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Read before the Philosophical Society of Glasgow, April 17, 1878.

THE

CONSTITUTION OF MALT LIQUORS,

AND THEIR

INFLUENCE UPON DIGESTION AND NUTRITION;

A PAPER

BY

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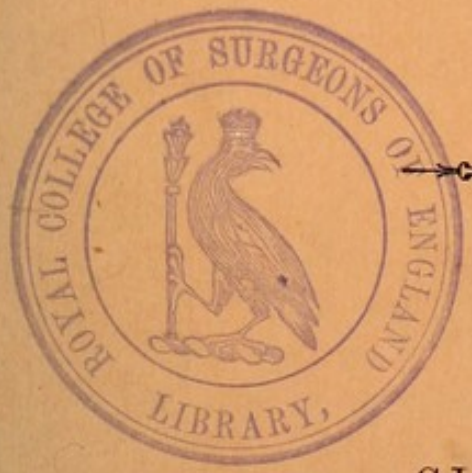

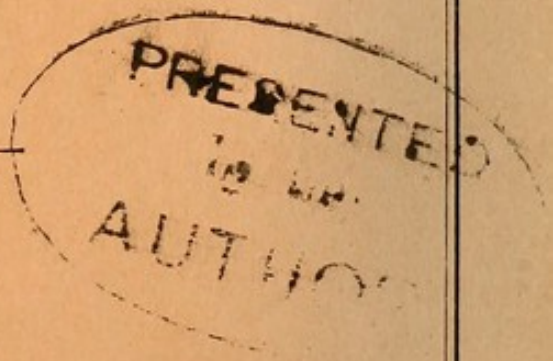

GLASGOW:
PRINTED BY BELL & BAIN, 41 MITCHELL STREET.
1878.

The Constitution of Malt Liquors and their Influence upon Digestion and Nutrition. By J. J. COLEMAN, Esq., F.I.C., F.C.S.

[Read before the Philosophical Society of Glasgow, April 17, 1878.]

A LIQUID resembling in appearance British porter, and labelled Malt Extract, has been sent to us from Germany during the last few years. It is retailed by pharmaceutical chemists.

Some remarkable statements are set forth by Joh. Hoff, the vendor of this preparation. It is affirmed to have been in use in nearly all the royal courts of Europe; that it has been honourably mentioned by four emperors, four kings, and a dozen or two of royal princes; and that it is sold by upwards of five thousand agents, and in all parts of the European continent. Our esteemed President, Dr. Fergus, brought it under my notice about twelve months ago, and acquainted me with the fact of its having in many cases coming under his own observation proved of service in restoring the energies of individuals suffering from faulty nutrition.

Suffering at that time from an attack of bronchitis, which had not only reduced strength, but brought on extreme exhaustion from inability to appropriate food, I tried the effect of Hoff's malt extract, in the usual dose of a wineglassful twice or three times a day. Its use was followed by marked effects,—1st, Food which had hitherto been found to pass the alimentary canal unchanged digested properly; 2nd, There appeared an increased power of evolving animal heat and storing up fat.

Passing beyond personal experience, I have experimented with it in other directions, particularly upon thin, cold, and aged people, who are unanimous in attributing to the liquid sustaining powers which are not commonly observed with alcoholic liquors.

It was therefore with considerable interest that I undertook

its chemical examination. The mean result of a number of analyses showed it to consist of--

Alcohol, ...	4·00
Extractive matter, . . .	8·12
Water, ...	87·88
	100·00

On evaporating to dryness and incinerating, there was obtained of ash residue ·05 per cent., calculated upon the liquid.

The preparation is therefore a variety of porter or beer, as will easily be seen from reference to the analysis of a number of well-known beers. In appearance, however, it resembles porter rather than beer.

	Alcohol.	Extract.	Water.	Authority.
Hoff's malt extract, . .	4·00	8·12	87·88	Coleman.
Royal Bavarian bock beer, .	4·00	7·20	88·80	Kaiser.
,, Salvator ,, .	4·20	8·00	87·80	,,
London beer, . . .	4·50	5·00	90·50	Average.
,, porter, . . .	4·00	4·50	91·50	,,
Edinburgh ale, . . .	4·41	3·58	92·01	Paul.

In fact, it reminds one of the royal beers of Bavaria, the analysis of which it closely resembles. These beers were very lovingly dwelt upon by Liebig, who uses the following words :—"The beers of England and France, and for the most part those of Germany, become gradually sour by contact with the air. This defect does not belong to the beers of Bavaria, which may be preserved at pleasure in half-full casks without alteration in the air. This precious quality must be ascribed to a peculiar process employed for fermenting the wort—that is, fermentation from below—which has solved one of the finest chemical problems." Without committing myself to any hypothetical views upon the nature of the process which has evolved the product, or as to its identity or non-identity with those celebrated Bavarian beers, it may be remarked, that the liquid imported varies a little in its tendency to turn sour. Sometimes it will not do so if exposed for weeks; other samples have turned sour with but slight exposure.

Referring again to the analysis of the liquid, there are two points to which I wish to direct attention.

The word "malt extract" is by common consent of chemists applied to that portion of a malt liquor which either has not been

fermented into alcohol, or which, after fermentation, has *escaped* conversion into alcohol. Further, malt extract is a solid, and is obtained by evaporating the liquids containing it to dryness. It will be seen therefore that Hoff's liquid is something more than "malt extract," for it contains besides this body alcohol and the usual quantity of carbonic acid gas, which causes any ordinary fermented liquid to froth up when liberated from the bottles containing it. In fact, the presence of large quantities of carbonic acid gas in Hoff's liquid shows that its alcohol has been produced by internal fermentation. But, on the other hand, this liquid of Hoff's produces on evaporation to dryness an extract which differs from the solid extract usually obtained from British beers. Malt extract obtained from such sources contains a large percentage of crystallisable sugar, whilst that from Hoff's liquid is almost entirely constituted of the dark-brown uncrystallisable extractive matter present, but in less proportion, in the beers of this country.

It will therefore be convenient to call this preparation merely Hoff's liquid, rather than lead to confusion by retaining the name it is commonly known by.

With the information gained by its analysis, the question arises, To what constituents of Hoff's liquid are to be attributed its marked physiological effects? There are, no doubt, some people who will be inclined to say that the value of the liquid is its contained alcohol. There are, no doubt, others who would strenuously deny this. The question of the nutritive value of alcohol has been ably dealt with by, amongst others, two very distinguished men, viz., Dr. B. W. Richardson, F.R.S., and Dr. Edward Smith, F.R.S., —not from a theoretical standpoint, but from that of laborious experiment.

Dr. Edward Smith administered, either to himself or one of his assistants, weighed quantities of food, selected from the fatty, the starchy, or the albuminous articles of diet. He carefully noted the effect of these varied foods upon the function of respiration. That is, taking hold of the well-established principle that animal heat is produced by the oxidation of food by means of air drawn into the lungs, he collected and analysed the products of respiration with the view to ascertaining to what extent and how soon the carbon of the food is eliminated from the lungs in the form of carbonic acid.

It would be out of the question quoting all Dr. Edward Smith's results, which have been embodied in a number of papers read to the Royal Society; but this is what he says about brandy:—"One and a half ounce of excellent brandy diluted with six ounces of

water caused an average *decrease* of 0·2 grain in the carbonic acid expired per minute." In another experiment the average *decrease* was 0·38 grain. The quantity of air inspired fell 42, 37, and 34 cubic inches per minute in different experiments.

In regard to whisky he remarks, "One and a half ounce of whisky, containing forty-five per cent. of alcohol in six ounces of cold water, caused an average decrease in the carbonic acid expired of ·33 grain per minute." Let us compare these results with what was obtained from the same weight of sugar.

He says, "One and a half ounce of sugar dissolved in water gave a maximum *increase* in the carbonic acid evolved of 2·18 grains per minute, and an increase in the air inspired of 111 cubic inches per minute." We are thus shown that if by food is to be understood substance that acts as fuel to the system by being burnt into carbonic acid and water, then *no* chemical evidence can be obtained that alcohol has a right to be called food.

Let us turn now to the evidence of Dr. Richardson. He says, "It would be impossible for me to recount the details of the long researches, extending with intervals over three years, and which were conducted in my laboratory, to determine the influence of alcohol upon animal temperature. The facts obtained may be epitomised as follows:—The first effect of taking alcohol is the stage of excitement—viz., a rise of temperature of about half a degree, especially on the cutaneous surface. This might be considered as due to the combustion of alcohol. It is not so; it is in truth a process of cooling.

"During this stage, which is comparatively brief, the internal temperature is declining, and the reddened skin is so far reduced in tone that cold applied thereto increases the suffusion. It is this most deceptive stage which led old observers into the error that alcohol warms the body. In the second stage the temperature first comes down to its natural standard, and then declines below what is natural. In man this fall is represented by three-fourths of a degree. During the third stage the fall in temperature rapidly increases, and amounts in man to as much as two and a half degrees, and in birds to fully five and a half degrees. There is always during this stage a profound coma, and whilst this lasts the temperature continues reduced. The sleep of apoplexy and the sleep of drunkenness may be distinguished by a marked difference in animal temperature. In apoplexy the temperature of the body is above, in drunkenness below the natural standard of 98°. What," exclaims Dr. Richardson, "is the inference? It is that alcohol is not burned

after the manner of food which supports animal combustion, but that it is decomposed into secondary products by oxidation, at the expense of the oxygen which ought to be applied to the natural heating of the body."

This concensus of evidence, coupled with the general experience that the so-called warming up effects of a dose of alcohol, when taken upon an empty stomach, is followed by a reaction in about forty minutes, goes far to prove that the *permanent* warming up effects of Hoff's liquid cannot be owing to its contained alcohol. But supposing alcohol is not a direct food, may it not be a fat-forming food? This question has been dealt with by Dr. Richardson. He remarks in his Cantor Lectures, "Notoriously ale and beer fatten, but this fattening may not be due to the alcohol itself, but to the sugar or starchy matters which are taken with it."

Dr. Richardson evidently sees a difficulty here, *but* offers an *insufficient* explanation. In the latter part of this paper I will show how the difficulty can be dealt with, but meanwhile note what he says:—"Alcohol, when it is largely taken, unless the will of the imbiber is very powerful, is wont to induce desire for undue sleep, or at least desire for physical repose. Under such circumstances there is an interference with ordinary nutritive processes. The wasted products of nutrition are imperfectly eliminated, the respiration becomes slower and less effective, and there is set up a series of changes tending, independently of the alcohol as a direct producer of fat, to development and deposit of fatty tissue in the body." Now this storing up of fat referred to by Dr. Richardson, which occurs with those who abuse alcoholic liquors, is a very different matter to the healthy nutrition which exists by one who has benefited by drinking Hoff's liquid in small doses, or from the daily swallowing of a glass of London porter. *There is* a distinct nutritive effect produced in some cases of this kind which cannot be attributed to the influence of the alcohol contained in the liquid. I have heard married ladies declare that whilst suckling their strength would have succumbed had it not been for the sustaining effects of a bottle of porter taken daily. Evidence of this kind, which I believe is very common, is most important. The maternal instinct is far too strong to leave in doubt a problem which so materially affects the welfare of her offspring. I am not going to argue that fatness is to be considered in all cases a desirable condition, but the very appearance of a score of beer-drinking Englishmen, as compared with an equal number of whisky-drinking Scotchmen, is an indication of some specific effect which malt

liquors have upon nutrition. Going a step farther in this inquiry, let us ignore the evidence of Dr. Edward Smith and Dr. Richardson. We have no right to do so, but for the moment let it be admitted that alcohol is a food. Let us take typical cases, on the one hand, of a person imbibing a tumbler of porter every day, on the other hand of a person swallowing Hoff's liquid daily, in accordance with the direction upon the label. The alcohol contained in the daily dose of Hoff's liquid will weigh about 100 grains, the extractive matter will weigh 200 grains. Without going into the minutiæ of chemical calculation, it may be stated that these substances contain about half their weight of carbon. Now, what proportion does this 150 grains bear to the total carbon consumed per day by an average man? Liebig, Playfair, and others have given us data. An average man consumes from 4,000 to 6,000 grains of carbon per day; so that the quantity contained in the daily dose of Hoff's liquid does not amount to more than three per cent. of one's ordinary daily diet. In the case of a tumblerful of London porter, containing say four per cent. of alcohol and five per cent. of extractive matter, the contained carbon would amount to about 200 grains, or about four per cent. of an average day's diet. But a more familiar illustration may be offered. The whole of the food value of a glass of porter cannot exceed *the weight of sugar equivalent to its alcohol or extractive matter, or about one ounce,* whilst most people consume three ounces of sugar daily, employed in sweetening tea, coffee, puddings, or fruits.

These figures, if we are to believe Drs. Smith and Richardson, show the food value of the liquids in too favourable a light, but even in the form I have just given them, they are utterly insufficient to account for their marked physiological effects, which are frequently the sensation of being lifted from a feeling of semi-starvation to the condition of being effectually warmed and nourished, and are incomprehensible from a chemical analysis of the liquids.

But although these liquids have no food value of any importance, may they not have the power of influencing the digestion of *other food?* If the extractive matter of beer and porter be really malt extract—that is, if it possesses the qualities of original malt—then the question is answered affirmatively. It is well known that if lukewarm water be poured upon fresh-bruised malt, a certain principle dissolves, which, from the difficulty of separating it in the pure state, has hitherto evaded chemical analysis. This substance, called diastase, is a ferment, being capable of converting an indefinite quantity of insoluble starch, through the stages of soluble starch and dextrin,

into the final product, glucose or grape sugar. The brewer knows perfectly well that one part of malt contains sufficient diastase to render soluble and convert into grape sugar the starch of four or five times its weight of barley. Indeed, the first stage of brewing beer or porter—viz., the preparation of the wort—is simply converting by the aid of diastase a certain quantity of starch into sugar, which dissolves in the warm water of the mash, and is then converted into alcohol by the process of fermentation by the yeast cell. When the starch has become entirely converted into sugar—an operation which requires that the temperature shall not exceed 180° Fahr.—then the wort is raised to the boiling point, the hops at the same time being added. The object of this operation is stated in our text books to be, first, the destruction of the diastase, which has served its purpose; secondly, the precipitation of albuminous compounds likely to interfere with the keeping qualities of the beer. The diastase is believed to be destroyed at the boiling temperature, and the liquid ready for a new fermentation by the agency of yeast, at least as soon as it cools down to the proper temperature for the second fermentation.

Hence it might be concluded *a priori* that it is impossible for malt liquors, as sold to the public, to contain diastase. It may be so, but the nature of these ferments are very obscure. It occurred to me that the extractive matter of our ordinary malt liquors might contain the element of a ferment in some latent form, ready to be called into activity during the process of digestion.

The importance of such an agent may be estimated, when it is considered that starch forms so large a proportion of the diet of man; that in its natural state, or even when boiled, it is not soluble in the sense of being capable of absorption through a membrane (although it may become pasty or sticky); and that before it can be absorbed by the assimilative organs it *must* become soluble.

Starch constitutes 47·4 per cent. of wheaten bread, 58·4 per cent. of oatmeal, 18·8 per cent. of potatoes, 66·3 per cent. of wheaten flour, 79·1 per cent. of rice, and 82 per cent. of arrowroot, so that the whole matter seems of sufficient importance to merit careful experiment. It is obvious that if malt liquors exert a solvent action upon starch, the phenomena can be investigated external to the stomach, provided the necessary temperature and other conditions of the animal digestion be imitated. Such experiments have been conducted, not only with Hoff's liquid, but with ordinary beers and porters.

The general method of procedure was to digest weighed quantities

of bread or potatoes with measured quantities of the liquid I wished to examine, at blood heat, for the required number of hours; fresh water was then added, to bring the bulk of the original mixture exactly to its initial measurement; the semi-fluid liquid was then either filtered or dialysed, and a fractional part evaporated to dryness, or examined in other ways to determine the total solids dissolved. Simultaneously with each determination a blank experiment was made with pure bread or potatoes and water, so as to ensure comparisons being made under precisely identical conditions.

The latter precaution was especially necessary, as scarcely two samples of bread are alike as to their soluble constituents. By digesting ordinary bread two or three days with warm water, it becomes soluble to the extent of ten or fifteen per cent., and in a short time becomes slightly putrid. Under such circumstances it is not unusual for the starch to become partially soluble by contact action with the decomposing gluten.

This fact was borne in mind most carefully from the very first, and in fact made the blank experiments absolutely necessary every time a fresh comparison had to be made.

Some of the experiments were conducted with ordinary beers and porters, as brought from neighbouring public houses; but I am indebted to the courtesy of Messrs. Bass & Co., Messrs. Allsopp & Co., Messrs. Truman, Hanbury & Co., and Messrs. Bates & Co., for samples sent me direct from their respective breweries.

Series I.

50 Grammes of bread were digested at blood heat for six hours with 250 cc. of water, and then dialysed into 500 cc. of water. A fractional portion of the dialysed fluid was evaporated to dryness, to determine the total solids, and another portion was examined volumetrically for glucose by the cupric test. This formed the blank bread experiment.

	Total Solids. Grammes.	Grape Sugar. Grammes.
A.—Blank bread experiment yielded . .	1·10	·40
B.—60 grammes of Hoff's liquid yielded by dialysing with the same quantity of water, ...	1·10	·36
Sum, . . .	2·20	·76
A and B mixed together, and then treated as in the blank experiment, . . .	2·20	·69
A and B mixed together, treated as in the blank experiment, but with the addition of a few drops of hydrochloric acid, ...	2·20	·68

These experiments were made simultaneously, and under exactly similar conditions, but the results did not give me any encouragement. They are, however, interesting in one point of view: they show what a small amount of crystalloids can be obtained from the dialysis of bread and water.

For a second series of experiments mashed potatoes were used; but in place of using Graham's dialysers, through the membranes of which dextrin will scarcely permeate, the semi-fluid masses were simply thrown upon a filter, no difficulty being experienced in getting perfectly clear filtrates.

Series II.

100 Grammes of mashed potatoes were digested for six hours at blood heat with 500 cc. of water, and then filtered—a fractional part of the filtrate, after dilution to the original bulk, being evaporated to dryness for the purpose of estimating the dissolved solids.

	Grammes of Dissolved Solids.
A.—Blank experiment, conducted as above, yielded .	4·86
B.—60 grammes Hoff's liquid yielded	5·00
Sum, ...	9·86
A mixed with B, and treated as in the blank experiment,	9·66
A mixed with B, and treated as in the blank experiment, but with a few drops of HCl extra, . . .	9·56

The results were again negative, and the matter was laid aside for some months. It then occurred to me that in all these experiments the conditions represented stomachic, but not intestinal, digestion. The digestion of the stomach is always effected by secretions which are acid, and it is essentially a peptic or albuminoid digestion.

With the exception of such action as may ensue from contact with the saliva, the starchy matters of the food in great part pass through the stomach unchanged, and do not become digested until they pass that organ and come in contact with the pancreatic and intestinal juices, which are always alkaline. Bread has generally an acid reaction sufficiently distinct to affect litmus. Malt liquors are invariably and still more decidedly acid; so that, independently

of the acid purposely added in some of my experiments, there must have been in all cases a decided acid reaction. It was therefore determined to re-commence these experiments *with a slight alkaline reaction*, as similar as possible to that of the saliva or pancreatic juice.

Series III.

50 Grammes of bread were digested at blood heat with 200 cc. of water, made faintly alkaline with sodic hydrate. The total dissolved solids were then estimated, after digestion for six hours at blood heat and filtration in the usual way.

	Dissolved Solids in Grammes.
A.—Blank experiment yielded	6·00
B.—60 Grammes of Hoff's liquid, exactly neutralised, yielded	5·51
Sum, ...	11·51
A and B mixed together, and subjected to the conditions of the blank experiment, yielded	16·33

For the first time there was clear evidence of the correctness of my surmises, 4·82 grammes of the bread became soluble by the agency of the Hoff's liquid, or about 20 per cent. of its constituent starch.

The semi-fluid masses were also dialysed, with the following results:—

	Grammes.
A contained of grape sugar	·26
B „ „	·39
Sum, ...	·65
A and B mixed together, and treated as in the blank experiment, yielded of grape sugar	·98

Series IV.

30 Grammes of bread were digested at blood heat for five hours with 300 cc. of water made faintly alkaline, filtered, and the dissolved solids determined.

	Dissolved Solids in Grammes.
A.—Blank experiment conducted as above, . . .	3·24
B.—180 grammes of public-house beer made neutral and evaporated, yielded	13·54
Sum, ...	16·78
A mixed with B, and then treated as in the blank experiment, yielded	19·00

It appears therefore that ordinary beer possesses a solvent power similar to that of Hoff's liquid, but to an inferior degree.

Series V.

30 Grammes of bread were digested for twelve hours at blood heat with 300 cc. of water made faintly alkaline, filtered, and the dissolved solids determined.

	Dissolved Solids in Grammes.
A.—Blank experiment, conducted as above, yielded .	6·22
B.—90 grammes of Hoff's liquid, made neutral and evaporated, yielded	7·50
Sum, ...	13·72
A and B mixed together, and treated as in the blank experiment, yielded	20·73
A.—Blank experiment, conducted as above, yielded .	6·22
D.—180 grammes of beer from a public-house, made neutral and evaporated, yielded	13·54
Sum, ...	19·76
A mixed with D, and treated as in the blank experiment,	23·30

In these experiments it is demonstrated that, with twenty-four hours digestion, 90 grammes of Hoff's liquid dissolved 50 per cent. of the starch of 30 grammes of bread, and that it requires four times as much beer to effect the same result.

Series VI.

Public-house bottled porter, examined in the same way, indicated six parts to be equivalent in solvent power to one part of Hoff's

liquid. This porter contained, however, only 4·7 per cent. of extractive matter.

These experiments were satisfactory; the quantity of sodic or potasic hydrate added was very minute, and regulated with the utmost care, to avoid communicating an alkalinity more than sufficient to imitate the natural alkalinity of the saliva. It was, however, thought advisable to eliminate doubts on this head by a series of experiments, in which the alkaline reaction was established by bicarbonate of soda, or tribasic phosphate of soda.

Series VII.

32 Grammes of bread were digested for twenty-four hours at blood heat with 300 cc. of water made alkaline by 1 gramme of bicarbonate of soda, and ½ a gramme of tribasic phosphate of soda, then filtered, and the dissolved solids determined.

	Dissolved Solids in Grammes.
A.—Blank experiment, conducted as above, yielded .	8·16
B.—90 grammes of Burton ale, neutralised and evaporated, yielded	11·50
Sum, ...	19·66
A and B mixed together, and treated as in the blank experiment, yielded	21·80
A.—Blank experiment, as above, yielded . . .	8·16
C.—90 grammes of London porter, neutralised and evaporated to dryness, ...	7·66
Sum, ...	15·82
A mixed with C, and treated as in the blank experiment, yielded	21·81
A.—Blank experiment, as above, yielded. . . .	8·16
D.—90 grammes of Wrexham ale, neutralised, yielded .	7·20
Sum, ...	15·36

	Dissolved Solids in Grammes.
A mixed with D, and treated as in the blank experiment, yielded	19·20
A.—Blank experiment, as above, yielded . . .	8·16
E.—90 grammes of Hoff's liquid, neutralised and evaporated, yielded	7·30
Sum, ...	15·46
A mixed with E, and treated as in the blank experiment, yielded	23·80

These experiments indicate as follows, the figures being calculated to avoid decimals, and to show the amount of starch in the bread which became soluble by the agency of the various liquors—the bread used in each case being of the same weight.

The Burton ale dissolved	15	per cent.	of the starch.	
London porter	„	40	„	„
Wrexham ale	„	26	„	„
Hoff's liquid	„	60	„	„

In an eighth series of experiments it was determined to eliminate all sources of error existing from the action of reagents upon gluten, by using pure starch, which would indeed have been used earlier had it not been that this investigation was purposely undertaken to solve a dietetic problem, the conditions of which are not the swallowing of pure starch.

Series VIII.

15 Grammes of starch mixed with 300 cc. of boiling water, so as to form a uniform paste, was made faintly alkaline with 3 grammes of bicarbonate soda, and digested at blood heat for twenty-four hours. The pasty mass was then diluted with water to 600 cc., and thrown upon a close filter of thick white paper. A fractional portion of the filtrate, which was brilliantly clear, was evaporated to dryness.

	Dissolved Solids in Grammes.
A.—Blank experiment, conducted as above, yielded .	5·18
B.—60 grammes Burton ale, neutralised, yielded . .	8·00
Sum, ...	13·18
A and B mixed, and treated as in the blank experiment, yielded	14·60
A.—Blank experiment, conducted as above, yielded .	5·18
C.—60 grammes of London porter, neutralised, yielded .	4·28
	9·46
A and C mixed, and treated as in the blank experiment, yielded	15·01

This last series of experiments is conclusive, and forms a fitting termination to this stage of the investigation, which has established a food value for malt liquors not generally understood. Chemically, of course, it is interesting to know into what substance or substances the starch is transformed, whether into ordinary dextrin, Bechamp's soluble starch, Dubunfraut's maltose, or ordinary glucose.

These are questions I do not purpose at present going into; but it may be remarked that the dissolved solids partook more of a gummy than a saccharine character. Neither have I been able to fix the limits of the reactions with any degree of certainty; but it is clear—and this, physiologically, is of the utmost importance—that there is a powerful solvent action exerted by all malt liquors examined, which, with the peristaltic and other muscular actions of the digestive organs, has probably been but poorly imitated by the laboratory experiments that have been undertaken.

Another very interesting point came out in this inquiry, viz., that it was not the ales richest in alcohol coming from our large breweries which afforded the best results, which may be explained in two ways,—either from the fact that in large breweries the diastase of malt is made to go as far as possible by using raw grain with the original malt—or secondly, as suggested by our Vice-

President, Dr. Wallace, from the excess of alcohol in strong ales precipitating the diastase before it reaches the consumer.

Before concluding this paper, I must remark that the possibility of malt in virtue of its diastase becoming a useful article of food was discussed many years ago. It was supposed that cattle could be made to assimilate their food better, and fatten quicker, by mixing with their ordinary diet a certain percentage of malt. Mr. J. B. Lawes conducted very elaborate experiments for the Board of Trade in 1866, on the relative values of unmalted and malted barley for stock. These experiments showed that, with healthy stock, the addition of malt to their food produced no more increase of weight than the addition of barley to which the malt was equivalent. But this is what might reasonably be expected. In a healthy state, neither man nor animal requires more digestive solvent than what is supplied naturally. But unfortunately a large percentage of our fellow-men, especially the inhabitants of cities, are not in a perfect state of health—nay more, vast numbers, from the wear and tear of life, are habitual dyspeptics, so that an innocent aid to nature is sometimes a daily necessity. On the other hand, there are many people whose tendency to develop fat, or secrete sugar in the form of diabetic urine, indicates at once that nature requires no assistance by the aid of such a ferment as diastase.

Lastly, a word or two as to the *alcohol* of malt liquors. We have seen, in the early part of this paper, that it has no claim to be called a food. It may be reasonably asked, Is it of any use whatever? I think so. It is a stimulant. It will be asserted by some that, so far from stimulants being of any use, they are actually unnecessary and hurtful. In truth, however, man's existence embraces a continual succession of stimuli, either physical or mental; and it will always be so, unless the system is brought to the dull level of the brute, that knows no stimulus but the stick of the drover. I have stood by a massive engine, with cylinders, valves, and gear all complete, and the motor power steam turned on, but which remained silent and immovable until a gentle *stimulus*, applied to the circumference of the fly-wheel, sent it magnificently into motion, ready to crush with its power the very agent which started it. So it is with the powerful liquid alcohol. Employed as a stimulant, it sometimes with a jerk sets into activity the deadened mechanism of the human body; but there its action ends, which can only be sustained by food, and alcohol is *not a food*. In brief, alcohol has its uses; but its per-

centage in some of the malt liquors I have been referring to might be safely reduced to lower limits,—indeed they could form more useful foods if their alcohol were reduced to just sufficient percentage to preserve their other constituents from becoming decomposed and useless.