk of potatoes, n. s.	55 474	Ditto, No. 3	3.44 76
Oak saw-dust, dry	72 362	White bread, made with	
Husks of wheat, n. s.	85 306	malt dough	3.9 66
Leaves of carrots, n. s.	85 306	Piperine	4.1 63
Husks of wheat, dry	94 277	Yellow peas, dry	4.4 59
Millet straw, dry	96 271	Garden pea, n. s.	4.42 59
Pulp of beet root, n. s.	1.14 228	Cow's milk, dried, 212° ..	3.78 68
Common rice, n. s.	1.10 225	White large bean, n. s.	4.59 50
Onions, n. s.	1.18 221	Lentil, from Vienna, n. s. ...	4.57 57
Pulp of beet, dry	1.26 208	Garden bean, ditto, n. s. ...	4.47 59
Hay, n. s.	1.5 174	Mushroom, dry	4.6 56
Upper portion of best wheat		Best white bread, made	
straw, n. s.	1.33 197	with upper malt dough	4.8 54
Ditto, ditto, dry	1.42 184	Yolk of egg, dry	4.86 53
Turnips, n. s.	1.45 180	Oysters, dried	5.25 49
Tartar buck wheat, n. s. ...	1.56 167	Fibrine, fresh meat	3.5 74
White potatoe, n. s.	1.56 167	Ox blood, albumen to chon-	
Underground trefoil root,		drine, n. s., by calculation	4 65
n. s.	1.62 161	Oats, maxim. (Wigtonshire)	5.51 47
Carrots, n. s.	1.67 157	Salt cod	6.7 38
Beet root, dry	1.7 153	Dry brain	6.7 38
Mangelwurzel, n. s.	1.81 145	Eel, raw, dry	6.91 37
Pulp of potatoes, dry	1.95 134	Eel, boiled	6.82 38
Rye flour, Vienna, No. 1, n. s.	1.87 140	Crushed bones, n. s.	7.01 37
Wheaten flour, Vienna,		Ditto, dried	7.58 34
No. 2, n. s.	2.12 123	Quinine	8.1 32
Oats, entire grain, with		Ham, raw, dry	8.57 30
husks	2.18 118	Cinchonine	9 29
Cerebric acid	2.2 118	Salmon, boiled	9.70 26
White bread (Thomson),		Salt cod, dry	10.86 24
dry, 212°	2.27 113	Cheese dried at 212°,	5.27 49
Indian corn, n. s.	2.3 113	to	to
Peas straw	2.3 113	varies from	7.11 36
Jerusalem barley, from Ho-		Tea	9 29
henheim, n. s.	2.31 113	Pigeon, raw, dried, 212° ..	12.10 21
Kamtschatka oats, from		Mutton, raw, ditto	12.3 20
Hohenheim, n. s.	2.39 108	Salmon, raw, ditto	12.35 20
Beet root, n. s. (Liebig) ..	2.43 107	Ham, broiled, ditto	12.84 29
Black bread (Playfair), by		Lamb, raw, ditto	13.26 19
calculation	2.4 108	Albumen of egg, ditto	13.44 19
Black bread, dry, 212°		Mutton, boiled, ditto	13.55 18
Thomson	2.63 100	Veal, raw, ditto	13.89 18
Wheat, mean, 3 expts., n. s.	2.61 100	Herring, ditto	14.48 18
„ Average with bran,		Veal, boiled, ditto	14.50 18
by calculation, n. s.	2.65 98	Beef, boiled, ditto	14.99 17
Martinique coffee	2.41 108	Extract of milk, ditto	15.8 16
Talavera wheat, n. s.	2.59 100	Roasted beef, ditto	15.8 16
Sandomier wheat, n. s.	2.68 98	Glutin from isinglass, dry	18.3 14
Whittingdon wheat, n. s. ...	2.69 97	Isinglass, dry	18.7 14
Common winter wheat	2.79 93	Asparagine, ditto	18.7 14
Rye, from Hohenheim, n. s.	2.78 93	Glycicoll, ditto	19.8 13
White early oats, n. s.	2.82 92	Creatine, ditto	28.1 9.3
Oats, grain without husks	2.82 92	Theine, ditto	29 9
Oats, mean, nine experi-		Caffeine, ditto	28.8 9.0
ments	2.92 89	Theobromine, ditto	35.3 7.4
Carrot leaves, dry	2.94 88	Creatinine, ditto	38 6.8
Liquid blood	2.94 88	Robertson's extract of meat,	
Biscuit made with flour		dry?	4.3

2. OF THE MINERAL INGREDIENTS.

The second group of the incombustible aliments are the mineral ingredients, consisting of alkaline phosphates, and carbonates of soda, magnesia, potash, the earths, silica, oxyde of iron, chlorides of sodium and potassium, besides water. These substances, although in themselves innutritious, are yet essential to life, the phenomena of which could not be carried on in their absence. These mineral ingredients are, in fact, those agents by which the nitrogenous and combustible aliments are preserved in a condition useful for the purposes of the economy. In a practical point of view, however, they do not require to be very specially considered, as the same salts usually enter into the composition of all animal and vegetable food, with slight modifications. As a general rule, it may be admitted that animal food contains more phosphoric acid, more soda and iron; vegetable food, more carbonic acid and potash.

To set forth the relative value of food, according to the quantity of salts each contains, in a tabular form, would necessarily involve the whole subject of dietetics. Thus each article of food would have a different equivalent for each ingredient it contained; for potash, soda, lime, and magnesia; for phosphoric, silicic, carbonic, and sulphuric acid; for sesquioxide of iron, and the chlorides of potassium and sodium. Reserving this work of labour for a future occasion, a few examples of the amount of alkali and alkaline earths on the one hand, and of the various acids found in the incinerated ash are here subjoined. It may be remarked, that the amount varies very greatly in each kind of aliment. Thus, some kinds of grain contain quite as much phosphoric acid and alkalies as blood. Generally, however, the quantity of phosphoric acid in plants is much smaller, and carbonic acid takes its place.

100 parts of the incinerated ash of the following substances contain :

	Potash and Soda.	Lime and Magnesia.	Phospho- ric Acid.	Sulphuric and Silicic Acid.	Carbo- nic Acid.
Wheat, mean 32 expts.	31·87	16·20	46·00	3·68	—
Barley, mean 10 expts.	22·70	11·13	35·20	27·52	—
Oats, grain, 7 expts.	29·25	11·62	18·19	48·37	—
Rye, mean	33·75	15·33	49·19	1·41	—
Maize, mean	42·59	12·74	30·93	10·13	—
Millet seed	22·68	8·52	18·19	59·98	—
Buck wheat	28·92	17·04	50·07	2·85	—
Rice	30·15	12·96	53·36	3·35	—
Peas, mean	41·23	13·82	36·48	5·06	—
Beans	47·05	41·55	32·22	2·45	—
Lentils	34·49	7·05	29·07	1·07	—
Hay	46·37	11·11	15·05	29·03	—
Potatoe dregs from disty.	42·99	12·52	16·78	8·94	12·27
Clover	56·81	30·19	4·12	3·66	—
Cabbage	31·64	82·96	1·94	10·14	19·50
White ditto	49·45	14·08	—	—	12·42
Fresh artichoke.....	29·58	14·70	38·96	12·20	14·00
White turnips	52·00	13·58	14·00	—	8·03
Potatoes	55·44	6·74	16·83	—	12·00
Beet root	40·63	10·21	2·39	16·57	29·10
Orange	47·84	32·58	11·07	4·18	—

	Potash and Soda.	Lime and Magnesia.	Phospho- ric Acid.	Sulphuric and Silicic Acid.	Carbo- nic Acid.
Grape juice	57.12	13.77	—	13.72	—
Tea	53.48	8.08	9.88	11.03	10.09
Cocoa	37.14	18.85	39.65	1.70	—
Coffee	51.45	12.25	10.02	4.74	20.50

Many of the means above given can only be considered as averages, as in some specimens of wheat as much as 60, in some of oats as much as 50 per cent. of phosphoric acid was found.

The animal substances may be included in two groups; the blood, in which there is excess of alkali; flesh, in which there is excess of phosphoric acid.

100 parts of the ashes of the following substances contain :

	Potash and Soda.	Lime and Magnesia.	Phospho- ric Acid.	Sulphuric and Silicic Acid.	Carbo- nic Acid.
BLOOD (ASHES OF).					
Sheep's blood (Verdeuil)	55.79	4.87	14.80	—	19.47
Ox blood (Stolzel)	59.97	3.64	14.04	—	18.85
Dogs fed on flesh (Verdeuil)	55.24	2.07	36.82	5.87	—
Fowl's blood (Henneberg)	48.41	2.22	47.26	2.11	—
Pig's blood	49.08	3.08	36.05	9.09	—
Human blood	0.58	99.00	31.78	—	3.78
Calf's blood	0.66	57.00	20.14	—	9.84
Pigeon's blood	33.55	7.24	49.93	0.29	—
Goose's blood (mean)	18.81	7.76	34.03	0.73	—
Young cock's blood (mean)	22.13	8.45	35.97	1.47	—
Frog's blood	18.12	2.36	46.48	0.75	—
Perch	20.42	5.83	37.52	0.78	—
FLESH (ASHES OF)					
Flesh	40.20	5.69 ¹	36.60	2.95	—
Residue of flesh after making soup	4.78	2.54	10.36	—	—
Soup	35.42	3.15	26.24	2.95	—
Ox flesh (Stolzel)	43.05	6.17	42.03	7.85	—
Horse flesh (Weber)	42.02	6.54	51.44	—	—
Veal	41.26	2.83	55.15	0.92	—
Cod	7.95	43.48	16.77	1.64	—
Gruyère cheese	13.48	40.99	45.00	0.18	—
German hard cheese	42.69	8.92	47.98	0.11	—
Ox flesh washed out (Keller)	24.97	10.45	46.13	—	—
Ox brain (Dr. Breed)	38.62	3.59	57.79	—	—
Yolk of Egg	14.15	24.20	60.34	—	—

The quality of food therefore which a person takes, will give rise to very different salts in the blood. Liebig has shown that the urine is a sort of index to the blood, i.e., that the same salts exist in the blood which do in the urine; so that the knowledge of the constitution of the former involves the knowledge of the latter. Now if food has been bread or flesh, the ashes of which contain only phosphates, the urine (the results of the combustion in the body) will contain the alkalies only in the form of alkaline phosphates. If, on the other hand, the food has been roots, green vegetables, or fruits, the ashes of which contain carbonates as the soluble salts, the urine contains alkaline carbonates. The following table, indicating the change in the urine, may be considered as also indicating the changes in the blood with different kinds of food.

¹ With iron.

² After lixiviation in lime water.

With food consisting of flesh, bread, beans, lentils, etc.		With vegetable food, hay, clover, turnips, potatoes, fruits, etc.	
Free phosphoric acid.		Free carbonic acid.	
Phosphates of lime and magnesia.		Carbonates of lime and magnesia.	
Phosphates	} of alkalies.	Carbonates	} of alkalies.
Sulphates		Sulphates	
Urates		Hippurates	
Hippurates			

The substance holding in solution the ingredients of the blood being in one case phosphoric acid, in the other carbonic acid. "The phosphate of soda has an alkaline taste and reaction like the carbonate, and its solution in the presence of free carbonic acid takes up as much of that acid as carbonate of soda does; and like it, only more easily, gives it off by agitation *in vacuo*, or by evaporation without losing its power of again absorbing carbonic acid. Hence it follows that the change of acid, combined with alkali by phosphoric acid, has no pernicious influence, and *vice versa*, because it gives rise to no alteration in the essential properties of the blood. The processes of sanguification, of the production of heat and secretion, are carried on alike under the influence of the predominating alkali."—*Liebig*.

II. OF THE COMBUSTIBLE ALIMENTS.

The combustible aliments include all the amylaceous, oily, alcoholic, saccharine, gummy, and pectinaceous compounds. These, it has been already seen, are especially rich in carbon and hydrogen, which, in the process of respiration, uniting chemically with the oxygen of the atmosphere, a process analogous to combustion is set up; water and carbonic acid being generated. This chemical combination develops a certain amount of caloric, which by conduction traversing the surrounding tissues, communicates to the body that degree of temperature essential to life, technically called animal heat.

It will follow from the remarks before made, relating to the secretion of fat, grape sugar, and fibrine by the liver, and specially the circumstances under which the former are produced, that a variety of aliments though not simply hydrocarbons, may undergo such chemical changes in the body as to be converted into combustible aliments; but the question here offers itself, into what proximate substances are purely combustible aliments as hydrocarbons rendered for assimilation? The experiment before quoted of Bernard, p. 518, proves that hepatic sugar is one of the substances consumed in the lungs. In like manner it is reasonable to conclude that all varieties of sugar, amylaceous or gummy substances, capable of conversion into *glucose*, are as such consumed in the lungs. Apart therefore from their numerical value as hydrocarbons, the readiness with which they are converted into glucose is a test of their combustible value. Fat, however, is without doubt a very rich respiratory per-combustible aliment. The emaciation which occurs in those who, not receiving a sufficiency of alimentary matters, or in whom, through disease, increased respiratory movements call for an additional supply of respiratory matter, is so much evidence of this. Is this fat converted into glucose? This is doubtful, as when diabetic patients grow fat on oily matters, the amount of sugar diminishes in the urine. Bernard also showed that the blood coming from the lungs contained nearly as much fat as that which entered them by the pulmonary arteries; and if this experiment be

received in a negative sense, it will follow that fat is not consumed in the lungs by a direct decomposition there, until after its conversion into glucose in some other part of, or by some other organ in the body. This would in part diminish its combustible value, as compared with glucose, and make its equivalent somewhat less than that which is numerically ascribed to it. Future experiments will probably solve these difficulties. In the meanwhile it is wiser to look alone to their numerical value, and estimate their combustible value accordingly.

The combustible value of aliments has not, so far as I am aware, been set forth in a tabular form, in relation to the amount of heat evolved by each during combustion, though some results are given for carbon singly. In the following table the result is given for *carbon and hydrogen conjointly*. The table is calculated upon the mean in both cases of ten experiments made by different observers.

The following parts of water are heated one degree by the combustion of one part of

Hydrogen in the formation of water.		Carbon in the formation of carbonic acid.	
Despretz	20624	Despretz	7815
Ditto	23640	Ditto	7912
Lavoisier	21375	Lavoisier	7237
Dalton	24000	Duborg	7167
Duborg	34743	Dalton	3000
Hesse	34792	Rumford.....	5325
Crawford	36000	Crawford	5175
Grassi	34666	Grassi	7714
Farre and Sulbermann	34662	Andrews	7900
Andrews	33808	C. D.	7012
Mean	29831	Mean	6625

Whence we learn that if the combustion of one part of carbon raises the temperature of water one degree, the combustion of one part of hydrogen will raise it 4·5 degrees.

Table of Combustive Equivalents.

Wheat, dried, C. 46·1 and H. 5·8, yielding 478442 units of heat=100.
(b. c., by calculation. n. s., natural state.)

Turnips, n. s.	1554	Extract of milk.....	121
Cow's milk.....	834	Crystallised citric acid	121
Ox blood	351	Rice, by calculation, n. s.	119
Potatoes, n. s.	351	Dry Lentils	116
Caseine, n. s.	343	Wheat flour	115
Fibrine, n. s.	343	Malic acid	114
Albumen, n. s.	336	Beans, dry	112
Fresh meat, free of fat, n. s.	325	Asparagine	112
Crystallised tartaric acid.....	179	Creatine	111
Formic acid	163	Wheat bran, best, b. c.....	111
Extract of milk.....	133	Average wheat bran, dry, b. c. ..	106
Fresh bread, white, made with average wheat, assuming 280lbs. wheat flour=320lbs. bread, and 115lbs. wheat, n. s.=100 dry ..	128	Narbonne honey	106
Tartaric acid	144	Turnips, dry	106
Best bran, by calculation	139	Arrow root	106
Average wheat bran, ditto, n. s. ..	137	Peas straw, dry	105
White bread, b. c.....	128	Hay, dry	105
Black bread (Playfair), No. 1....	126	Starch from wheat	104
Ditto, No. 2	124	Beet root, dry	104
Rye bread, b. c.	126	Anhydrous malic acid	104
Anhydrous citric acid	124	Crystallised sugar	104
		Impure sugar candy.....	102
		Crystallised sugar.....	105
		Red clover stalk, dry	102

Table of Combustive Equivalents, continued.

Acetic acid.....	102	Albumen of blood, ditto	85
Rice, b. c., dry	102	Roasted flesh, roe deer	84
Creatinine	101	Fibrine of ox blood, dry	82
Grape sugar		Albumen of eggs, ditto.....	
Beet root sugar		Caseine from cows' milk	81
Maple sugar		Lactic acid.....	83
Pure sugar candy		Biscuit, b. c.	78
Yellow peas, dried 212°	100	Butyric acid	75
Arrow root 212°		Piperine	71
Starch from wheat		Biberine.....	77
Starch, dried 350°		Brain, n. s.	69
Lichenine		Alcohol	68
Gum Arabic	100	Quinine	
Milk sugar		Cinchonine	65
East India sugar		Cerebric acid.....	62
Refined ditto		Capric acid	59
Cane sugar		Elain of olive oil	56
Wheat straw	97	Walnut oil	
Wheat, dried at 230° ¹		Brain, dry	55
Rye, ditto		Mutton suet	
Rye flour, b. c., dry		Almond oil	54
Pectine ..		Margaric acid.....	
Indian meal, dry	98	Train oil	53
Caffeine		Oleic acid	
Theine		Fatty oil from maize	52
Ordinary gum		Hogs' lard	
Oat straw		Oil of fat	51
Potatoes, dry.....	96	Palmitic acid	51
Lignine, dry	96	Olive oil	
Rye straw, dry	95	Beeswax.....	51
Peas, dry.....		Spermaceti	51
Theobromine	93	Stearic acid	50
Oats, dried.....	90	Margarine	
Chondrine, dry	88	Caproic acid	49
Gelatine from isinglass, ditto ..		Butter	
Tendons of calves' feet, ditto ..			

Thus we find that fresh meat, which has the highest equivalent as an incombustible proteinaceous aliment, has the lowest equivalent among combustible aliments. This relative value is not without its importance. The extraordinary appetite of the natives of cold climates, as compared with those of the more temperate, is made hereby susceptible of explanation. Ten pounds of flesh and oil is not an unusual quantity for an Esquimaux to devour in twenty-four hours, besides drinkables. The very coldness of the temperature requires a larger amount of duty to be performed by the lungs; besides, the capacity of the chest is, on an average, the same in all climates. The atmosphere, however, expands by heat, and contracts by cold; moreover, in very cold air there is an absence of moisture, which abounds in hot. It must needs be, therefore, that a given volume of air inspired in a cold climate must contain absolutely more oxygen than if inspired in a hot climate; more combustible aliment, more *fuel*, so to say, must be

¹ Thus, wheat dried at 230° contains 46.1 parts of carbon and 5.8 parts of hydrogen per cent. Therefore the heat evolved by the combustion of 46.1 C + 5.8 H = $46.1 \times 6,626 + 5.8 \times 29,831 = 305,412 + 173,030 = 478,442$; upon which number, being considered as equal to 100, so as to put the whole in a per centage scale, the other equivalents are calculated.

therefore consumed, by reason of the greater quantity of oxygen; and, secondarily, to keep up animal heat. It is a matter of common experience, that the appetite is keener in cold than in warm weather; indeed, bakers and butchers have practical knowledge of this in the larger stock of provision prepared in winter as compared with summer. The converse proposition is equally illustrated in the familiar proverb, "The south wind always blows after dinner". Providence seems, in like manner, to have pointed out that, in warm climates, less combustible food is required. The fruits in these countries contain only about 12 per cent. of carbon, and 2 to 4 per cent. of hydrogen. On the other hand, the fat, blubber, and oily food, on which the inhabitants of the snowy regions subsist, contain 70 to 80 per cent. of carbon, and 10 to 13 per cent. of hydrogen. Thus is again exemplified the supreme wisdom of the Creator, who placed at the disposal of man, according to the climate each inhabited, those articles of food most appropriate and necessary to his existence; and it is chiefly when he transgresses in selecting food not of a kind adapted to the climate in which he resides, that disease results. Hepatic derangement, or diseases arising from excess of carbon in the system, are most common in summer and in tropical climates, because this excess is not consumed in the lungs. Pulmonic disease, on the other hand, is more frequent in winter, from a diminution of hydrocarbon, and an excess of oxygen.

From the foregoing considerations, the following conclusions may be drawn, that, 1. Food to support life must consist of nitrogenous, mineral, and combustible elements. 2. The quantity of the latter must be proportionally large in cold climates as compared with warm.

Thus, to determine the quantity of food necessary to support life, and the relative proportion of each class of aliment, comes to be almost impossible. It must vary with the climate, sex, age, occupation, etc. Take, for instance, the amount of bread allowed to a soldier in different parts of Europe.

France	wheat	12 oz.
Sardinia	ditto	11·7 "
Spain	ditto	10·7 "
South Germany, 1-6 wheat, 4-6 rye, 1-6 barley		14·3 "
North ditto	rye	16 "
England	wheat	12 "
Belgium	ditto	12·4 "

It has, again, been stated that a healthy adult on the continent will consume above 800 lbs. of oxygen, during respiration, in one year; and assuming that, on an average, he consumes 3 lbs. of food daily, this would make a totality of about 1,900 lbs., and yet his weight would probably remain unchanged at the end of this period. But this proportion would be greatly increased in cold climates, and diminished in the tropics. I shall therefore confine myself to answer the question for this country only.

All physiologists seem to have admitted the truth of Prout's proposition, that milk is the best model we have of food. Thus milk contains both combustible and incombustible aliment, and is capable of supporting life for any length of time. The composition of milk may be stated as follows:

Casein . . .	4.48	or nitrogenous matter . . .	4.48
Butter . . .	3.13	nearly equivalent in fat, or	
Sugar of milk	4.77	combustible matter . . .	6.13
Salts . . .	.75	salts	.75
Water . . .	86.67	water	86.67

—100

In hospital milk-diet the usual allowance is, two pints of milk to twelve ounces of bread. Few persons, however, could, on an average, consume more than seven pints of milk, if restricted to this article alone, in twenty-four hours. This would fix the following as the absolute and relative amount of food consumed :

Casein, or nitrogenous matter	5.01 oz.
Fat, or combustible matter	6.86 „
Salts, or mineral matters	.84 „
Water	96.92 „

Two pounds of flesh, or two pounds of bread, would contain a quantity not very different; the former, however, not containing fat.

Fibrine and albumen	6.20 oz.	Fibrine and albumen	6. oz.
Equivalent in fat	— „	Starch & sugar, equivalent in fat	11. „
Salts	.64 „	Salts	.60 „
Water	25.6 „	Water	7.4 „

Speaking practically, however, if we consider that all butchers' meat contains more or less fat, it may be concluded that 2 lbs. of meat, 2 lbs. of bread, or seven pints of milk, are almost equivalent quantities. Thus the army regulation, which allows each soldier three quarters of a pound of meat, and as much bread, is not too small a quantity when we take into consideration the other articles of food procured, such as cocoa and vegetables, and liquor. But the proportion given to the navy appears almost more than sufficient :

	Weekly.	Daily.	Weekly.	Daily.
Bread	112 oz.	16 oz.	112 oz.	16 oz.
Meat (fresh)	112 „	16 „ (salt)	84 „	12 „
Vegetables	56 „	8 „	— „	— „
Flour	— „	— „	42 „	6 „
Peas	— „	— „	29½ „	3½ „
Oatmeal	5 „	5-7 „	5 „	5-7 „
Sugar	10½ „	1½ „	11½ „	1½ „
Cocoa	7 „	1 „	7 „	1 „
Beer	7 gallons.	1 gallon.	7 gallons.	1 gallon.
Vinegar	½ pint.	22-7 „	½ pint.	22-7 „
Tea	1½ oz.	½ oz.	1½ oz.	½ oz.

In as far as the articles, fresh and salt meat, are concerned, there is error, and the remark applies equally to our army supplies, where the same weight of each is given. The amount of nourishment contained in salt meat is less than that contained in fresh meat, from the abstraction of juice of flesh in the former.

It will be well to speak of these several aliments specially, under three heads : of bread, as representing the perfection of food as derived from the vegetable kingdom ; of meat and its substitutes, extract meat and blood, as representing the best kind of food to be derived from the animal kingdom ; of milk, or rather the extract of milk, which may be looked upon as representing a quality of food intermediate between the two former.

1. Bread, like meat, contains (vegetable) albumen and fibrine,—the nitrogenous element of nutrition; starch and sugar, the combustible elements, for respiration; salts, the mineral ingredients, to keep the former in such a state of solution or preservation to serve the purposes of the economy. The composition of white bread, exclusive of salts, is as follows in 100 parts :

Starch	68	Veget. albumen, 15
Gluten	24	Gummy sugar . 5

The salts vary in different varieties of grain, and necessarily in different kinds of bread. In 100 parts of ashes, a mean of thirty-two analyses gave 46 of phosphoric acid, and 49·57 of alkali and alkaline salts. In one specimen, however, from Leipsic, analyzed by Schmidt, there was as much as 60 per cent. of phosphoric acid; in one from Egypt, by Way and Ogsden, there was as much as 52 per cent. of alkali and alkaline earths. "The finest American flour is richest in gluten. Rye contains a substance resembling starch-gum in its properties, *dextrine*, as it is called, which is easily converted into sugar. The starch of barley represents cellulose, and is therefore less digestible. Oats are very rich in plastic matter" (14 to 18 per cent., sometimes as high as 22 per cent.), "especially Scotch oats, which contain in the ashes, after deducting the silica of the husks, very nearly the same ingredients as are found in the ashes of meat." (*Liebig*.)

It is evident, therefore, that according to the grain with which the bread is made, so must its value as an aliment be estimated.

Black bread is capable of supporting life for an indefinite period, and, in this sense, it is more nourishing than white bread. The experiments of the French academicians proved, that dogs fed exclusively on pure white bread, died in a few weeks, with all the symptoms of starvation; whereas the coarse brown bread proved both nourishing and fattening. Again, the analyses of Thomson give, for white bread, a nutritive equivalent of 113; and for black bread 100; that obtained by calculation from Playfair, is 108. In either case, it appears white bread contains less plastic matter than black bread.

Again, according to Playfair's analysis, black bread has a combustible equivalent of 126; white bread has one only of 128. White bread, therefore, is inferior, as a combustible aliment, to black bread, though not to the same degree. These results can, however, only be regarded as approximative, nor in any way to justify the general conclusion that, in all cases, white bread is inferior to black bread. The following table in some measure explains the reason of this disparity :

COMPOSITION OF	Wheat, Mean 7 expts.	Average Bran. (Johnson)	By Cal- culation. White Bread.	Black Bread, made with a preparation of 21·3 pts. Bran in the Flour.
Starch	39·9	—	44·4	31·6
Starch, with husks ..	—	55·6	—	9·2
Gluten	14·8	—	13·8	9·2
Albumen	—	10·3	—	3·2
Sugar	19·1	—	{ 16·7	{ 12·0
Gum				
Woody fibre				
Fat or oil	—	4·7	—	0·7
Salts	1·6	7·3	1·4	2·3
Water	12·4	13·1	23·7	31·8

Whence it would appear that whatever change it may have undergone in the process of baking, white bread contains, in reality, very little more nitrogenous, *i.e.* about 1.4 per cent. more than an average black bread, but less combustible matter, and a much smaller quantity of *salts*; to which latter cause is probably specially due the fact, that pure white bread, singly, will not suffice to support life. The above calculations have been made on the supposition, that 280 lbs. of good wheaten flour will yield 320 lbs. of bread; whereas flour containing about 21.3 of bran, the average quantity in black bread, will yield 336 lbs. of black bread. To add a larger quantity of bran does not apparently increase the quantity of bread, for although, by so doing, more dough (by the larger quantity of water absorbed) is made, still in baking it loses the water more readily.

There is another circumstance which renders white bread, as an alimentary substance, inferior to black bread. In many cases, by way of facilitating the separation of the husk from corn, the latter is moistened. If this moisture is not, by a subsequent process, removed effectively, the flour becomes musty. To correct this defect, bakers have been in the habit of adopting one of two plans, both of which have the additional advantage of rendering the bread peculiarly white,—sulphate of copper, an acrid poison, being added, or alum. The late revelations of the Sanitary Commission of the *Lancet* have shewn to what an extent this practice is carried on in London. The bread is, by this process, deteriorated in its sanguific value; the phosphate of alumina, an insoluble salt, being, as Liebig informs us, formed, and the phosphoric acid, so essential to the system, not assimilated. It is probably chiefly to this cause that the so-called pure white bread is insufficient in itself to support life; and, as again suggested by Liebig, this circumstance will probably explain the reason that foreigners find English bread so indigestible. To the soldier or the labouring man, the black bread would seem, therefore, to be preferable in every way. To the former, in time of war, it is, besides, most easily procured.

The same plan, which is the only efficient means of saving for a large community in times of scarcity, is also the best to adopt, even in more prosperous periods. Liebig informs us that, in many parts of Westphalia, the entire meal, including the bran, is baked in a species of brown bread called the “pumpernickel”; and he adds, that there is no country where the digestive organs in a population are more healthy.

Other means have, however, been suggested. In the experiments of the French Academy, gluten was found to be alone capable of supporting life. We have already explained the reason of this to be its impurities; but as it occurs seldom, if ever, in commerce in a pure state, it must be looked upon as one of the most nutritious of the ordinary vegetable substances prepared. Liebig has directed attention to a source whence it may be procured in large quantities, and, at the same time, at a very cheap rate. In England, many cwts. of the best and finest flour are employed in the manufacture of cotton goods; the starch being extracted for dressing these, while the gluten, which forms the refuse, is for the most part lost for the food of man. This gluten constitutes from 12 to 20 per cent. of the weight of the dry flour; and, used in combination with flour of inferior quality, it is clear it would form a very excellent and highly nutritious bread. (*Liebig's*

Letters.) Gluten bread, which is used for diabetic patients, mixed with but one-sixth part of starch only, is tolerably light, and moderately agreeable. (*Liebig's Letters.*) No doubt, therefore, an immense quantity of bread might be prepared from this source alone in England, and our manufacturers, with their cry of cheap bread, ought to produce us this requisite from what they waste.

There is yet another source whence a large quantity of bread might be obtained. Schlossberger made a trial of malt-dough (*maltzteig*), or upper dough (*oberteig*), of beer breweries, as recommended by Essig of Leomberg, as a substitute for flour. By these terms is understood, as is well known, the dough-like mass which is deposited upon the grains in the process of washing, and which is formed from the mealy portion of the malt. It contains from 4 to 7 per cent. of starch, and from 3.9 to 4.8 per cent. of nitrogen, indicating a much larger quantity of gluten than is contained in flour, and a considerable quantity of phosphates. (*Liebig and Kopp.*) This forms, in every respect, an unexceptional bread.

Rye bread, prepared with an addition of malt-dough, was found to contain from 3 to 4 per cent. of nitrogen, and from 50 to 52 per cent. of water. The bread appeared to keep well, and had not the slightest unpleasant taste (*ibid.*). The breweries of Bavaria alone produce 30,000 cwts. of this malt-dough annually; and 7 lbs. of it afford, according to Essig, 4 lbs. of bread. (*Knapp, quoted by Liebig.*) It is a question whether, in government contracts for bread for the troops, this should not be taken advantage of, whereby a cheaper kind of bread, and one containing nearly one-third more plastic matter, would be obtained. Its equivalent would probably be somewhere between 70 and 60, instead of 100 to 120; between which limits ordinary bread may be supposed to range.

Excellent edible bread might be procured, in many different ways, by the combination of peas, potatoes, and various less rich kinds of grain. The composition of each ingredient should be known, and where there is a deficiency in nitrogenous, combustible, or mineral ingredients, this might be remedied by the artificial addition of the required material. The ingredients might be, perhaps, more easily obtained from the animal kingdom. Thus it appears rational, in a case where we have a deficiency of salts and nitrogenous matter, as with many of the inferior sorts of grain, to add directly animal albumen or fibrine, it may be the serum of blood. The bread would then be very nourishing, and the material obtained from a comparatively cheap and abundant source; and, to the taste, there is reason to believe the bread so produced would be infinitely more agreeable than that sometimes formed by the admixture of oil-cake, or the raspings of hides. With vegetable admixtures, it is important to notice one fact,—the great advantage derived, in point of nutriment, by drying the vegetable substance before admixture. Take, for instance, the white garden cabbage. In its natural state its nutritive value is very low, its equivalent being 810; when dried at 212°, however, it is 95,—positively higher than wheat. Turnips, in like manner, in their natural state, have an equivalent of 1554; in the dry state, 106; and, in the subsequent admixture, they do not reabsorb as much moisture by a good deal, as they possessed originally.

An aliment which requires notice in this place, is the biscuit. Biscuit is much more nourishing, in every respect, than bread; this must needs be, since 100 lbs. of flour yield 132 lbs. of bread, but only 90 lbs. of biscuit. The principle in baking biscuit seems to be, to get rid of as much water as possible, so that, in relative proportion, the amount of, both combustible and incombustible matter is increased. In this manner an aliment is produced far superior to bread in many respects. That prepared by the commissariat abroad, where means are adopted to get rid of the water by compression with heavy weights, at the same time as the thorough admixture of the mass is ensured, is unexceptionable; and biscuit so prepared will keep for years. It might be laid an indefinite time in simple barrels.¹

From what has preceded, the incorrectness of Dr. Prout's views on the value of bread made with lignine is at once apparent. If lignine be digestible, it can only be so when in a very minute state of division; but as it does not contain any nitrogen, it cannot support life. The following is the composition of lignine:

Willow lignine, ordinary temp.	42.7 carbon	57.3 hydrogen.
Ditto, at 300° to 350° F.	42 „	57.4 „
Box, at ordinary temp.	50 „	50 „
Ditto, at 300° to 350° F.	49.8 „	52 „

Whence it appears that lignine, at best, can only be reckoned as a combustible aliment, if an aliment at all; by probable conversion into sugar. Pereira, however, does not believe this; as the husk of fruit, which is lignine in a minute state of division, is indigestible, and seems only to act as a slight laxative. If, therefore, the lignine has nourished animals at all to whom it has been given, it can only have done so from the presence of starchy saccharine, or other alimentary matters intimately mixed with it, and from which it had been but imperfectly separated.

II. In reference to meat and its substitutes, the extract of meat and preparations from blood, it may be said, generally, that the alimentary properties of these are greater than those of bread. Playfair has shown that the compositions of dried meat and blood are identical. In the natural state, however, this is not exactly the case. Muscular flesh always contains an excess of acid, that acid being phosphoric acid: blood, on the other hand, contains an excess of alkali; but the acid may consist in great measure of carbonic acid, instead of phosphoric acid, if the food have been green vegetables, fruits, etc.

Meat may be considered as the essence of vegetables, its nutritive qualities being more concentrated, if I may use the expression; in evidence of which, apart from its chemical analysis, we have the anatomical conformation of the intestinal canal in carnivora, by the very reason that their food requires less digestion, much shorter than in the herbivora. Meat has a nutritive equivalent of 48, wheat being 100, in its dried state 15, so that in its natural state it may be considered as more than twice, in its dry state nearly seven times as nutritive as wheat. In its purely lean state, as a combustible equivalent, it is

¹ The nutritive equivalent of biscuit is 87, the combustible 78, in both cases much higher than bread. But by increasing the quantity of gluten, or using the malt dough, even the nutritive and combustible equivalents might be increased, so as to equal probably the richest animal productions.

nearly expressed by 325, wheat being 100, and therefore rather more than three times less valuable in this respect than wheat. In its dry state, however, it is superior to wheat, being 88, while wheat is 100.

The subject of preserved meats has lately been so prominently before the public, that it can scarcely be passed over in this place. Indeed, the revelations of the daily journals, and the government board of inquiry, have sadly poisoned the public mind against their employment. The subject, however, now appears in a different light before us, having lately been so lucidly explained by the editor of the *Medical Times and Gazette*; to whose leading article I cannot forbear alluding. It would appear that the utmost that can be urged against Mr. Goldner is a little carelessness, if even that. In a late return, moved by Mr. Miles, it is stated, 2,741,988 lbs. have been issued to the navy, since the contract with Goldner, up to January 7, 1851. Out of this number, 2,613,069, or 95 per cent., have proved fit for use, only 19 being rejected from containing so-called offal (which was, however, only undigested food); the remainder were so from the putridity of their contents: the price at which these were issued being 5d. per pound, and we are informed by the editor that the same could now be supplied at 3d. per pound. There is nothing repugnant in pieces of heart, roots of tongues, palates, or liver, which some canisters contained. Many esteem these as luxuries. The putridity of the meat in others is rather to be attributed to the carelessness of those who stored them away in Her Majesty's ships. To knock about the canisters, the contents of which only could have remained good so long as a vacuum surrounded the meat, was precisely the way to admit the atmospheric air: and, further, to expose iron canisters, which in parts might have been inadequately tinned, in damp situations, was the best method to insure the rapid rusting, subsequent breaking down of the canisters, the consequent admission of atmospheric air, and the rapid putridity of the meat. And yet the process is one which is, after all, most simple; and the boon thereby conferred on our navy especially, or it might be on our poor, in lieu of salt meat, and many other less nutritious articles of food, is immense.

It is the peculiar property of all organic substances to putrify when exposed to an atmosphere containing oxygen, not too cold in temperature, and not such as to freeze the meat. This process of putrefaction is, after all, one of fermentation, under the influence of which the elements of these organic substances undergo the chemical changes which were, during the life of the animal or vegetable, impeded by *vitality*. This fermentation, however, is prevented, indeed annihilated, by heating the substance to the boiling point. Most ferments have a constitution analogous to albumen, and at a higher temperature pass into a new state. The process is thus described by Liebig: "The prepared aliments are enclosed in canisters of tinned iron plates, and covers are soldered on tight, and exposed to the temperature of boiling water. When this degree of heat has penetrated to the centre of the contents, which it requires about three or four hours to accomplish, the aliments have acquired a stability, which we may almost say is eternal. When the canister is opened, after the lapse of several years, the contents appear just as if they had been only recently enclosed. Housewives make use of this method in preserving green vegetables through the

winter. This method of preserving food will become of the greatest importance in provisioning fortresses, since the loss incurred in selling off old stores, and replacing them by new, is far more considerable than the value of tin canisters, which, moreover, may be repeatedly employed, by being carefully cleansed." (*Liebig's Letters*, p. 228.)¹

It has been well remarked by the editor of the *Medical Times*, that although there may be some blame attached to Goldner, in some minor points, still he is entitled to our thanks, for having directed attention to this source of procuring a most useful article of consumption, and one well calculated to do immense good to thousands of our fellow-creatures. For when we look at the large supply that may be obtained from Moldavia, and the cheap price at which it may be purchased, it is no small advantage gained to be able to avail of it. The editor informs us that the meat of the oxen and cattle which abound on the Danube in Moldavia, costs absolutely nothing on the spot, as the price obtained in Turkey for the hide, horns, hoofs, and tallow, more than pays for the value of the animal. (*Medical Times and Gazette*, p. 265, No. for March 13, 1852.)

A plan has been lately recommended by the French, which it is supposed, might be advantageously employed in the preservation of meat. The vapour of chloroform, unmixed with air, is perfectly antiseptic: as such, it might be very easily superadded to the plan usually followed, and substituted for the vacuum around the meat. Mr. Richardson, of Mortlake, has likewise made the ingenious suggestion, in a communication read before the Medical Society of London, of substituting nitrogen in lieu of the vacuum around preserved meats. The specimens of pathological preparations so preserved, appeared perfectly unchanged after a lapse of several months. It remains yet to be proved, if the experiment will prove equally successful for years. In so far, however, as the abstraction of oxygen is concerned, this is well effected, either by the substitution of the vapour of chloroform or nitrogen.

The remarks above made for preserved meats, apply with equal force to preserved vegetables. The advantage in a sanitary point of view would be immense, since it would effectually remove that scourge among mariners, scurvy; which, even in the present well-devised improvements in the navy, has not been yet thoroughly eradicated. The experiment has already been tried, in the expedition in search of Sir John Franklin, with potatoes, and proved perfectly successful.

¹ The ingenious Soyer has already offered his opinion on this process, and few, as proficients in the culinary art, are better able to offer one than he is. His suggestions are so simple and valuable, that I shall be pardoned for bringing them prominently forward. 1. The meat selected should be good of its kind, and the preserved should not, if it were possible, be prepared in summer. 2. The meat should not be too fresh, but allowed to cool before submitted to the process for preserving. 3. Each canister should not contain more than six pounds of meat, and as many ounces of fat. 4. The contents of each canister should be slightly seasoned with the following ingredients:—bay salt, pepper, thyme, bay-leaf in powder. 5. No other vegetable but a few sweet herbs should be used, which will give a good flavour without provoking fermentation, and no jelly be added to the meat, which should be left to produce its own gravy. 7. Every part of the atmosphere should be allowed to escape while under the process of ebullition in the bath, till the vapour has finally ceased to ascend through a small pin-hole left for that purpose, before the canister be finally sealed.

It is unfortunate, then, for the British government, that the preparation of these stores had not been rather placed under its own superintendence; and that a wish, otherwise laudable, not to interfere with private commercial speculations, should have proved in its application so unfortunate. There might have been at the onset some additional expenditure, yet in the end a real saving; and it would seem but natural to conclude that, in such an arrangement, justice would more certainly have been rendered to the government by their own officers, than by commercial speculators here; who, however honest in their intentions, could exercise no control over those on whose good faith they were compelled blindly to rely.

1. The advantage of meat over vegetable food is, as we have seen, that it contains in a given weight much more nutritive matter; meat being, as it were, the essence of vegetables. An essence or extract of meat would thus contain, in a still smaller weight, all the nutritive properties essential to the maintenance of life; and, if mixed with a little fat, all the nutritive and combustible properties to be desired. Unfortunately, a complete extract of meat, which could be redissoluble in water, cannot be easily made, owing to the insolubility of its fibrinous elements.

The following account, abbreviated from Knapp and Liebig, is subjoined, as explanatory of these changes. When flesh is very finely divided, and repeatedly extracted with cold water, all the soluble matters are removed, and a perfectly tasteless, inodorous, residue is left, which is in every case white like flesh. When boiled, a precipitate is thrown down, which is coagulated albumen. It consists besides of lactic acids, inosinic acid, creatine, creatinine, a nitrogenous organic acid, which forms a pellicle on the surface like casein, though differing from it in many other respects. There are several other constituents, not very clearly made out, besides lactates of potash, phosphates, especially of the alkalies, a little lime, more magnesia.

Dried flesh will, on an average, yield only from 12 to 13 per cent. of extract of meat. (*Liebig*.) 100 lbs. of ordinary meat, (*i. e.*, not dried), therefore, will yield 4 lbs. of extract of meat, since 75 per cent. at least of the meat is water.

By lixiviation of dried meat with cold water, from 16 to 24 per cent. of it is taken up, and what remains behind, or fully three-quarters of it, is *fibrine*. In the process of boiling, the albumen coagulating at 133°, and the colouring matter at 158° Fahr., these two substances are removed. The proportion of albumen varies from 1 to 2 per cent. in old animals; but in young animals it may vary from 12 to 14 per cent. (*Ibid.*)

In making the extract, therefore, it is desirable that the temperature should not be raised, either of the water during lixiviation, or of the juice of flesh which is evaporated, beyond 120° Fahr.: and in this manner about 20 per cent. will be, on the average, the quantity furnished by the dried meat; 6 per cent. by ordinary fresh meat, the whole albumen and colouring matter being retained.

The extract prepared by Mr. Robertson, of Manchester, is made upon this principle. It consists entirely of the albuminous and saline portions of the juice of flesh extracted cold, and by a peculiar arrangement of the evaporating process, obtained in the form of a dry powder,

with a very limited application of heat. It is estimated that one ounce of this dried extract contains the whole of the nutritive properties of one pound of solid meat; a statement which is probably in some measure exaggerated, if we look to the explanation above given of Liebig's process as correct. (*Lancet*, 1852, for Jan. 7, 10, and March 27.) The disadvantage of this extract is in the entire removal of the fibrinous portion of the meat, and in the diminution of salts. The whole of the flesh might, however, be appropriated. Fibrine, when separated from blood in its natural state, possesses the characteristic softness and elasticity of flesh, and contains about three-fourths of its weight of water. It may, however, be artificially deprived of its water, and then becomes a hard and brittle substance; in which state it may be ground and reduced to powder. By the incorporation of this powder, intimately mixed with the extract, and in proportionate quantity, we shall obtain an artificial meat, as it were, differing from meat only in the smaller bulk it occupies, from the absence of water; four ounces of which would be equivalent to one pound of meat.

2. Fibrine, in its ordinary state, is insoluble in water; when boiled, however, for a long time, under water, its nature is altered, and it becomes soluble. Mixed with the juice of flesh in this state, it might be easily incorporated with it.

3. There is another way in which this desideratum in the extract of meat might be obtained. We have seen that while fibrine, casein, and albumen, are identical in chemical composition, and readily convertible one into the other, fibrine is, of all three, perhaps the most indigestible. The substitution of either of the other two proteinaceous substances, might in this manner prove very beneficial. The serum of blood is at once a source whence albumen might be derived in large quantities, and at a very cheap rate.

4. By the addition of the gluten from flour, before spoken of, a substitute for the fibrine could be made; and gluten, as obtained in commerce, is of all simple substances, that which is capable, even when given alone, to support life.

An intermediate course would be, to add pemmican or the raspings of dried flesh to this extract.

These varieties of extract of meat might be distinguished under the names of the *fibrinised*, *albuminised*, and *glutenised* extracts. The extract, without these additions, as the *simple* extract.

The simple extract of meat, obtained after lixiviation with cold water, has the same composition in all animals, whether it be prepared from pork, beef, venison or poultry, excepting only that each preserves the peculiar flavour of the animal whence it was procured. This fact is not without importance in its application. Many animals, hitherto rejected for alimentary purposes, might be employed in times of scarcity. The toughness of the flesh in many of those which are usually not eaten for this reason, depends on the fibrine present, and which constitutes the chief ingredient of their flesh. A judicious admixture of the extracts of meat from several different animals might be made, the various flavours of which might be covered with a larger quantity of one of those usually most in favour, such as hare or venison, and in this manner the extract made be palatable, cheap, and nutritious.

"But even the simple extract contains the several conditions necessary for the formation of the whole muscle; since in the albumen we have the transition product to form the fibrine of the muscle, and, with other products, the matters required for the production of cellular tissue." (*Liebig*.) These remarks apply with equal force to the fibrinised and albuminised products; besides, most of the constituents of extract of meat are very rich in nitrogen, kreatinine, and kreatine; of which substances, two, we have seen, are highly nutritious, 9 parts of the former, and 6 of the latter, being equivalent to 100 parts of wheat.

The simple extract of meat is probably slightly inferior to meat in salts. The difference in the latter is well set forth in the following table from *Liebig*.

	Ashes of flesh (dry).	When heated, there enter in the soup.	And there remains in exhausted meat,
Phosphoric acid	36.60	26.24	10.36
Potash	40.20	35.42	4.78
Earth and oxide of iron . . .	5.69	3.15	2.54
Sulphuric acid	2.95	2.95	
Chloride of potassium	14.81	14.81	
	<hr/> 100.25	<hr/> 82.57	<hr/> 17.68

The soup contains 0.46; the residue, 1.42 of phosphate of iron. The addition of the serum of blood, so as to constitute an albuminised extract of this soup, would at once, by the addition of the salts required, make the extract, in this respect, equal to meat.

The great advantage to be derived from extract of meat by the hospitals of armies, has been strongly urged by *Liebig*, but, it is to be feared, without attracting the attention of our government. "In the supplies of a body of troops," says *Parmentier*, "extract of meat would offer to the wounded soldier a means of invigoration which, with a little wine (the combustible element), would instantly restore the powers exhausted by great loss of blood, and enable him to bear being transported to the nearest hospital." "We cannot," says *Proust*, "imagine a more fortunate application. What more invigorating remedy, what more powerfully-acting panacea, than a portion of genuine extract of meat dissolved in a glass of noble wine? The most *recherché* delicacies of gastronomy are all for the spoiled children of wealth; ought we, then, to have nothing in our field hospitals for the unfortunate soldier, whose fate condemns him to suffer, for our benefit, the horrors of a long death-struggle amidst snow, and the mud of swamps?" (*Liebig's Letters*.)

Apart, however, from its use among the sick, it might prove of singular advantage to the soldier in many harassing marches, combined with alcohol or oily matters; and this remark applies with double force to the other varieties before alluded to. The amount of extract of meat that could be procured, and made subservient to the purposes of mankind, is something extraordinary. *Liebig* has drawn attention to the nominal value of meat in Podolia, Buenos Ayres, Mexico, and Australia, where thousands of cattle and sheep are boiled down to obtain the fat, the nutritious part of the meat being absolutely thrown away as useless. I have made the calculation for Australia:

upwards of 700,000 lbs. of simple extract might be annually preserved, or enough to keep an army of 30,000 men for a year; or, if the fibrinous or albuminized extracts were preferred, as much as 83,000,000 lbs. might be procured, or enough to keep an army of 360,000 men for a twelvemonth,—the ration being fixed at the rate of 10 oz., as the equivalent of 2 lbs. of meat. It is hoped, in this way, it might be obtained at a less exorbitant rate than that at which it is offered at present for sale, viz. 8s. a pound.¹

An excellent combination of the extract of meat and biscuit would be found in Borden's patent meat-biscuit: 1 lb. of this substance, it is alleged, contains the nutriment of 5 lbs. of the best beef. Its preservative qualities have been fully tested by its being carried to California, across the Plains, from New York to Canton and back, and other long voyages. The reports from Colonel Sumner and Surgeon Wright, of the United States' army, fully confirm its value as a nutritive agent. The opinions of Colonel Sumner, in so far as they apply to the advantage of this article for the supply of an army, are of so much practical value, that I may be excused for referring to it. From experiments upon himself, in which he restricted himself, for successive days, to this article, he concluded he could live upon it for months. He, however, could not use more than 4 oz. a day, made into soup, adding only pepper and salt, and was able, besides, entirely to dispense with tea and coffee:—"I have long thought," he adds, "*that the compression of food into a smaller compass, was one of the most important things that remained to be discovered in this age of inventions. Think of a regiment of 500 men cutting loose from all magazines for two months, with no other baggage than fifty or sixty packed mules, at 5 oz. a day for each man; the weight would be 9,375 lbs., which forty-five mules would carry.*" (*Lancet*, 27th March 1852.)

Assuming the statement here made, that 1 lb. of the meat-biscuit is equivalent to 5 lbs. of meat, this would give a nutritive equivalent of 14, and a combustible of 65; yet, theoretically, a meat-biscuit of even greater nutritive and combustible value might be procured. Assuming the biscuit to be prepared from the upper malt-dough, its nutritive value would be 61 instead of 87; mixed in equal quantities with Robertson's extract of meat, it would yield a variety of meat-biscuit with a nutritive value of 32·7, i.e., admitting the estimate of the value of the extract to be in the proportion of 1 oz. to 1 lb. of meat. In so far, however, as this rude calculation goes, there is, perhaps, reason to believe this statement of the nutritive value of Borden's meat-biscuit is exaggerated, unless, indeed, the proportion of extract of meat in the meat-biscuit be much greater than has been supposed. Besides, the Analytical Commission of the *Lancet* remarks, that the nutritive portion of the meat is extracted by heat, and that they are unable to

¹ The annual number of animals slaughtered in Australia is estimated at 96,000 sheep and 187,000 cattle. The weight of this quantity may be stated as follows:—96,000 sheep at 40lbs. each, 187,000 cattle at 400lbs.=748,394,000lbs. Deducting two-thirds for fat, bones, etc., we have 249,461,000lbs, which are equivalent to 83,000,000lbs. of the fibrinised extract, or 700,000lbs. of extract of meat. Fixing the ration at 10oz., the latter would make 11,200,000 rations, or enough to feed 30,900 for a year; the former would make 83,000,000lbs., or 132,800,000 rations, or enough to feed 363,000 men for a year.

state if the whole albumen is retained or not. In the latter case, its nutritive value would be diminished.

III. Prepared blood is an expression which might sound peculiarly offensive to some; and, it may be, create among a few a sort of religious objection, since by the Levitical law the blood of animals, by the Christian, of strangled animals, was forbidden to be eaten. Without wishing to enter upon the controversy at present, it may be presumed that where we have a composition in the dry state identical with that of meat, and in its natural state differing only from meat in possessing an excess of alkali instead of acid, in a Christian and enlightened land like this the objection can scarcely hold; especially as in the process of preparation, chemical and physical changes are brought about, by reason of which it can scarcely again be considered as blood.

The only aliment which we are in the habit of preparing from blood in Europe is the ordinary black pudding. This article of food is usually prepared by boiling grits in water, and then draining: hog's blood is then added, and intimately mixed with the grits. The whole being then duly seasoned with spice, fat is added. The liquid is then poured into skins, which, closed at both ends, are perforated with pins and boiled for an hour.

In this process it is clear the whole nutritious matters of the blood and oats are retained. It is, in fact, a sort of *vegeto-animal* aliment. In the stirring up the fibrine is separated, it is true, from union with the blood, but remains intimately connected with it. Thus we have the fibrine and albumen and all the salts remaining, while the admixture of fat supplies the combustible element in which blood is not necessarily rich. The addition of the grits supplies a certain excess of phosphoric acid to neutralise the predominance of alkali in the blood, thus rendering it not only more palatable, but more adapted to the formation of muscular fibre. There is certainly an objection in the coagulation of the albumen, which is thereby rendered more indigestible; but as an alimentary substance, the compound is complete in all the requisites. The cheapness, moreover, of this article of food, and the small space in which it could be packed, are circumstances which should tend to enhance its value among military and naval supplies; while by varnishing over the surface of the skins, or completing the boiling process in canisters instead of skins, and hermetically closing them afterwards like preserved meats, they might keep for an indefinite period.

There is an advantage which animal possesses over vegetable food, rendering it peculiarly useful to a soldier or sailor, whose occupation imperatively requires occasionally that they should be exercised as fighting men. 1. It is well known that the slightest movement of a muscle cannot occur without a necessary waste, as it were, of the muscular fibre. Animal food being especially rich in fibrine, or its transition products, such as albumen and caseine, will best and most readily supply this waste. 2. Besides, the influence of food extends to mental manifestations. "It is certain that three men," says Liebig, "one of whom has had a full meal of beef and bread, the second cheese or salt-fish, and the third potatoes, regard a difficulty which presents itself from entirely different points of view." Carnivora

are in general stronger and bolder than herbivora: in like manner animals who live on vegetable food, especially the inhabitants of warm climates, are more cowardly and indolent than those who live more exclusively on animal diet, as the American Indians, for instance, or generally the inhabitants of cold climates. Animals may be made more courageous or ferocious by animal food. "A bear kept in the anatomical department of the Giessen University, exhibited a very gentle character as long as he was fed exclusively on bread. A few days after feeding with flesh he became very prone to bite, and was even dangerous to his keeper. It is well known the *vis irascibile* of swine may be so exalted by feeding them with flesh, that they attack men." (*Liebig*.) Hounds kept for hunting wild and ferocious animals are fed exclusively on animal food, usually raw, which last condition has been stated by some to encrease ferocity to a greater degree than cooked meat. It is remarkable that in the prophecy foretelling universal happiness in this world during the millennial era, it is specially stated that "the lion will eat grass with the lamb"; and the comparative antediluvian tameness of animals of all kinds, such that Noah could collect them in an ark, may be in like manner attributed to the same circumstance, that before the deluge, all animals lived exclusively on vegetable diet: Animal food appears therefore to be a *sine quid non* to a fighting man.

III. The *extract* of milk is a substance which has but very lately been brought into general use. Prepared, I presume, by a process analogous to that of *Liebig's* extract of meat, it seems to possess all the attributes of milk. The best preparation appears to be Moore's concentrated preserved milk. The strength of one part of the extract may be considered as equivalent to seven of milk, since the artificial milk is prepared by mixing one spoonful of the extract with six of water. This artificial milk, chemically analysed by Mr. Urey, of Ham-burgh, has been found to possess all the properties of genuine milk. After its preparation it will in a few hours quickly throw off cream, and by agitation yield butter, by acids curds and whey, and it is applicable to all culinary purposes. For the sick, or for a sea voyage, this concentrated extract possesses the very greatest of advantages. Indeed, it has been used extensively in the voyages to the Arctic regions, and with the best advantages, about nine ounces being equivalent to two pounds of meat. Its nutritive value is 15, and its combustible equivalent 133, wheat in both cases being 100.

There are some other articles of food which have been introduced among naval stores of late, and which cannot be too strongly recommended. These are the artificial extracts of coffee and cocoa, and a third might be conveniently added, the extract of tea.

These substances, in their composition, are very analogous to extracts of meat, the active principles, theine, caffeine, and theobromine, closely resembling creatine. The salts are also very similar, cocoa containing most phosphoric acid—all containing albumen, fibrine, or caseine, besides oily (or starchy) matters. That they serve the purposes of strong soups in some countries, is evidenced by the fact that thousands who are deprived of animal food nourish upon them: and it will be at once apparent how advantageously for army and navy purposes, concentrated extracts of these substances might be employed.

Under circumstances of emergency they might, like the meat biscuit and the extracts of meat, prove invaluable; occupying, if packed up in tin cases, a very small space, and admitting of being kept for an indefinite period.

From the preceding considerations, the following practical conclusions in reference to the question before our naval and military authorities may be made.

1. That in the supplies of troops and mariners, especially in time of war, black bread should be selected, as more nutritious, more wholesome, more easily procured than white bread.

2. That as an aliment biscuit is superior to either, and as such might be more often employed.

3. That if possible, the bread and biscuit should be made with upper-malt dough and flour, as being then more nutritious.

4. That preserved meats, similar to those introduced by Mr. Goldner, should continue to be issued; care only being taken to ensure their careful preparation, if necessary, under Government control, and means adopted to prevent their being carelessly stowed away in damp places.

5. That measures should be adopted to encourage the manufacture of meat biscuit, extracts of meat, for field and hospital service, and for provisioning fortresses, especially in time of war.

6. That in the supplies served out to the navy, especially in addition those enumerated above, it would be well to conjoin prepared extracts of blood, milk, coffee, tea, cocoa, etc., and preserved vegetables for more general use.

19, Dorset Square, May 1852.

AN INQUIRY INTO THE *MODUS OPERANDI* OF THERAPEUTIC AGENTS UPON THE HUMAN FRAME.

By R. HUTCHINSON POWELL, M.D.Lond., etc.

“Les observations au lit du malade sont le fondement de la science, mais elles ne suffisent pas et donnent lieu aux plus grossières erreurs. De même que la physiologie éclaire l'histoire des maladies, de même les recherches chimiques, les expériences faites sur les animaux, en fournissant les moyens d'étudier les modifications que le médicament produit ou subit et les changements qui en résultent dans l'activité des divers organes, font connaître les vertus essentielles du médicament. C'est la route que la science doit parcourir.”

THIS extract, taken from a French Review, aptly represents the tendency of modern investigation; with what propriety, or leading to what result, the future must decide. The safe course, however, would appear to be a resolution to carry out that eclectic system in medicine, successfully pursued in other partly intangible sciences. The search after the *origin* and *cause* of natural phenomena has been wisely abandoned; one being satisfied, after close observation of these operations, to determine the laws by which they are governed, and the necessary conditions without which they cannot be developed.