Thesis
on the
Action
of Infused Beverages on Peptic Digestion

presented by
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On the Action of Infused Beverages on Peptic Digestion.

That infused beverages have a retarding action on digestion has often been asserted, chiefly on theoretical and clinical grounds, but the author is not aware that any number of experiments have been made for the investigation of this action. Indeed, Dr. Pavy*, in his work on Food, complains of the discordant statements made respecting the effect of Tea on the body generally and of the irregularities in the advice, given by members of the medical profession regarding its use. It was with the view of obtaining some degree of certainty about one factor in the action of these beverages that the following experiments were performed.

as to require no recommendation is shown by the figures in Table A, which are compiled from the Board of Trade returns, the Statistics of Population & other sources. From the former part of this Table, it is seen, that the consumption of Infused Beverages of all sorts, in the year 1881-1882, amounted to 6.14 lbs. of the raw material, for every man, woman & child in the United Kingdom, or to about 7 ounce per diem. The latter part of the Table shows figures, derived from the business returns of a large Temperance Public-House Company, owning 13 Public-Houses, in a town of about 170,000 inhabitants. These returns are for 11 months only, viz. 1st March 1881 to 31st January 1882. This part of the Table also shows the amount of beverage in gallons, produced from the 22,016 lbs. of raw material used and of the figures, referring to the amount of raw material used in the United
Kingdom be treated in the same way to ascertain the number of gallons of beverage, they represent; the enormous total of 1,234,635,277 gallons of infused beverages used in the year 1881-1882 is reached, giving 35.3 gallons per head for the whole population for that year or about 75 pint per diem.

The ingestion of such a quantity of fluid must have an effect on digestion, by its diluent action, & when the fluid contains, either dissolved or suspended, substances having a marked chemical or physiological activity, the effect must be greater & may be productive of inconvenience or even disease.

Two classes of complaints have long been attributed to the excessive use of infused beverages; 1st, a class, characterised by gastric symptoms, viz, flatulence, pain & nausea, with consequent palpitation, shortness of breath & nervousness; & 2nd, a class
caused by a true alkaloidal poisoning, with nervous symptoms, dizziness, noise in the head, & sleeplessness. Of these two classes of disorders, the first is chiefly found to occur among women of the lower orders, with whom, the teapot is seldom away from the fire, always brewing with constant additions of water—but rarely, if leaves, a thin liquid, which with little or no milk or sugar, they heartily drink in large quantities. The poor quality of the Tea, rich in tannin, & almost devoid of alkaloid, also aids in producing the action on the stomach.

The second class of complaints is found more among the higher grades of society & is caused as often by coffee as by Tea. The raw material is good in quality, rich in its essential principles, the infusion is strong & its astringency is reduced by a sufficiency of cream & sugar; every assistance is
given to the rapid absorption of the alkaloid its action on the nerve centres of it is on these, that the ill effects are produced.

It was to the investigation of the causes of the first class of complaints, that these experiments were directed. Owing to the difficulty of obtaining vivisection licenses, they were obliged to be performed as laboratory experiments with apparatus arranged to stimulate vital actions as nearly as possible. It is for this reason that the word "Peptic" is used in the title of the paper, rather than the word "Gastric", to indicate, that it is merely the chemical action of a certain quantity of a beverage, on the digestion of a certain quantity of meat, by a certain quantity of an artificial gastric juice, which is discussed in the paper, that the actions of the beverages on the vital processes of digestion, such as the secretion of the gastric juice.
its amount & quality, & the muscular movements of the walls of the stomach are, by the nature of the experiment, ignored. Despite this defect, by carefully arranging the experiments, results were obtained, which, by the correspondence of those obtained by various methods, show their credibility.

In experiments of this sort, it is requisite to make all the factors invariable, except two, the first with a known & controlled variability & from the variations, ascertained to be produced, by the variations of this, in the second variable factor, to deduce the results.

In the chief series of these experiments, the known variable factor was the kind of beverage used, the factor whose variability was to be ascertained was the amount of digestible organic matter produced in each case, by the digestion of a fixed quantity of meat, for a fixed time, with a fixed quantity of an
artificial gastric juice of a fixed composition, in the presence of a fixed quantity of the variable beverage. The Experiments of this series were called for the sake of reference "Peptone Experiments", from the unknown variable factor and are referred to by this name in the paper.

Another set of Experiments were performed, in which the unknown variable factor was the time required for the entire digestion of a fixed weight of hard-boiled white of egg, the known variable factor being, as before, the kind of beverage used, the invariable factors being otherwise the same as in the first series. The Experiments of this series were known and are referred to as "Time Experiments".

Further Experiments were performed, to ascertain the causes of the actions of the beverages, under varying special conditions.
Infused beverages are divided by Johnston into three classes, viz.,
1st the Teas or infusions of prepared leaves;
2nd the Coffees or infusions of prepared berries;
3rd the Cocoas, which are more properly soups or gruels than infusions, consist of prepared vegetable matters, mixed with water, after being ground to a paste or powder.

Of the first class, ordinary China tea is the chief example, the plant (Thea of various species) from which it is derived being cultivated in China for the most part, but also in India and British Burmah. Other "teas" are used in various parts of the world, viz Coffee Tea, made from the leaves of the Coffee Plant in the New Guinea Archipelago; I Mate or Paraguay Tea (Ilex paraguayensis) in South America. With these Johnston enumerates no fewer than 35 teas and tea substitutes in Chemistry of Common Life, Johnston, Edinburgh, Blackwood 1856, p 156 Vol.I
3 Chemistry of Common Life, p 198 Vol.I
use in various parts of the world. Of the second Class, Coffee with its adul-
peration, Chicory, are the chief examples though the latter is prepared from a
root & not from a berry. Johnston mentions along with these at least
19 species of plants, used as coffee substitutes; among others, the
roasted white peas or corn used as a substitute for coffee in this country
after the “Peterloo massacre” as a protest against the duty on that
article. Since the date of his book, a host of Coffee substitutes under
the names of “Malt Coffee” “Date Coffee” have been produced & under the
name of “Vegetable Matters used as Chicory” pay a duty & find a place in the
Board of Trade returns.

Of the third Class, the Cocos & Chocolates
made from Theobroma Cacao are
the characteristic Examples & but few
substitutes are named by the above
authority, the chief of these being the
Chemistry of Common Life pp.212-213 Vol I
Guarana (Paullinia sorbilis) used in South America*. Of the cocoa's prepared from the Theobroma, two classes are, chiefly, in use in Great Britain, viz., a class of preparations, in which stand 1 sugar are added to the ground body to act as a vehicle for the fat they contain in abundance, which make a thick infusion, and a second, in which most of the fat has been extracted from the seeds, which make a thin infusion, more like a coffee than the former class.

This long list of infused beverages found in use in all regions from those tropical lands, where Coffee Tea and Paraguay Tea are drunk by the inhabitants of Borneo, Tropical South America to the Arctic regions where the inhabitants of Siberia, their Samovars continually steaming to infuse their Chinese tea, & those of Labrador prepare a substitute from the Ledum latifolium, points Chemistry of Common Life, p. 229. Vol. I
to the fact that these beverages supply a want in the human economy, which shows itself whenever man is found & not only where the rigorous climate makes the beverage grateful for its heat alone. Examples of each of the three classes of beverages were subjected to experiment, those chosen being contained in the following list.

Of the "Teas", Mixed Tea, China Tea, Indian Tea, Green Tea, tea, infused with water made alkaline with Carbonate of Soda, Mate.

Of the "Coffees", Coffee, Coffee with Chicory, Arab Coffee.

Of the "Cocoa's", The preparation known as Schweitzer's Cocoa Lime, as an example of those from which the fat has been extracted, that known as Eggs Cocoa
(Cocoa cont.) as an example of those, which contain sugar, starch, chocolate, guarana. Infusion prepared from cocoa nibs, which is more properly a coffee than a cocoa.

Of these beverages, 5 were chosen as more important than the rest, viz. mixed tea, coffee, cocoa tina, efflorescent chocolate; to this list, water was added to give an experiment for comparison with those with the more active beverages. These six were subjected to experiment with 8 kinds of food, viz. coagulated albumen (hard-boiled white of egg), roast beef, boiled salt beef, lamb, boiled ham, roast fowl, fish (boiled haddock), and bread. The remaining beverages, being of less importance at any rate in this country, the experiments on their action on digestion were tried with white of egg only. Two experiments were tried, viz., on white of egg & roast
Beef, with undiluted digestive fluid to ascertain the effect of the presence of water on digestion. The raw materials of the beverages & the beverages derived from them had the following characters. The mixed tea contained Indian & China teas blended, but no green. The China Tea was sent direct to the Author, by a resident in Hong Kong & the Indian & Green Teas were obtained from the dealers. The Mate was a rough powder mixed with stalks & resembling coarse mustard, with an odour closely resembling that of Chinese tea. The Coffee was obtained ready ground & kept in a tin. When Chicory was used, it was added to the Coffee in the proportion of 1 part of Chicory to 4 parts of Coffee. In Arabia, Coffee is stated by Parry to be drunk in the form of an infusion of the raw bean but the beverage

* Food & Dietetics p.359
here called Arab Coffee was prepared, from the bean after the recipe given by the Arabian Traveller, W. G. Palgrave, which may be shortly given. The picked Coffee beans were slightly roasted, till they just began to crackle and turn reddish-brown; they were then broken into small fragments on a mortar and formed a coarse powder. The water, having been heated, the powder was added to it and the mixture brought just to the boiling point, and strained.

The Chryso requires no description and the same applies to the two sorts of Cocoa by Epp's & Schiwekens. The Chocolate was the ordinary Chocolate Mencor.

The Guarana was said to have been roasted swa in the form of a fine red brown powder and the Cocoa nibs were irregular fragments with a dark red colour and characteristic scent.

*Central and Eastern Arabia, Palgrave, 6th Edition, Macmillan. p 36-37*
In preparing these beverages, care was taken to follow, as far as possible, the ordinary culinary methods & the most approved recipes were obtained. The three typical beverages, with which the larger number of the experiments were performed, are the Mixed Tea, the Coffee & Effs Cocoa. The recipes for these were, 1st. For the Tea, 5 teaspoonfuls of leaves (25 gms) to the Teapotful (1 litre) of water; the boiling water added to the leaves & the mixture infused, by covering the vessel with flannel for 20 minutes. This gave a Mahogany coloured liquid with characteristic scent & a Specific Gravity of 1.001-24. The liquid became opaque, on standing, from the formation of a yellow precipitate.

2nd. For the Coffee; 6 teaspoonfuls (45 gms) to the Coffee potful (1.5 litres) of boiling water, the ground coffee being placed in a muslin bag & the water poured through it. The liquid was dark red brown in colour, not quite clear, but with the scent of Coffee; Specific Gravity 1.008-93
before filtering, 10.05.13 after filtering.

3rd. For Cocoa, the recipe was 2 teaspoonsful of Eagle Cocoa (21 grms), to the breakfast cupful (300 ccs) of boiling water; the cocoa to be simply mixed with the water; the beverage is ready. The result was a thick brown liquid, on cooling, the suspended matter separated out, leaving a yellow clear liquid, while globules of cocoa fat floated to the surface. It was very viscous when cold & filtered with great difficulty; specific gravity, before filtering 1.0152; after filtering, 1.008365.

These three beverages were further analysed by the following process, with the results shown in Table B. To the filtered beverages, Sulphoacetate of Lead in solution was added, which caused a precipitate to be filtered off. This precipitate was freed from lead by Sulphuretted Hydrogen & the filtrate, from the Lead Sulphide, evaporated to dryness & weighed. This residue contained chiefly the Sanny Acid or its modification
contained in the beverage & the weight per cent of this residue is that stated under the head of Tartrate Acid in the Table. The filtrate from the Tartrate of Lead was freed from Superfuscent Sub-acetate of Lead by Sulphuretted Hydrogen, filtered & the filtrate evaporated to dryness & weighed. The residue was treated with alcohol & the solution filtered. The alcoholic filtrate contained in solution chiefly the alkaloid, as was shown by the crystalline nature of the residue left on evaporation. The weight percent of this residue is shown under the head of alkalioid in the Table. In the case of Cocoa, the alcohol dissolved a good deal of sugar & hence the Theobromine is noted as impure.

The weight of the solids extracted by Alcohol, subtracted from the weight of the residue before its extraction with Alcohol, gives the weight of Salts & Extractives contained in the beverage. The volatile oils were also estimated but the process employed gave much too
Large results owing to the admixture of some water with the volatile oil. The percentage of solids contained in Tea (14.2%), is rather greater than that stated by Dr. Lethby* (10%.6%) to be the proper strength for Tea; this percentage in the case of Coffee approaches more nearly to the amount stated to be proper by Payen] 25% of the ground roasted Coffee, extracted by the water, or about 8.03 grms by 1 litre of water from 30 grms of Coffee. Than to the estimate of Dr. Lethby, which is equal to about 33% of the roasted Coffee.

Of the other beverages of the Tea Class, the same quantity, viz. 25 grms of the raw material, to the litre of Water, was used with the infusions, thus produced, in the cases of Chinese and Indian Teas closely resembled that from Mixed Tea and had the Specific Gravities of 1001.82 and 1001.07 respectively.

* Food & Dietetics, Pavy. p351
p do. p360-361
In the case of Tea, infused with Water rendered alkaline with Carbonated Soda, Johnston asserts*, but without giving any reason, that, 40 grains of dry Carbonate of Soda, to the pound of Tea, is the proper proportion to use in accordance with this. 15 grams of the salt was added to the litre of water before making the infusion. The resulting beverage was darker than that prepared in the ordinary manner & had a Specific Gravity of 1.001.6.
The infusion of green Tea was dirty yellow in colour, with a fragrant odour & a Specific Gravity of 1.004.38.
For the mate infusion, the boiling water was poured on the powdered leaves & after standing a few minutes, the liquid was strained off. It was greenish in colour, rapidly darkening on exposure to the air. It was very bitter, had a scent like inferior tea & a Specific Gravity of 1.002.366.

* Chemistry of Common Life p 211 Vol I
Coffee with Chicory (30 gms of the mixture to the litre of Water) gave a darker infusion with a sweeter taste than pure Coffee & a Specific Gravity of 1002.56. Arab Coffee made by the recipe on p. 14 gave a pale yellow liquid with a Specific Gravity of 1000.2.

Of the remaining Cocas, the Cocostria was made of the strength of one teaspoonful (4.5 gms) to the breakfast cupful (300 ccs) of boiling water, the powder mixed with the water. It gave a red brown liquid, on cooling the solid matters settled to the bottom & Cocoa fat rose to the surface. The filtered liquid was ruby coloured; Specific Gravity, unfiltered 1001.05, filtered 1000.32.

The Chocolate was made by the directions furnished with the Chocolate Pierre, viz, one of the semicylindrical bars, broken into fragments, to a breakfast cupful of boiling water (20 gms to 300 ccs). The broken chocolate boiled with a little water, till it was dissolved.
Then the rest of the water added & the mixture boiled for a minute or two. It formed a thick brown fluid; on cooling, the suspended matters settled & a large crop of globules of cocoa fat rose to the surface. Specific gravity after filtering 1016.9. The Guarana was used in the proportion of 15 grms of the powder to the breakfast cupful of boiling water; the powder simply mixed with the water. It gave a buff opaque liquid with an unpleasant bitter taste & a Specific Gravity of 1015.128.

The infusion of cocoa nibs was made of the same strength as the Guarana, viz, 15 grms to 300 ccs of water, & the nibs were infused in the water, for 1½ hours at a temperature 90°C. The resulting liquid was brown, almost clear, & on cooling, cocoa fat floated to the top, Specific Gravity 1001.68.

The Artificial Gastric juice employed in all these experiments had the
following composition
Bengers Liquor Pepticus, 20 ccs,
Hydrochloric Acid dilute, 12 ccs,
Distilled Water, to 100 ccs.
The dilute acid was the Volumetric Normal Hydrochloric Acid Solution, containing 3.65 grams of Hydrochloric Acid gas in the 100 ccs.
The Bengers liquor Pepticus is a yellowish fluid with an ethereal smell & acid reaction. Its boiling point is 93°C & its Specific Gravity varies from 992.38 to 992.769.
The acid was used in the proportion of 2 ccs. of the Normal solution in the 100 ccs. of digestive fluid for every hour the Experiment lasted.
The artificial gastric juice thus prepared was a pale yellow acid liquid, differing from the natural fluid among other particulars, in not rotating the plane of polarised light. * Specific Gravity from 997.48 to 998.039. On carefully heating the fluid

A cloudiness formed at 65°C. It became a precipitate at 75°C. The liquid began to boil at 93°C but the temperature soon rose to 100°C. If the liquid was now filtered, the specific gravity was found to be 1.015.936. The precipitate formed gave the Kanthoprotein reaction on boiling with Nitric Acid and thymol was albumenoid in nature. All the experiments were performed almost exactly by the same process, which will be fully described and for the sake of brevity will in future be spoken of as the "Standard Process." In cases where deviations from it took place, these alone will be described. The rest of the experiment will be said to have followed the Standard Process. In all the experiments, the most rigid exactness was aimed at in every detail, where measuring apparatus was used not merely similar pieces were used but as
far as possible the same piece in all the experiments, where several similar pieces had to be used, the most exact similarity possible was obtained.

In the Standard Process, the raw materials of the beverages, having been weighed out, with a balance turning with 0.5 milligrams, when loaded with 50 gms; of the water having been measured out, in each case with the same measure, the beverages were prepared as detailed above. The meat was next weighed out, 5 gms being used on each case. The meat was cooked before weighing, it was lean & free from sinew; the hard boiled white of egg, free from yolk of the bread from crust. Meat was minced by a sausage machine before weighing but fish, white of egg & bread were broken small with a fork.

The weighed quantity of meat having
been placed in a beaker. 50 ccs of digestive fluid were added to it & then 25 ccs of the beverage under examination. The beakers, for several experiments were usually in progress at the same time, were then placed in a water bath & in each beaker, a tube was placed & held in a stand; the nature of action of this tube will be understood from a reference to Figure I in which A is the beaker B the tube called, from its action & for the sake of a name, the "convection tube" & C is a pinchcock. The liquid, from the beaker, was drawn up into the tube, by sucking the air out through the small tube D, for closing the pinchcock, the liquid was retained in the tube & cooling there caused convection currents in the direction marked by the arrows, which could be traced by small particles being carried by them. These currents had
to some extent, the effect of the muscular movements of the stomach in aiding digestion by keeping up a continuous circulation of fluid through the meat. The convection tube in Fig. 1 is represented as dipping too deeply into the liquid; in practice it was dipped as little below the surface as possible.

The water bath, containing the beakers, was heated by a small flame, which was controlled by a mercury regulator in the bath, so as to maintain the temperature in the beakers, as close to 37.7°C as possible. The average temperature from all the experiments was 38.1°C, with 36.6°C + 38.8°C as the extreme temperatures.

Digestion was continued for 6 hours, for although 3 hours is usually given as the duration of gastric digestion, yet the process outside the stomach takes much longer. Dr. Beaumont in his experiments on
Alexis St. Martin found that if two similar pieces of beef were taken, one suspended in the stomach, by a string through the foræulis present in that subject, while the other was placed in one ounce of digestive fluid, withdrawn from the stomach & kept at 37.7° C, the former was digested & gone in 2 hours, the latter, not till 6 hours had elapsed. On this account, therefore, to obtain larger figures to deal with, the process of digestion was continued for 6 hours; at the end of which time, the meat had undergone more or less complete chymification; Beef, Lamb & Ham being most disintegrated, while Egg & Fish seemed to have dissolved, without breaking up. In all cases an acid unpleasant smell was noticed, which sometimes resembled that of the meat used, particularly in the case of fish.

The scents of the beverages were also recognisable, that of coffee being too strong, as almost to mask the smell of the chyme.

The chymified mass was filtered a process which in many cases was very slow; the filtered liquids had an acid and bitter taste, or varied in colour with that of the beverage used. The specific gravity of most of these liquids was taken, and will be found in Table 2. The examination of these results are on p. 135.

The next step in the process was the separation by dialysis of the peptonised organic matter from that unaltered and simply in solution in the filtered chyme. For this purpose, 25 ccs of the filtered liquid were removed in each case, placed in a dialysing bag, covered with parchment paper, and suspended in a saucer containing 100 ccs of distilled water. Dialysis was allowed to continue for 24 hours, then the water was removed from the saucer.
and 100 ccs fresh distilled water added & dialysis continued for 24 hours more of this second ammonium. The saucers & undersurfaces of the dialysers were washed with distilled water & the washings were mixed with the 200 ccs of liquid from the saucers & preserved for the next step. By this device, viz., removing 25 ccs of filtered liquid for dialysis, all difficulty in washing the indissolved part of the meat & the vessels used, was avoided & greater accuracy obtained, for it is evident, that as each beaker contained 75 ccs of liquid & 25 ccs were removed, the result obtained by the dialysis of this amount of liquid, multiplied by 3 will give the result for the whole 75 ccs. The dialysers used were 4 inches in diameter & the parchment paper was carefully examined for holes. In hot weather, a few drops of an alcoholic solution of Thymol were
added to the liquids in the dialysis & Saucer to prevent a fungoid growth, which occurred in one case, where this precaution was not taken. When dialysis had continued for 48 hours, the contents of the dialysers had quite lost their acid bitter taste, indicating an almost entire removal of the peptones, while the water in the Saucers had acquired this taste & a colour varying with that of the filtered enzyme & darkest in the case of Coffee, the 200 ccs of liquid, in this case, being often of a distinct straw colour.

The 200 ccs of liquid from the Saucers & the washings in each case, were then evaporated to dryness in the beakers in a water bath at the temperature of boiling water. In order to make the residue a more manageable substance, 5gm of Sodium Chloride, were added to the liquid. As evaporation
Approached to dryness an aromatic smell was noticed in most cases but in that of fish it was unpleasant and in the cases of Cocoa & Chocolate, a smell of caramel was present, resulting from the Charring of the Sugar, which had passed thru the dialysers.

When Evaporation was complete the beakers, containing the dry residues, were weighed, after cooling in a desiccator over Sulphuric acid, & the mixtures of Salt & dialysed matters having been removed from the beakers were powdered in a mortar & transferred to tubes each with a distinguishing number & tightly corked up to await the next step. The beakers were weighed, after cleaning after each evaporation, that no error might result from any glass which had been dissolved by the water.

and their weight when empty having been subtracted from their weight, when they contained the salt and dialyzed solids, the figure obtained was noted as $I$.

The next step in the process of ascertaining the amount of dialyzed organic matter present in $I$ was to weigh out a quantity of the mixed salt and dialyzed matters into a crucible. This weight was called $A$. The crucible was heated in a hot water oven, for about 3 hours, to drive off any traces of water remaining in its contents and after cooling in the desiccator was again weighed, the new weight being called $A'$. The difference $A - A'$ representing the weight of water if any contained in the sample of

$$\frac{I \times (A - A')}{A}$$

representing the amount of water contained in $I$. A small weight quantity (about .15 gm.) of Chlorate of Potash was added to the contents
of the crucible to assist oxidation. The crucible covered & heated carefully till all the organic matter was oxidised. After cooling in the desiccator, the crucible was weighed, & the weight of the crucible empty & of the Chloride of Potash, left by the Decomposition of the Chlorate of Potash, having been subtracted from the weight obtained this figure was noted as $B + \frac{A' - B}{A}$ represents the amount of organic matter in $A$ of course 

$$\frac{T \times (A' - B)}{A}$$

represents the organic matter in $T$. But $T$ only contains the dissolved matters of 25 ccs of liquid & 75 ccs were used in the digestion, therefore to obtain the full result of the experiment, the formula must be

$$\frac{T \times (A' - B)}{A} \times 3.$$

In every case a second combustion was performed & the average of the
Two taken to represent the true result but of the difference between them, when the formula \( \frac{T \times (A - B)}{A} \times 3 \) had been worked out for them, amounted to 1 gm or more. Other combustions were performed till two results were obtained satisfying this condition. If two separate pairs of results, each pair satisfying this condition, but the four results not agreeing among themselves, the average of the smaller pair was taken as the correct result, unless some good reason was found for taking the average of the other.

It is to be noted by this process that all the dialysable organic matters, obtained from the 25ccs of fluid placed in the dialysers, are included in the results, whether they are derived from the digestion of the meat, of the digestive fluid or of the beverage — also that any dialysable organic matter not peptones but derived from the
meat, which may occur, will be reckoned as ketones.
It has been seen (p. 23) that the digestive fluid contains albumenoid
matter, capable of becoming dialysable
by digestion, if the beverages contain
bodies, either dialysable to begin
with or capable of becoming so under
the influence of digestion.
Therefore, that no error might
occur through confounding
matters derived from the digestive
fluid or beverages with those
derived from the meats, a set
of experiments were performed,
the results of which are seen in
Table C. These experiments were
performed by the standard process
with the one exception, that no
meat was used in digestion but
simply a mixture of beverage (25 cc)
and digestive fluid (50 cc).
The figures in the column marked
"Factors" (Table C) are those derived
from the formula \( \frac{T \times (A' - B)}{A} \times 3 \)
applied to the results of these experiments while those in the column "Nutritive Values" are simply the factors for the digested beverages with the factor for digestive fluid + water digested together subtracted from them. These latter figures however can be of but little value because in the cases of all the "Teas" precipitates formed on the addition of the beverages to the digestive fluid & in the case of Effs Cocoa, when a filtered solution of it, was added to some digestive fluid, a precipitate formed, thus it may be assumed that the same took place with the other "Cocoas", but was masked by the suspended matters. Also in the case of the "Teas" the precipitates, not only formed on mixture but remained throughout digestion, undissolved & required to be filtered off. Whereas some of the organic matter contained in the digestive fluid which might, otherwise, have passed through the dialyser was removed from the action of the pepsin & acid & therefore these figures of the nutritive values of the
beverages are too small. In the case of
the "Coffees" no precipitate formed, though
the nutritive values in these cases are
more worthy of credence. Examining
the factors, it is found that the factor for
the digestive fluid with water is
1.92 gms, amounting to 85.9% of the
organic matter contained in the
digestive fluid, which was ascertained
by experiment to contain 4.47% of
organic matter at 22.3 gms in 50 ccs.
All the teas give factors very close
together, that of green tea as would be
expected, being exceptionally large
4.13 gms for the 7.5 ccs of mixed brave
digestive fluid, while Indian Iea
gives a factor of 3.18 gms; Mixed
Tea gives 2.26 gms of the alkaline liquid
used in the case of Tea with Soda
has the effect of raising the factor
to 2.59 gms. The "Coffees" are all
very close together, Coffee with Cherry
being the largest; but the "Cocoas"
show a large divergence among
themselves, varying from 2.87 gms
for Cocounta, up to 0.53 grams for Epps Cocoa, and 1.059 grams for Chocolate. Thus, Chocolate yields to digestion and analysis \( \frac{2}{3} \) of the weight of the raw material used. Cocoa about \( \frac{1}{3} \), while Tea only yields about \( \frac{1}{10} \) of the raw material or \( \frac{1}{3} \) of the total solids in solution in the infusion. Coffee about \( \frac{1}{10} \) of the raw material or \( \frac{1}{3} \) of the dissolved solids. The largeness of the figures in the case of the Cocoa & Chocolate shows the necessity of noting and subtracting these factors from the results obtained by the digestion of meat in their presence, for they would cause a very serious error in the experiments. Therefore, from the results of the formula \( \frac{T \times (A' - B)}{A} \times 3 \) obtained by the digestion of any of the meats, if needful, in order to get a reliable result, to subtract the factor found against the beverage used. The three principal beverages, Tea, mixed, Coffee, & Epps Cocoa, were also
analysed after digestion, a comparative experiment being performed with water as the beverage, the process of analysis being similar to that detailed on pp. 16-17. The beverages having been digested & dialysed by the Standard Process, the liquids contained in the dialysis sacs were evaporated to small bulk. Absolute alcohol, with a drop of acetic acid, added to precipitate albumenoids. After standing for 24 hours, the liquid was filtered & the precipitate, after washing with alcohol, dried & weighed. Subacetate of lead solution was added to the filtrate, & the other steps followed as on p. 16, with the results shown in Tables D & E. The results in these Tables have been multiplied by 3 to take in the whole 75 cc of mixed beverage & digestive fluid & not only the 25 cc dialysed. Analysing these Tables & comparing them with Table B remembering that the expressed percentages were in the amounts in 25 cc of beverage.
it is seen that another line has been added, viz. a line containing the amounts of albumenoids, derived from the artificial gastric juice, from the digestion of any albumenoid matter in the beverage. It is interesting to note that these two beverages, in which the albumenoid matter is known to be very small, viz. Tea & Coffee give erroneous results in Table E, indicating that any proteins they have yielded to digestion were not sufficient to supply the place of those, the digestion of which was retarded or which were precipitated from the digestive fluid by the beverage; while on the other hand the beverage, which contains suspended matter rich in albumenoids, viz. Cocoa, yields enough of these bodies to digestion just to supply the place of those removed from the digestive fluid by its action. The same fact is seen from another point of view in the next line where the amount of Tannic Acid or its derivative
dialysed, is recorded & where it is seen that the largest amount of dialysed matter, corresponding to this acid, is found in the case of cocoa, where the amount of proteide is also largest, because, both has the form of acid found in cocoa little action on protid bodies & hence little of the acid is removed by the precipitation of the albuminoids of the digestive fluid, & also, the acid contained in the suspended matter of the beverage is not extracted by water, is to some extent removed by digestion. Hence it is found that the acid in this case, is nearly double, that contained in the beverage filtered before digestion. The amount which appears in this line, under the head of Water, consists of some substances, probably albuminoid, contained in the artificial gastric juice & precipitated by the Subacetate of Lead, of that which appears in the next line consists of salts & derived from the same source not precipitated by the lead salt.
soluble in alcohol. In the third line, the amount of alkaloid digested & deaipated ought to be shown but, apparently from salts derived from the digestive fluid, & soluble in alcohol, the figures are fallacious, while the last line shows similar results to the second, the Extractives, after subtracting those derived from the digestive fluid, in the case of sea being just about what was to be expected from Table B but in that of cocoa nearly double. Having, thus, examined more or less minutely the results of the digestion of the 14 beverages, attention may next be turned to Tables F & G, embodying the results of about 60 experiments on the digestion of the various meats mentioned on p. 12 with digestive fluid, alone or with water, or these beverages. Table F gives the actual figures obtained by the digestion of 50 ccms of each meat for 6 hours with 25 ccms
the beverage + 50 ccs of digestive fluid, after deduction of the beverage factors, while Table C is obtained by dividing the results in the case of each meat, in the presence of a beverage, by the figure expressing the result of the digestion of that meat in presence of water + multiplying by 100, thus obtaining percentage results compared with the results of digestion in presence of water as a constant & also showing the digestive power of 50 ccs of digestive fluid in presence of the 25 ccs of beverage in rarely appreciable figures; for it is evident, that the digestive power of a mixture of digestive fluid & beverage varies directly as the amount of peptones produced from a quantity of meat, if that quantity be such as to leave some meat undigested at the end of the period of digestion + if the quantity of meat + of the beverage of digestive fluid + all other active factors be kept invariable in
all the experiments. Hence the figures in Table G show the percentage digestive powers of the mixtures of beverages and digestive fluid, subjected to experiment, when mixed in the proportions used under the conditions of the Standard Experiment. Examining, first Table F, it may be noticed in passing, that the results of digestion in presence of water correspond, to a certain extent, with those obtained by Honigsberg*, viz., that in artificial digestion, Boiled meat yielded 26.5% of peptones & Roast meat 48%. The roast meats examined, in the experiments in Table F, were Beef, Lamb, & Fowl giving an average of 0.87 gms dissolved from 5 gms of meat or 17.4%; The boiled meats were White of Egg, Salt Beef, Ham, & Fish, which gave an average of 0.81 gms dissolved from 5 gms of meat or 16.2%. These figures agree in direction with those of Honigsberg.

But differ in amount.

Before proceeding to draw comparisons between the actions of various beverages, as compared with water, with each other, a few remarks about the process followed, must be made, and some irregular results noticed.

As regards the process, it is to be noted that the experiments were performed in batches of 6, the larger number of these batches being performed with one meat only; the beverages used in each batch were the five more important (e.g., Tea, Coffee, Cognac, Cocoa, Chocolate) with Water for a comparative experiment. Therefore these 6 were performed, under precisely similar circumstances, the ground is cleared from any such sources of error, as variations in the strength of the gastric juice, or in the temperature.

It is also to be noted that, in two instances, this rule was departed from, viz., in the case of Whisky and Egg.
the results marked (a) in Table F belong to a special set of tests, differing from any of the others & necessitated by the accidental destruction of the Water & Coffee. Experiments of the original set of in the case of Roast Beef those marked (c) also are special ones for a similar reason. The Beef with Tea experiment of the original set is also introduced in Table F. It appears to point to the fact, that the digestive action in this case, in those of the rest of the Roast Beef experiments not marked (c), has been more powerful than in the case of those marked (c) & therefore that the effect of the "Cocoa" on digestion is greater than it appears to be, in the case of this meat.

With those other beverages, experiments with which were tried with White of Egg alone, the six beakers were divided into two sets of three, a former set, in which the beverages alone were digested to obtain their factors & second
in which the White of Egg was digested to obtain the "Peptone" results the figure obtained for water by the former experiments was used as a basis of comparison.

The experiments with undiluted digestive fluid were also tried separately & in them 50 ccs of the fluid were digested with 5 grms of meat for 6 hours & 25 ccs of the filtered enzyme were subjected to dialysis. Thus the formula to ascertain the dialyzable organic matter in the 50 ccs of liquid was,

\[
\frac{Tx(A' - B)}{A} \times 2, \quad \text{not} \frac{Tx(A' - B)}{A} \times 3, \quad \text{as in the other experiments.}
\]

The remarkable results to be examined are 6 in number.

The two first are cases where minus results occur, that is where the result, when the meat was digested in presence of a beverage, was less than the beverage factor. This
occurred in two cases, viz. White of Egg with Chocolate & Bread with Chocolate. The other four are best noticed in Table 8, where it is found that there are four results above 100%, viz. White of Egg with Coffee, Ham with Coffee, Fish with Cocoa & Fish with Cocoa. Now, if the process followed be carefully studied, it is seen that at many points causes, for these irregularities may occur. But at starting it may be said that all weighings & measurements for these experiments were performed with the utmost care & the temperature during digestion carefully regulated. It is, therefore, improbable that it is from any cause of this description that the errors arise.

Among the other possible causes of the results being too small, the following may be mentioned, viz. 1°. If the beverage, as in the case of Chocolate contain suspended solid matters, it may have settled thus...
Of the suspended matter may have been present in the 25 ccs, with which the "Peptone Experiment" was performed than in those, with which the "Fata" Experiment was performed. This was, however, guarded against by storing the liquid, before measuring out the 25 ccs.

2nd. The suspended matters may, indeed, clog the action of the "Convection Tube" & they also collected around the meat & thus may have acted, as a protection to it, against the action of the digestive fluid.

3rd. The dialyser may not have been wholly immersed, or may have touched the bottom of the vessel, but such irregularities were carefully guarded against.

4th. The sample chosen for combustion may have been poorer in organic matter than the rest put, as many combustions, were performed in each of these two cases, this cannot have been the cause.
Therefore of these possible causes the only ones which could not be guarded against are those, under the second head, i. in the stomach, these would not occur, on account of its muscular movements mixing the contents more powerfully than the convection currents could do; and hence these must be put down as unavoidable errors of experiment. That they are the causes of these minus results, is also rendered more probable by the fact, that these results occur in the case of the beverage containing most suspended matters of all, viz., chocolate. The minus result, Bread with chocolate, as seen from the note to Table E, has, however, another cause to account for it, for, during the evaporation of the dialyzed liquids, in this case, considerable charring occurred. The case of White of Egg with Chocolate is free from this source of error. Turning next to the results about 10%
Errors depending on weighing or measuring may again be set aside, but the following may have operated to produce the large results must be noticed.

1. Too much suspended matter may have been present in the 25 cc. of coca tincture in cocoa.

2. The dialyzer may have leaked, but careful examination by filling with water and standing on blotting paper was made in every case.

3. In combustion the decrepitation of the salts may have caused some solid matter to be thrown out of the crucible. But as this always had its lid on, this cause does not appear probable.

Indeed the cause of these large results, in the case of the two fish experiments, above named, does not appear evident, unless it should be that under the first head, which is supported by the fact, that the
which beverages are again the offenders. With regard to the experiments, Ham with Coffee + White of Egg with Coffee, it will be shown (p. 70411) that, there are reasons for believing that the presence of Coffee, as the beverage, mixed with the digestive fluid, promotes the digestion of White of Egg & may be presumed also to promote that of Ham. In the Examination of the Table, therefore, the menus results were omitted & they do not appear in the Percentage Table. The results above 100% are, however, incorporated in that Table, though those in the case of the two Fish experiments with Cocoaatina & Cocoa are presumably erroneous.

On looking at Table F, the actual results of the digestions, after the deduction of the beverage factors, it is seen that the largest result is that of Salt Beef digested with 25 ccs of Water + 50 ccs digestive fluid, with 1.121 grams or 22.4% of the 5 grams
of meat used; the nearest approach to this is the doubtful result of Fish with Cocoa, with 1.107 gms or 22.14% of the meat used, followed nearly by Salt Beef with Tea, with 1.063 gms or 21.26% of meat used; Salt Beef with Coffee, with 1.047 gms or 20.9% of meat used; & Beef with Water, with 1.042 gms or 20.8% of meat used.

The smallest result, with the exception of the minus result, is Egg with Cocoa, with 1.164 gms or 3.28% of meat used, nearly approached by Egg with Indian Tea, with 1.07 gms or 3.94% of meat used.

But the results are found in a more comprehensible form in Table C, where they are reduced to percentages as compared with the results derived from the digestion of each meat in the presence of water as the beverage, & the average result for each beverage, deduced from the experiments with all the meats, is shown in a separate column.
Of the average results the largest in the case of the 5 principal beverages is, that with Cocacina with 89.96%; Tea follows, with 84.06%; then Coffee with 88.79%; Eggs Cocoa with 76.05% and Chocolate with 72.44%. Of the 9 beverages of lesser importance experiments, with which were tried with White of Egg only, Tea with Soda heads the list, with 97% following in order, Malt with 82.7% Cocoa with 78.8%, China Tea with 72.8%, Arab Coffee with 67.97%, Coffee with Chicory with 62.9%, Guarana with 57.14%, Green Tea with 57.6%, and Indian Tea with 45.4%. The only other average to be noted is that of the results of digestion with 50ccs of undiluted digestive fluid in the two cases White of Egg + Roast Beef, viz. 80.3%. It is thus seen that with a digestive fluid of the strength used with a digestion of 6 hours, the clogging action of the accumulation of peptones and the deficiency of acid cause a decrease in the amount digested.
of 19.7% as compared with a case where to the same amount of digestive fluid half its bulk of water had been added.

From these average figures it would seem that of the five principal beverages Cocaotina has the least effect in retarding digestion, reducing the digestive power of the artificial gastric juice, when all the conditions are as in the Standard Experiment, from 100 to 89.96% that Chocolate has the greatest effect, reducing the digestive power to 72.44%, the other beverages being between, in the order quoted on p. 54.

From these results, it would appear at first sight, that of these beverages Cocaotina was the least harmful to drink along with nitrogenised food & Chocolate the most so, but reasons will be given (p. 105) for regarding this latter result, as probably not applying to digestion, taking place in the stomach, though, as it is undoubtedly true in this experiment, this result will be
considered with the rest.

On Examination, it will be seen that the high average of Cocoa is due to the fact that, with one exception (that a doubtful one), though it has no very high results, yet, on the other hand, none are very low, while Tea and more especially Coffee, have certain high results (in the case of Coffee, two over 100\%). But they also have some very low, which reduce their averages below that of the more equally acting Cocoa.

With Tea the higher set of results contains the cases of Roast Beef with 96.4%, Salt Beef, 94.8%, Ham, 95.98%, White of Egg with 91.7%; the lower set Fowl with 66.73%, Lamb, 88.4%, Fish, 88.26%, Bread 89.23%. With Coffee the higher set of results contains, White of Egg with 106.45%, Ham, 100.44%, Roast Beef, 98.8%, Fish with 96.3%, Salt Beef with 93.14% of the lower set, Bread, with 58.27%, Lamb, 69.95%, and Fowl with 86.74%.
Now, the only case, not in the same set in both series of results, is fish & as already seen, this is, from some cause unknown, for every case was taken with the experiment & no accident occurred, one of the most untrustworthy of all the experiments. Therefore, excluding fish, it is seen, that with regard to the action of Tea & Coffee, Meats may be divided into a set the digestion of which is less influenced by these two beverages, (e.g., White of Egg, Roast Beef, Boiled Salt Beef & Boiled Ham), & a set, the digestion of which is more influenced (e.g., Lamb, Fowl & Bread). It is to be observed, that three of those in the higher set, viz Egg, Salt Beef & Ham are the usual occupants of the breakfast table. This is the only meal, at which custom seems to have made it usual to eat animal food & drink infused beverages at the same time. Whether the selection of these meats
Which experiments show are the least affected in digestion, by infused beverages, has resulted from a kind of "survival of the fittest" or no, it is impossible to say but clinical evidence is forthcoming to show that when one of these three meats, especially in the case of the two salted ones, has been eaten at breakfast, less inconvenience is felt, than when a meat of the other class has been used. The Roast beef is the only incongruous member of this class for it is hard to see why beef should be less influenced by the presence of these beverages, than other roasted fresh meats. Comparing the two beverages, Tea and Coffee, the comparison is in favour of Coffee, so far as its action on the peptic digestion of this group of meats, under the conditions of the Standard process, is concerned, for as has already been seen, the presence of Coffee positively appears
To assist the digestion of White Egg and Ham, its effect in reducing the action of the digestive fluid is less than that of Tea, in the case of Roast Beef, while it is but little more in the case of Salt Beef. Turning next to the set of lower results, it is found that Coffee has more action on Bread & on Lamb, than Tea, but less on Fowl. Referring to Table II it is seen that the experiment Bread with Coffee, is one which was considerably charred, in the evaporation of the dialysed liquids, hence this result is smaller than it should be, though from analogy, it would probably have not been greater than that with Tea, had this source of error not occurred. This action on Bread is to be noticed, but it must be remembered, that in these experiments, the diastatic action of the saliva was entirely neglected, & hence the figures in the results only refer to the action of the digestive fluid in
the autogenous ingredients of the bread. Thus though Tea or Coffee both have a considerable action on the digestion of the albumenoid constituents of bread, further experiment is required to ascertain, whether this action extends to the hydrocarbonaceous constituents, which are of the most importance in the present case, for, if Tea or Coffee have little action in reducing the digestion of the albumenoids of meats eaten with bread, or even assist it, their action in retarding the digestion of the much smaller quantity of albumenoids contained in bread may be neglected.

Turning now to the other three principal beverages, it may be remarked, in the case of Cocoa, that the average of the percentage results expressing its action on digestion, when used under the conditions of the standard experiment, places it above both Tea & Coffee, on examination.
It will be found, that it really in most cases has a greater action in impeding digestion, than either of these beverages, for while the widest extremes of the percentage results in the case of Tea are 96.4% + 66.73% or nearly 30%, in the case of Cocoa, the widest extremes, of the doubtful result Fish with Coocata, 139.77%, be excepted, are 88.96% + 66.52% or rather over 22% + thus the results are closer together, than in the cases of Tea & Coffee. The greater action of Coocata, than Tea, on digestion will be evident from the figures in the Table, for the special experiments, when all the results are less in the former case than in the latter; except that doubtful one under the head of Fish; while its greater action than Coffee has two other exceptions, viz. Lamb & Bread. The division into two classes, in the case of this beverage, is less evident, than in those of the two last considered, still it may be
observed, that, White of Egg, 85.25%, Roast Beef, 88.09%, Salt Beef, 86.88%, Ham, 88.46%

In this case Bread, 87.22%, from a set distinct from one of the lower results, Lamb, 77.04%, & Poule, 66.52%.

The higher set differs from that in the case of Tea, by containing Bread, & from that, in the case of Coffee, by this & also by the absence of Fish, while from the doubtful character of its result has been omitted. Thus, it is seen that Cocoa, though having less effect in the average than either Tea or Coffee really, in most cases, has more effect, especially on those foods which are least affected by the two latter beverages.

Eggs, Cocoa, + Chocolate throughout give smaller results than any of the above three & in such grouping as in the cases of Tea & Coffee, can be detected. The higher set, in the case of Cocoa, consists of Salt Beef, 86.8%

Lamb, 83.35%, & The Doubtful Fish, 102.5%, & the lower set, Roast Beef, 78.2%, Ham,
70%, Bread, 73.76%, & White of Egg, 37.78%.
In the case of Chocolate, the two members of the higher set are, Fowl, 86.12%, & Fish, 83.38%; those of the lower set, the prunes results being omitted, are Salt Beef, 52.45%, Lamb, 62.71%, & Ham, 72.25%. This grouping gives no such intelligible results as are found with Tea & Coffee.

Turning next to the 9 Beverages, only subjected to Experiment with White of Egg; 5 Teas are found, viz. Mixed Tea infused with water rendered alkaline with Carbonate of Soda, which gives the highest percentage result, under 100%, derived from any experiment, viz. 97%; this is followed by Black Tea, with 82.7%, China Tea, with 72.8%, Green Tea, with 51.6%, & Indian Tea, with 45.4%. The harsh flavour of Indian Tea has led to a belief that it is more astringent than Chinese Tea, which is justified by the above result. Of the "Coffeees" both Arab Coffee & Coffee containing Chicory act
on the digestion of White of Egg, in a
manner, the reverse of ordinary
coffee lowering the digestive power
of the 50 ccs of artificial gastric juice
in the former case, to 67.97% of the
latter to 62.49%. Of the two "Cocoas",
not included in the 5 more
important beverages, Coca Hibiscus
lowers the digestive power of 50 ccs
of digestive fluid to 78.8% & Guarana
to 57.14%.

Reasoning from the 8 experiments
tried with each of the 5 principal
beverages & from those with the
9 less important ones, the
results are obtained (1) that, when the
conditions of the Standard Experiments
are observed, in the cases of the
5 principal beverages, judged by
their averages, Coca Hibiscus would
seem to have the least injurious
effect, but, as already seen in
every special case, except one
doubtful one, the results with Tea
are superior to those, with Coca Hibiscus.
And the same is true with regard to Coffee, with three exceptions.
(1) That with all the meats except three (Salt Beef, Lamb, Doubtfully, Bread) Coffee has less retarding action than Tea, that Cocoa and Chocolate follow after the other three.
(2) Meats may be grouped into two sets according to the greater or less action of Tea and Coffee, on their digestion, Roast Beef, Salt Beef, Egg, Ham, being less acted on than Lamb, Fowl, Fish or Bread, that a very similar grouping is to be noticed in the case of Cocoa and Chocolate. These meats less acted upon by the two first beverages are those usually eaten at Breakfast.
(4) That the 5 beverages arranged in the order of their action on the digestion of those meats usually eaten with them beginning with that having least action, would stand thus,
Coffee, Tea, Cocoa, Chocolate, but for the meats usually not eaten with them, a special order would have to be made for each meat.

In the cases of the less important beverages, Tea infused with water containing Carbonate of Soda gives the least action and Indian Tea the most. The latter, however, being very nearly approached by Green Tea and Guarana while the percentage results for all the other beverages lie between 70% and 90%.

The next set of results, to be analysed, are found in Tables II and III, which show the figures obtained from those experiments referred to on p. 1, in which the known variable factor was the kind of beverage used, & the variable factor, to be ascertained, was the time taken to dissolve entirely, a constant weight of White of Egg, by a constant quantity of a gastric juice of constant
composition, mixed with a constant quantity of the beverage examined, the digestion taking place at a constant temperature. The process followed was the Standard Process, with the following variations, viz.

(1) Only 0.5 gm. of white of egg was used.
(2) The white of egg, broken into small pieces, was placed in the convection tube & retained there, by a piece of coarse net tied over the mouth of the tube.
(3) The process was only continued till the digestion was complete as no dialysis or estimation of peptides was required.
(4) 1 cc of 3.65% solution of hydrochloric acid was added to each beaker every hour.

The experiment was difficult to manage from the length of time occupied by it, owing to other engagements, it had to be stopped
for 15 hours, during which the white of egg was exposed to the action of the digestive fluid thrown at the temperature of the air, but, as this period, was the same in each case, it does not vitiate the results stated in the Table, the 15 hours being omitted. It is evident, that the amount of peptones derived from a given amount of albumenoid, in a given time, provided at the end of the time, some remains undigested; if the time required for complete solution by peptonisation of a given amount of albumenoid, are quantities depending upon one another, if the other factors of the experiments are invariable. To recognise this agreement between the results in Table II & those of the Peptone experiments, it is necessary to reduce the former to percentages. When it is found, that taking the time required for complete solution
In presence of water as 100, that required in presence of tea is 112.03%, in presence of Coffee 86.94%, of Cocoa, 138.8%, of Chocolate, 131%. Now the power of the mixture of digestive fluid + beverage varies inversely as the time required for complete digestion of a given quantity of albumen, taking the digestive power of the mixture of digestive fluid + water as 100, it is found by the formula:

\[
\frac{\text{the time required}}{\text{the time per cent}} = \frac{\text{percentage digestive power of the mixture of beverage + digestive fluid}}{100}
\]

For example, in the case of Tea, the proportion will be:

\[
\frac{112.03}{100} : \frac{100}{100} = \frac{\text{Percentage digestive power of the mixture of tea + digestive fluid}}{100}
\]

Giving the percentage digestive power of the mixture of Tea + digestive fluid as 89.26%. The results thus obtained
are embodied in Table I Column A, and for facility of comparison in Column B are given the results obtained by the "Peptone" process extracted from Table C, these being the results of the process in the digestion of White of Egg, while in Column C are given the average results of the experiments with all the foods.

In examining this table it is seen that considerable resemblance is to be traced between all the results. In the case of Tea, the result of the "Icine" Experiment is 89.26%, that of the "Peptone" Experiment with White of Egg, being 91.7%, and the average of eight "Peptone" Experiments 89.06%. The resemblance between the "Icine" Experiment and the "Peptone" Experiment with White of Egg, in the case of Coffee, is also considerable and had it not been so the result of the "Peptone" Experiment making it appear that Coffee assisted the
digestion of White of Egg would have been rejected as erroneous but the similar results, arrived at by quite dissimilar processes, cause the result to be accepted as correct. The average result with Coffee is quite different from the result obtained by the "Time" Experiment, owing to the action of Coffee on most meats, being quite different from its action on coagulated Albicmen. The resemblances between the results of the "Time" Experiments and those of the "Peptone" Experiments in the three remaining cases, are not so close but are still traceable altogether, these experiments may be taken, as confirmatory of those performed by the other process. To sum up the results obtained by both processes; it has been shown that, all the infused beverages, subjected to experiment, retard digestion when the conditions of the Standard Process are observed.
Two exceptions, viz., White of Egg with Coffee & Ham with Coffee, where the beverage appears to assist digestion & two doubtful cases; doubtful because unsupported by any confirmatory evidence, viz., Fish with Cocoa or Fish with Cocoa, have been noticed.

Under this general rule, some subdivisions have been noted, viz., that Tea & Coffee have much less effect on those meats usually eaten at breakfast, viz., Salt Beef, Ham & Egg, than on Roast Beef, than on the other meats & that Coffee has less effect than Tea. Cocoa, also, has been seen to act on these meats less than on the others but its action is greater than that of either Tea or Coffee, while, from its action on all the meats being much the same in degree, its average of results comes to be greater than that of either Tea or Coffee. Thus it is seen that the
That the average is not altogether an accurate guide in estimating the effects of infused beverages on digestion.

It has also been seen that cocoa and chocolate produce greater effects than those of any of the above beverages, so that there is no division to be noted into a class of meats more acted upon by them and a class less acted upon.

In the cases of the beverages of less importance, as experiments were performed with them with Whitted Egg alone, the figures in Tables IV 

& may be allowed to speak for themselves.

Before leaving, this part of the subject attention may be called to the fact, that the concentration of the proteoses, in the case of digestion of White of Egg, with undiluted digestive fluid, produced a greater effect than the presence of 25 ccs of either Tea or Coffee & almost as great an
Effect as the presence of 25 ccs of Coca-cola, while, in the case of Roast Beef, it produced more effect than any of the beverages.

Having now examined the effects produced by these beverages, the causes producing them, call for some attention, and as a first step toward determining these, the chemical reactions of the beverages with various albumenoid substances, other nitrogeneised substances were ascertained. These, at all the other experiments in search of the cause of the effects of the beverages, were performed with the three typical beverages, only, viz., Mixed Tea, Coffee, & Yps' Cocoa.

The reactions with Tea were as follows:

Added to a solution of Egg Albumen in water, Tea gave a slight brown precipitate; added to a solution of gelatine, it gave a copious brown precipitate; added to the artificial gastric juice, as already seen, it gave a copious flocculent precipitate, which, however, was not
dissolved by the addition of more hydrochloric acid as was shown to be the case with a precipitate produced by Tannic Acid in an artificial gastric juice*. Tea added to a solution of Syntomine gave a copious light brown precipitate with a solution of Peptones a copious flocculent precipitate.

In the case of Coffee, it may be mentioned that the same solutions were used in the experiments with each of the beverages, so that no errors by variations in the strength of the solutions were introduced. Coffee added to the solution of Glutin Syntomine to the artificial gastric juice gave no precipitate, but with the solution of Albumen a slight one was produced & a similar one with that of peptones. The Epps Cocoa was of course followed, before using for the

Reactions I gave with albumen, a slight white precipitate, of similar precipitates with gelatine. Synthone solutions with the digestive fluid, while when added to the solution of proteines, a brown precipitate slowly formed.

After digestion of a mixture of digestive fluid + water, it was found to give a slight precipitate, when added to the solution of albumen thus agreeing with true gastric juice. A mixture of tea + digestive fluid, digested & filtered, gave a precipitate with albumen solution, very little different from that in the last named case & a similar one with Synthone solution, while it gave no precipitate with gelatine solution, this result differing from that obtained by Mr. Brownen*, which seemed to show that the action of the pancreatic juice

Pharmaceutical Journal, August 16, 1882.
was required to effect the change into gallic acid & rob the tannic acid of its power of precipitating gelatine.

The mixture of digestive fluid, coffee & cocoa, respectively, digested together & filtered, gave no precipitate, with any of the above solutions more than could be attributed to the digestive fluid.

From these experimental results & from various theoretical considerations, the following series of causes, which may possibly assist in producing the action of infused beverages on peptic digestion, was compiled:

1. Removal of pepsin by its being carried down entangled with the precipitate formed by the action of the tannic acid of the beverage on the albumenoids of the digestive fluid, or only partially redissolved.*

2. Coagulation of albumenoids, which

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* Analyse Chimique, appliquée à la Physiologie et à la Pathologie, Hoppe Syler, Traduit par Schlagende Savry, Paris. 1877 p 311
may happen to have escaped coagulation by the cooking of the meat.

(3) The gelatinous parts of the meat, altered by the lactic acid, contriving of pressing on the albumenoids. This action may be compared to the delay in digestion caused by wrapping a piece of fibrin firmly with a piece of thread so as to prevent it swelling.

(4) Action of the volatile oils in preventing the peptic fermentation.

(5) A similar action on the part of the Alkaloid.

(6) Precipitation by the beverages of the Sputum, formed as the first stage of digestion of albumenoids, or of the Peptones, as formed.

No cases, where the beverages possess this power have been noted above.

(7) Accumulation of Peptones, checking digestion & precipitation of Peptic

* Handbook for the Physiological Laboratory, Beadon Sanderson, 1873, p.488.
** do. p.489.
by the undissolved albumenoids, as was shown to take place by
von Wittich.*
This may take place with beverages rich in albumenoids such as the
Cocosas.
(8) The suspended matters of the
thick beverages, clogging the action of
the convection tubes, & also, by gathering
round the meats, partly protecting
them from the action of the digestive
fluid.
These, theoretically, possible causes, were
examined in detail & various
experiments tried to decide, which
are the true causes & how much
of the effect produced depends on
each.
The first possible cause, viz., the
removal of some pepsin by its being
entangled by the albumenoid precipitate,
formed from the gastric juice, by
the formic acid of the beverage.

*Analysse Chimique, appliquée a la Physiologie
applies only to those beverages, which caused a precipitate, viz.: (1) All the "Teas" including Mate (2) Ephs cocoa, reasoning from the analogy, of which, it is believed that all the "Cocos" caused a precipitate, while it has been seen that the "Coffee did not. The precipitate appeared rather to increase than diminish during digestion, therefore it is evident that all the pepsin was not carried down by it, from the digestive fluid, for if it had been, no digestion at all could have taken place. Not some of the pepsin, carried down, entangled in the precipitate, was redissolved, as shown by two experiments, the results of which are found in Tables I, II, III. In these tables the results are drawn from experiments in which the beverages were mixed with the digestive fluid & the mixtures boiled, then added to the meat, in this case White of Egg, the proportions of meat beverage & digestive fluid & the rest of the experiment, rigidly following the
Standard process. An experiment was performed with each filtered mixture without the White of Egg to ascertain the factors for the beverages filtered before digestion. Examining this factor for Tea 1, comparing it with the factor for Tea digested unfiltered, it is seen that in the case of the Tea, filtered after mixing with digestive fluid, the factor is slightly (0.009% less than in the case of the unfiltered mixture; this amount representing the dialyzable matter which would have been re-dissolved from the precipitate had it been allowed to remain during digestion. In the case of the results from the digestion of White of Egg with the filtered mixture of Tea digestive fluid, the difference between the results with the filtered mixed the unfiltered mixtures is much greater (0.513.4% in the former case + 3.982% in the latter or 91.7% of the results with water only, in the latter + 78.34% in the former. The largeness of this difference
points to the fact that the 0.01gm removed from the precipitate by digestion, when it was not filtered off, consisted of Pepsin, which, in the case, where the precipitate was not removed, was recovered to make the digestive fluid more active. The results, in Tables 3 and 4, referring to Coffee, are seen to be the same as with the unfiltered mixture but those with Cocoa show a large difference. Cocoa, as has been seen gives a precipitate with artificial gastric juice, which may, from analogy be supposed to contain Pepsin, which might be redissolved by the removal of which reduced the digestive power of the mixture but the removal of the suspended matter of the Cocoa shifts its action in impeding digestion (p. 105) so greatly increases the digestive power of the mixture that any decrease from removal of Pepsin is quite masked. These facts support the belief that the
Removal of leaven by its being entangled in the albumenoid precipitate, produced by the addition of "Teas" or "Cocoa" to the digestive fluid is, partly at least, the cause of their retarding action on digestion. The two next causes, by the 2nd, 3rd, 4th, coagulation of albumen, not coagulated in cooking, & the contraction of the tanned gelatinous matters of the meat, pressing on the other albumenoids, are reducing digestion, may be considered together. It has already been seen, that Tea & Cocoa precipitate albumen & gelatin, while Coffee precipitates albumen, but slightly & gelatine not at all. Therefore the 2nd cause applies to all the beverages more or less but the 3rd, only to the "Teas" & "Cocoa", which alone precipitate gelatine. The actions on gelatine would take place in the meat, where the gelatinous bands, resulting from the cooking of the white fibrous tissue forming the perimiscium &
of the flesh would, by the action of these two classes of beverages, be converted into leathery bands. By their contraction would hinder the digestion of the true muscular substance, as the thread in the case referred to above (p. 78) hindered the digestion of the fibrin compressed by it. 

Hearing on the examination of these causes, the experiments, the results of which are contained in Table I., must be considered; in these five experiments, the following different cases were tried. In the first, 5 grms of minced Roast Beef were digested according to the Standard Process, with 50 ccs of digestive fluid and 25 ccs of Water. It may be noticed that, for some unknown reason, a smaller result was produced in this case than in the experiment, the result of which is found in Table I. In the second experiment of the five, 5 grms of the same beef were soaked for 6 hours at a temperatura
From each of the results the factor in 50cem of digestive fluid + 25cem of Water digested together was subtracted.
of 37.7°C, in 25 ccs of Water, which, at the end of that time, were strained away & the solid residue, digested by the Standard process, for 6 hours with 25 ccs of Water + 50 ccs digestive fluid. In the 2nd Experiment 25 ccs of Tea were used for the soaking + 25 ccs of Water + 50 ccs of digestive fluid, for the digestion; Coffee took the place of Tea, in the fourth experiment, & filtered Effs Cocoa in the fifth. In all other particulars (analysis & estimation of organic solids), the Standard process was scrupulously carried out. It is to be noted that, at the end of the soaking, the meat soaked in water +, that soaked in Cocoa, were pale & swollen & the liquids were apalescent; the meat soaked in Coffee was brown, that in Tea was brown shrunken & hard-looking + the liquids in these cases very thick. On looking at the Table, the results at first seem contradictory but it will be found
possible to reconcile them with those already observed, for here the meats soaked in tea and in cocoa give the largest results, in the latter case larger than those when the ordinary digestion in presence of water was performed, while the meat soaked in coffee before digestion gives smaller results that soaked in water, the smallest of all. From all the albumenoids soluble in water and therefore, most easily acted on by digestion, are removed from the meat in this last case by the preliminary soaking in water, only the albumenoids, coagulated by cooking, are left to the action of the digestive fluid. The same applies to coffee for caffeine-tannic acid does not precipitate albumenoids at all powerfully, therefore, the coffee would dissolve them in much the same way as water did, but in this case with that of cocoa a considerable quantity
of the beverage containing, not only its share of the dissolved albuminoids, but also of the solids dissolved in the beverage, would soak into the meat; this would probably be sufficient to give the additional 0.33 gms. in the case of Coffee, as compared with Water to bring the result in that of Cocoa up to 1.002 gms., this large result being due to the sugar contained in this beverage. On coming to the case of Tea, a larger result is found than with the meat soaked in Water or Coffee, but still its percentage, as compared with the result of digestion of unsoaked meat in the presence of Water a Digestive Fluid by the Standard Process, 83.72%, is less, than in the case of the Beef with Tea Experiment by the Standard Process, which is 96.4% (see Table C). The larger result, with meat soaked in Tea before digestion, than with that soaked either in Water or Coffee, depends on the
fact that the active tannic acid of tea* coagulates the gelatine and albumin of the outer layers of the meat and protects the inner layers from the dissolving action of the water of the beverage. It also, of course, protects them from the action of the digestive fluid but not so thoroughly as the removal of their soluble proteins by the soaking fluid, and hence this result is larger than that with meat soaked in coffee or water; but less than that obtained by the ordinary standard experiment. Because, none of the tannic acid of the beverage being precipitated by the albuminoids of the digestive fluid, the whole gets its full action on the meat. The second cause, therefore, may be considered to act in the cases of all the beverages; the third in the cases of those, having the power of precipitating gelatine, viz., the "Teas" and "Cocoas".

The fourth cause, to be considered, is the possible action of the Volatile oils of the beverages, in delaying the action of the pepton.

To ascertain if any such antifermentive property, existing in the Volatile oils of these beverages, had any action in delaying digestion, the following experiments were performed.

The Volatile oil of 25 ccs of each beverage, having been distilled off, was made up to 25 ccs, with distilled water, and used as the beverage of an experiment, otherwise performed by the standard process, White of Egg being the meat used. The Volatile oil of Tea was found to distil off, mixed with water, at 99°C; that of Coffee at 97°C; that of Cocoa at 95°C. Experiments were performed with the Volatile oil of 25 ccs of each beverage dissolved in 25 ccs of water, digested with 50 ccs of artificial gastric juice, but without any meat, to obtain the
factors for the results of digestion of these mixtures, which were subtracted from the results obtained, when similar digestions were performed with white of egg. No precipitate was formed on mixing the solutions of the Volatile oils with the digestive fluid, but as the digestion of the white of egg progressed, a precipitate formed, first in the cases of tea and cocoa but afterwards in that of coffee. It was found by experiment that the Volatile oil of none of these beverages caused any precipitate with solutions of either tyrosin or peptones and therefore it is only right to conclude that any action the Volatile oils had on the formation of this precipitate could only be to the extent of assisting it, that the precipitate must have been of the nature of that somewhat indefinite body, the "depeptone" of Hessemer.*. Turning to the results

Of these experiments, shown in Tables M, N, the factors for the results of digestion of the Volatile oils, water & digestive fluid are seen not to differ widely from those obtained in the case of the digestion of a mixture of water & digestive fluid only. The results of digestion of White of Egg, with the Volatile oils, are all seen to fall below the result obtained from the digestion of White of Egg in presence of Water only; the decrease being greatest in the case of Coffee, viz., from 434 gm to 234 gm, or 46.04% at least in that of Cocoa, viz., from 434 gm to 286 gm, or 34.11%; Tea more nearly approaches to Cocoa with 266 gm as a loss of 38.77%. From these figures, it is seen that the Volatile oils have a certain anti-fermentive action & it may, therefore, be taken as proved that this cause has a share in producing the action of the beverages, on peptic digestion; though the results of this Experiment...
on account, probably, of the above
noted precipitate, fall much short
of what would have been, a priori,
expected.
The fifth cause, viz, the action of the
alkaloids of the beverages, in reducing
the action of the peptic ferment is
next to be considered.
To put this theoretical action to the test,
the following experiment was performed.
The alkaloid, obtained from 25 cc of
each of the typical beverages, by the
process detailed on p. 17 was
dissolved in 25 cc of distilled water
the solution used, as the beverage for
experiment, otherwise, conducted, on
the lines of the Standard Process.
Three experiments were performed with
the alkaloid of 25 cc of beverage
dissolved in 25 cc of water digested with
50 cc of digestive fluid for 6 hours,
without any meat, to obtain the factor
to be subtracted from the results, when to
the same mixture, 5 grams of White of Eggs
were added to be digested.
On adding the solution of alkaloid to the digestive fluid, no precipitate occurred nor did any form during digestion. The results are shown in Tables O & P. On examining the factors (Table O) derived from the digestion of the alkaloids, it is seen that, while those for the Theine of Tea and Caffeine of Coffee, are close together; that of the Theobromine of Cocoa is much greater, but this depends on the impurity of the alkaloid in this latter case, which, by the process followed, contained a considerable quantity of Sugar. Turning to the results of the digestion of White of Egg, it is seen that in the presence of the Theobromine only, does the result fall below .434 gmon, being in this case .391 gmon, or a decrease of 9.91%, as compared with the result of the digestion of 5 gmons of White of Egg, in the presence of Water only. With the alkaloids of Tea & Coffee the results are above .434 gmon viz .437 gmon
An increase of 68%, in the case of Theine, and 48%, in the case of Caffeine. This is this resemblance surprising, when it is remembered, that Theine and Caffeine are only two names for the same alkaloid or Methyltheobromine. Therefore their actions must be the same, while Theobromine is a different body. The difference between the results, obtained with the impure Theobromine, and those with the pure (or almost pure) Theine, seems, however, to be too great to be attributed to the difference between the alkaloids; the chemical actions of which are very similar, but appear rather to be attributable to the impurity of the former. The conclusion on this head is, therefore, that Theobromine alone, and that doubtfully, possesses any retarding action on digestion, while Theine appears to rather aid the action of the pepsin on coagulated protein.

Albumen and its presence in coffee is the probable cause, why the results of the digestion of this substance, in the presence of coffee, exceed those with water as the beverage.

The sixth possible cause is the precipitation of the syntonin and peptones, as formed, by beverages. It has already been seen that syntonin is precipitated from its solutions by tea and cocoa that peptones are precipitated by all the three typical beverages unless all that ingredient of the beverage, which acts on these bodies, is used up in other ways before they are formed, or unless the beverages are thoroughly digested, when as seen on p. 70 it seems to precipitate them; it is evident, that they will be precipitated.

That this precipitation does occur is rendered probable by the fact observed that a precipitate is seen to be formed in all cases of digestion in presence of infusor beverages when
not masked by suspended matter, with the exception of the "Coffee": Now, it has been seen, that syntemin dipeptones are precipitated by the typical beverages, that digestion is retarded by the presence of these beverages, except in those special cases, that the alkaloid of the beverages exerts any action, it possesses, apparently rather in aiding digestion than in retarding it. That the volatile oil alone of the active ingredients of the beverage, examined so far, exerts any action in retarding digestion. The only other active ingredient remaining of those contained in the beverage, viz., the acid (syntemin or its homologue), is the one, to which most of this result must be traced, for it is its action, in precipitating syntemin dipeptones, which produces the effect. That this is the case, is shown by the experiments, the results of which are contained in
The acid precipitated from 25cc. of beverage by a solution of Sulphate of Lead & freed from Lead by Sulphuretted Hydrogen by the process described on p. 16, was, after evaporation to dryness & weighing, dissolved in 25cc. of distilled water & the solution used as the beverage of an experiment performed by the standard process. A precipitate occurred on mixing the solution of acid with the digestive fluid most marked in the case of that derived from Tea but also with that of Coffee & Cocoa. Factors for the result of the digestion of the acid with the digestive fluid & water were also obtained & are shown in Table A from which it is seen that the Tannic acid of 25cc. of Tea dissolved in 25cc. of Water & digested with 50cc. of digestive fluid, gives a factor the same as that derived from the digestion of the same quantity of water.
digestive fluid, this being accounted for by the precipitation of some albumenoid from the digestive fluid by the tannic acid, the loss in degradable organic matter, being made up by some of the acid, not so consumed, but digested, so as to lose its power of precipitating peptones. In the case of the caffeo-tannic acid, the factor is above that of the mixture of digestive fluid and water. The same is the case with cocoa, this pointing to the fact, that any loss of degradable organic matter, by the precipitation of the albumenoids, by the acid, is more than made up for by that derived from the digested acid. Turning next to the results of the digestion of white egg in the presence of the tannating matter of the beverages, it is seen that only in the case of that digested in the presence of the tannic acid of tea, is any marked reduction, amounting to 21.8%.
produced while with the acids of Coffee & Cocoa; the reduction is less, with that of Coffee 3.25% than with that of Cocoa 3.69%; showing, as was to be expected from the less active nature of the acid in the cases of these two latter beverages, viz, a less interference with digestion. It is to be observed, that this result depends on a different action of the beverages than the result of the experiment with Beef soaked in the beverages, before digestion, for in this case, White of Egg, coagulated by heat & therefore not susceptible of further coagulation by the tanning material of the beverage, was used. Therefore, the only way in which the reduction in the results could be caused, was by the action of the beverage removing some of the pepton of the digestive fluid (first possible cause) & by the precipitation of Syntomins & peptones, as formed, by the digestion of the White of Egg.
of peptones was the cause of the great reduction, in the result of the albumen digested in presence of the tannic acid of tea, is also supported by the fact observed in this experiment that the precipitate produced in this case increased as digestion proceeded, while in the case of the acids of coffee and cocoa, no increase of the precipitate appeared to take place. Therefore, the action in these two cases appeared not to depend so much on the precipitation of syntonin + peptones. Another experiment, bearing on the action of this cause, was also tried. The results of which, are shown in Table 5. Here syntonin, having been first prepared by the action of dilute hydrochloric acid on raw beef (raw muscle yielding syntonin with especial ease, perhaps from the presence of a minute quantity of pepton in it*), was digested with digestive fluid.

*Physiological Chemistry of the Animal Body, 1882, p. 324, Vol I
which thus found the first stage of digestion ready formed for it, of the beverage under experiment. The details of the experiments were as follows. The Strychnin having been prepared by the action of the dilute Hydrochloric Acid on Minced Raw Beef, was precipitated from the solution, by neutralising it with Carbonate of Soda & the liquid decanted off the precipitate, which after washing, was redissolved in Dilute Hydrochloric Acid & 25 ccs of this solution were used in each experiment. Thus the amount of Strychnin used was unknown but the same in each case; to this 25 ccs of Strychnin solution, 25 ccs of a digestive fluid, made of double the strength named on p.22, was added, the double strength gastric fluid with the 25 ccs of water in which the Strychnin was dissolved making 50 ccs of digestive fluid containing Strychnin in solution.
25 ccs of water & of each of the three typical beverages were added each to the contents of its special beaker. On the addition of the Tea, a dense precipitate was caused, which appeared to become still more dense as digestion proceeded, while the addition of Coffee caused no precipitate; in the case of Cocoa, if any formed, it was masked by the suspended matters. In the rest of the experiment, the Standard Process was followed. The results in Table 5 show that a very great reduction took place in the dialyzable matters produced by the digestion of the syntonicin in presence of Tea & Coffee, as compared with that produced, when water was the beverage used, i.e. a large reduction, though less than in those cases, where Cocoa was the beverage. The very small result in the presence of Tea depends on the weakness of the syntonicin solution, nearly the whole of that body, being precipitated
by the Tea & removed from the
action of the digestive Fluid.
The small results in the presence of
Coffee are not so easily understood
as they may depend on some unknown
error. From these two sets of
experiments, it may be taken as
proved, that in the case of Tea the
most active agent, in reducing the
action of the peptic ferment, is the
Tannic Acid; while its homologues
in Coffee & in Cocoa though they have
some action are not nearly so
powerful.
The latter experiment may also be
quoted to show that the precipitation
of the Syntonicin, as produced in the
first stage of digestion, is a very
large element in the action of the
Tannic acid, if not the chief.
The seventh possible cause applies
only to those beverages, which contain
considerable quantities of albuminal
matters, viz. the Cocos & is that
the accumulation of peptones derived
from these albumenoids, the action of the undigested albumenoids in precipitating hemosin may hinder digestion. That such an accumulation of precipitation does occur & prevent the further action of the digestive fluid on albumenoids exposed to it has long been known & its action has already been noticed in the results of the experiments made on the digestion of Roast Beef & White of Egg with undiluted digestive fluid, which are shown in Tables F & G, but it is on entirely theoretical grounds that it is put forward in this connection.

The eighth & last possible cause, also applies only to these beverages & depends on their containing suspended matter which both clog the action of the connection tube & by gathering around the meat prevent the digestive fluid acting on it to the best advantage.

* Handbook for the Physiological Laboratory, Bruden Sandeau, p. 489
* Analyse Chimique Appliquee a la Physiologie, G. Wolff, Seyler, p. 463
That this action really exists is shown by the result with Cocoa in Table X. Here 25 ccs of Efflorescent Cocoa were mixed with 50 ccs of digestive fluid, the mixture filtered, 1.6 gms. of White of Egg digested with the filtrate for 6 hours, the Standard Process being otherwise strictly carried out. An experiment, without White of Egg, was also performed to obtain the factor for Cocoa, filtered after mixing with digestive fluid, then digested. This factor is seen from Table X to be 0.412 gms. as against .53 gms. as the factor for unfiltered Cocoa, showing that the digestive fluid extracts 1.12 gms. of dialysable matter from the suspended solids of the Cocoa. The result of the digestion of 5 gms. of White of Egg is .547 gms. as compared with .164 gms. when unfiltered Cocoa was used, thus showing a very large amount in favour of the filtered beverage, which appears even to favour digestion. This claying action of the suspended
Matter can, however, only take place in such experimental digestions as those at present considered for the movements produced by the muscular action of the stomach walls, cause a mixing of the meat, beverage & digestive fluid contained within them, much more thorough than the action of the convection tube is able to effect. Hence the results for “cocoa” contained in Tables II & Co apply only to experiments under the conditions of the standard process. It is probable that, had the movements representing those of the stomach been sufficient to cause a more thorough mixing, not only the average result for the digestion of all the meats in presence of Cocoaïna, would have been higher than for digestions in presence of Tea or Coffee, but also each special result would have been larger.

In the cases of Chocolate & Caff. 
Cocoa the results would not have 
been as small as they were. 
Still in these experiments, this action 
of the thick beverages evidently 
has its share in producing the 
results.

Summing up the causes determining 
the actions of the infused beverage; 
it may be said that the action of 
Tea, taken as the type of all the 
"Teas", in reducing the digestion of 
albumenoids depends chiefly on 
the activity of the Tannic acid 
contained in the beverage, which acts 
by coagulating albumenoids which 
have escaped the action of the cooking 
by tanning the gelatinous constituents 
of the meat & causing them to contract 
& press upon the albumenoid parts, 
by removing the pepton itself, by 
entangling it in the precipitate, 
formed with the albumenoids of the 
gastric juice; & by precipitating the 
"Syntonic" & peptones as formed.
The volatilie oil of the Tea has also been seen to show some activity in reducing the digestion of white of egg, but the alkaloid appears, if anything, to favour digestion. The action of coffee appears to be, in the direction of favouring the digestion of white of egg, but that of all other meats experimentally shown, except Ham, is retarded though as a rule to a less extent than in the case of Tea. The Tannic Acid of Coffee, Caffeo-Tannic Acid, is of a less active character than that of tea & does not precipitate gelatine or tyrosin; only slightly precipitates albumen & peptones. Hence the action of this acid is, as already seen, slight compared with that of its homologue in Tea. The Volatile oil however, has more activity than that of Tea, in delaying digestion, while the alkaloid being the same as that contained in Tea favours the digestion of White of Egg & to its action
must be ascribed the effect of Coffee in increasing the digestion of
White of Egg, 1 of Ham. This action of the alkaloic in the case of Tea
is masked by the Tannic Acid of the Tea.

The effect of Coffee in reducing the digestion of the other nitrogenous
meats, in which it is a type of the other "coffees," must depend on
the action of the Coffees, Tannic Acid
on the albumen + peptones + on
the antifermentic action of the
Volatile oil.

The action of Cocoa is in some respects
intermediate between that of Tea and that
of Coffee, for in its case the acid is
more active than that of Coffee, but less
than that of Tea, producing slight
precipitates with all the albumenoid
solutions + also with gelatine.
Hence it is found that the action
of Tannic acid of Cocoa on digestion
is slightly (46%) greater than that
of the Acid of Coffee, while the action of
the volatile oil is less than that of the volatile oils of either tea or coffee. But the suspended matters of the "cocoa" give rise to two more causes, in the case of these beverages, of their action in retarding digestion, viz., one depending on the accumulation of the peptones, the other on the clogging action of the suspended solids. Both of these causes only affect these experiments, for when digestion takes place in the stomach, on the one hand, the peptones will be removed by absorption, and on the other, the movements of the stomach will prevent the clogging.

Having considered the total action of infused beverages on peptic digestion, the probable causes of this action, a series of experiments remain to be examined, which were performed with the view of ascertaining the effect of the presence of the three principal beverages, on some of the constituents of the mixture of
Substances present in the liquid resulting from the digestion. For this purpose experiments were performed with 5 gms of White of Egg in each, by the Standard Process following it only as far as the end of digestion, no dialysis being performed. The acid of the digestive fluid was estimated by volumetric analysis and was found, in this case, to be equivalent to 4.24% of Hydrochloric Acid. Digestion was allowed to proceed for 6 hours, the resulting fluids having been filtered from any precipitate, which had formed, from undissolved White of Egg, the acid contained in a measured quantity was estimated by the Volumetric process of the amount in the whole 75 ccs of mixed fluid, (25 ccs of Water or beverage + 50 ccs of digestive fluid) deduced with the results shown in Table T. The acid in the 50 ccs. of digestive fluid used, would be equal to 0.212 gm.
seen from the Table that in the
leptinisation of the amount of Whey
of Egg digested, this had been
reduced in the case of digestion in
presence of Water, as the beverage,
in that of Coffee to 0.18 gms or a
reduction of 0.064 % in the 6 hours
without allowing for any effect
in reducing the apparent loss of the
concentration of the fluid, which
must take place under the
circumstances of the experiment.
It is also seen that in digestion
with Tea as the beverage, less acid
was consumed than in the above
cases the amount remaining of the
0.212 gms contained in the 75 ccs of
mixed beverage & digestive fluid
being 0.195 gms, while with Cocoa
more had been used, the amount
remaining being 0.172 gms. The
former result evidently depends
on the retarding effect of the beverage
on digestion, the less albumen
transformed into Systonin, of course
the less acid used in affecting that transformation; the latter results, on the presence of finely divided solid matter suspended in the coacoa containing albuminous bodies capable of undergoing transformation into syntonin. In another experiment, with the same digestive fluid, in other respects exactly similar to the above, but carried on for 12 hours, the amounts of acid remaining in the various cases were ascertained (Table V) to be apparently larger than in the 6 hours experiment, this depending of course on the evaporation of the water from the mixture of digestive fluid & beverage, during this longer exposure, at a temperature of 37.7°C. The same order is, however, seen to be maintained, Water & Coffee having the same effect on the consumption of acid, while Tea has so far lessened it that with the effect of the concentration of the liquid, all the acid that appears
to have been consumed is .002 gms. Cocoa has again consumed the largest amount, viz., .015 gms, more than either Water or Coffee.

Turning again to the 6 hours experiment, another measured portion of the filtered liquid resulting from this experiment was concentrated to small bulk in a water bath at 100° C and the albumenoids precipitated by absolute alcohol; this being done with a measured quantity of the filtrate, from each of the four experiments, making up this set. The precipitate was removed by filtration, washed with alcohol dried & weighed & the filtrate & washings evaporated to dryness after mixing & the resulting residue weighed, the weights of both precipitate & residues, being shown in Table I. Here it is seen that the albumenoids are very small in quantity & smallest in the case of digestion in presence of water, this, of course,
resulting from the fact that any peptones derived from the digestion of vegetable albumenoids, contained in the beverages, would be precipitated by the alcohol. Tea is seen to show the largest amount of these albumenoids, the reason, apparently, is, that from the manner of its preparation it contains rather more vegetable albumenoids than coffee, while cocoa, though rich in vegetable albumenoids, causes such a clogging action that the peptones derived from these only suffice to supply the place of those not produced from the white of egg, on account of this action of the beverage.

Comparing these small results with those from the Peptide Experiments Table II, it is evident that some dialysable organic matter must have escaped precipitation, by the alcohol, to be contained in the residue from the evaporation, the more so, when it is remembered, *See Table II*
that undialysable syntonin is included in the albumenoids precipitated from the solution by alcohol.

Now supposing, the whole amount of matter represented by the Beverage Factors (Table C), which includes chiefly the dialysable matters derived from the beverage, viz., such bodies as the alkaloid, digested tannin, acid, & the dialysable matters derived from the digestive fluid to be included in the residue from the evaporation of the filtrate; it is reasonable to suppose that the greatest amount would be, as the albumenoid constituents of the beverages except in the case of the "Cocoa" are very small in amount; it is evident that on subtracting these factors from the amount of these residues, the amounts left vary from .25 gm. in the case of Coca to .354 gm. in that of Tea, the intermediate figures.
being those with Water, 278.5 gms. & with Coffee, 133.1 gms.

These amounts include the salts, both of the beverage & of the digestive juice, as well as those of the White of Egg, excepting such as might be precipitated by alcohol & reckoned with the albumenoids. But these salts did not make up the whole of the residue, even in the case of digestion in presence of water, though in all cases, except that in presence of Cocoa, the residue contained crystalline matter; for on redissolving in water & boiling a small portion of the solution with Citric Acid, the Xanthoprotein reaction was produced, indicating the presence of nitrogenised organic matter. From the smallness of the result in the case of albumenoids precipitated by alcohol, it is rendered probable that some of this nitrogenous organic matter must have been dialysable & have represented that part of the amount
of dialysable organic matter found by the "Peptone" experiments to be produced by the action of digestive fluid on white of egg, which was not contained in the albumenoid precipitate produced by alcohol.

It is known that protracted digestion of albumen by the pancreatic ferments produces leucine & tyrosine, with glutamic & aspartic acids; and, if any of these bodies, had been produced by the peptic digestion, they would be found in the residues from evaporation of the alcoholic filtrate. These were therefore tested for the presence of tyrosine, the tests for this body being more delicate than those for leucine, which seems always to accompany it, by both Hoffman's (mercuric nitrate & nitric acid) test & Piria's (sulphuric acid & ferric chloride) test. The former test is stated by Handbuch für die Physiologische Chemie, Band III, S. 178.
Hoffe Seyler to be so delicate, as to detect $\frac{1}{1000}$ part of Tyrosine, in a liquid. When this test was applied to a portion of the solution of the residues, no colouration beyond that of the Xanthoprotein reaction was produced in the residue from digestion in presence of water, or tea, but in those from digestion in presence of Coffee & Cocoa, this yellow colour was turned to orange probably by the pink of the Hoffman's reaction. In the case of Piria's reaction, a distinct blue was not obtained in any case, but in that of the residue from the digestion in presence of Coffee, the yellow of the Ferrie Chloride was turned greenish & as this test is not so delicate as Hoffman's, the presence of Tyrosine in the residue from digestion in presence of Coffee may be considered, if not proved, at least very probable, in the case of Cocoa, possible. This bears out the
Truth of the result, shown in the "Reptone" experiments, that the action of coffee on the digestion of white of egg is in the direction of increasing the effect of the pepsin.

There is one item in the effect of infused beverages on digestion, which is familiar to most people, viz., the amount of flatulence, often produced by their use, along with animal food. The amount of this effect in the cases of water and the three principal beverages, was made the subject of experiments, the results of which are shown in Tables V, VI, and which were arranged to ascertain the amount, not the quality, of the gas produced by this action.

The method used was as follows; 2 grams of the meat under experiment were weighed out into a small flask, to this were added 10 ccs of the beverage and 20 ccs of digestive fluid. The flask was tightly corked and through the cork, was passed
a tube bent to form a small
manometer & containing mercury.
Five of these flasks were used, four
containing minced Roast Beef
with digestive fluid & water, tea
coffee, & Cocoa, respectively, & one
other containing minced Ham with
digestive fluid & tea. The flasks,
having been placed in a waterbath,
were maintained at a temperature
of 37.7°C, for 6 hours, the height of
the mercury in the manometers,
being noted every hour. The height
of course depended on the pressure
within the flask, which, after the
height due to the vapour tension of
water at that temperature (found
by experiment to be 57 millimetres),
was reached, would represent the
amount of gas produced. The
experiment with Cocoa was a
failure owing to the apparatus
leaking, that with Tea & Ham also
leaked but this was repaired.
Indeed all the corks leaked thoroughly.
slightly, for by examining Table V, it will be seen that, in some of the hours, the amount of gas produced was insufficient to maintain the height of the mercury which, therefore, shows a decrease. In Table V, the results are obtained by adding together the millimeters of increase in each hour when there was any without omitting any decrease, which depended on the apparatus and not on the action of the beverage, while all increase depended on the production of gas. The result of digestion in presence of water may be taken as an example. The height of the mercury was just maintained, for the first two hours, at 52 millimeters rather below the vapour tension of water, for that temperature, this depending on the smaller vapour tension of digestive fluid; by the end of the third hour, the mercury had sunk on account of some leakage
to 48 millimetres, to rise again at the end of the fourth hour to 55 millimetres and to sink to 54 millimetres at the end of the fifth, and to 49 millimetres at the end of the sixth hours respectively. The whole increase here consists of the 7 millimetres at the end of the fourth hour. Proceeding in a similar manner with the results of the experiments with the other beverages, the figures in Table W are obtained, from which it is seen, that Beef digested in the presence of Tea produced the most flatulence, equal to a tension of 8 millimetres, while Beef digested in the presence of Coffee produced the same tension as was obtained, where water was the beverage, viz., 7 millimetres and Ham, digested in the presence of Tea, produced a tension of 5 millimetres only, though from the cause above noted, this would have been higher had the apparatus worked properly but
probably not so high as with
Beef digested in presence of Tea.
The fact that Ham produces less
flatulence when digested in presence
of Tea than Beef under similar
circumstances, is quite in accordance
with the teachings of experience for
it is often seen that much
more flatulence is produced after
breakfast, when fresh meat has
been partaken of, than when
salted meats have formed the
albumenoid portion of the meal &
this is perhaps the reason why
salted meats have come to form
the usual breakfast dishes.

Summing up this portion of the
paper it may be said that coffee
still maintains the position
assigned to it by the Peptoné
experiments, for it is found that in
the digestion of White of Egg in
presence of Coffee more acid is
consumed than in that of any other
infused beverage except Cocoa & as
as much as in the case of Water.

More albumenoids, precipitable by

alcohol, are produced by digestion,

in presence of Coffee, than when

water is the beverage & as much

as, in the case of Cocoa, though less

than in that of Tea; for the

reason noted above (p.115).

With regards to the solids not

precipitated by alcohol, Cocoa

heads the list in account of the

sugar contained in it; but Coffee

comes next in this residue.

The presence of Tyrosine was so

distinctly indicated, as to leave

very little doubt, that it was

really present, while in the case

of Cocoa its presence was very
doubtful, & it was absent in those

of Water & Tea.

Portions of the Chymified mass

from the digestion of Beef in the

presence of Water, of Tea & of Cocoa

in the "Flatus" experiment were

removed \after cooking in glycemic
were mounted as microscope specimens in that fluid & examined under a ½ inch object glass magnifying about 300 diameters. The drawings in Figure II were made from these preparations.

The Beef digested in presence of water (Fig II A) showed in parts the transverse three of the muscular fibres very faint & often a well marked longitudinal striation while in places these appearances had passed on into division of the fibres into discs & fibrille & some single detached discs were noticed. In other places the sarcolemma of the fibre appeared empty, as a clean tube. These appearances resemble those noticed by Dr. Ramsetz* & by Dr. Dalton$. The

muscle-nuclei were distinctly seen mostly as dark linear bodies but sometimes granular. Some were found floating free in the fluid, the so-called Nuclein, composing the nuclei, being insoluble in gastric juice & set free by its action on the masses of protoplasm surrounding the true nuclei. The vessels & nerves of the muscle could be recognised in various parts but with difficulty as they were almost entirely digested.

In the case of beef digested in the presence of tea (Fig II B), the transverse rhiz of the muscular fibres were more distinct than in the case of that digested in the presence of water, the division into discs was seen but it, as well as that into fibrillae, was rarer & less advanced than in the former specimen & moreover...
was a perfectly empty sarcolemma tube to be found, the transverse lines being noticeable in all cases, tho' sometimes very faint. The nuclei were more distinctly granular & fewer were found floating about free. The nerves & vessels, also were more distinct than in the case of the Beef digested in presence of Water. In the case of the Beef digested in presence of Cocoa, the transverse strike of the fibres were very distinct & division into discs was sometimes seen (see Fig.11C) but longitudinal striation & division into fibrille were very rare & very few empty sarcolemma tubes were seen. The nuclei were distinctly granular & but few were seen free. The specimen also contained much of the suspended matter of the beverage, of the vessels & nerves of the muscle were very distinct. On examining these results, it will be seen that they point to the
following conclusions, regarding the manner of action of the beverage,

(1) That tea delays digestion of muscular fibres by precipitating the albuminoid matter of the sarceous substance, as is shown by the preservation of the transverse stripe of the muscular fibres.

(2) That while digestion in the presence of water dissolves the protoplasmic matter of the muscle-nuclei & acts free the true nuclei (nuclein), thus causing the places occupied by the nuclei to appear as dark linear marks; the protoplasm is coagulated by the Tannin of the Tea & causes by its shrinking the @ape of the muscle nuclei, shown in Fig II B, where they appear as a row of circular bodies getting smaller towards each end & when floating free much resemble some diatoms (navicula).

(3) That the action of the Tannin in the white fibrous tissue surrounding the vessels & nervees of the muscle preserves these from the action of
of the Gastric juice.

(2) That the conclusions in the case of Cocoa are similar as regards the action of the Tannic Acid, but as this acid has been seen to be, of a very weak form in Cocoa, it requires the assistance of the suspended matters of the beverage protecting the meat to account for the action of digestion on the meat being less in this case, even than in that of Tea.

The microscopic appearances therefore support what has already been shown by chemical methods. All the foregoing experiments have been tried with the infused beverages as they are prepared with water, but not in the state in which they are usually drunk in this country at any rate, to ascertain the effect of the additions of Milk and Sugar, which are customary here, in modifying the action of the beverage on digestion, the
Experiments, the results of which are contained in Tables X and Y, were performed. The process followed was the Standard Process for "ferment" experiments (see p.24 etc.) with White of Egg for the meat; the only exception to the usual course of the process being, that to the 25cc of the beverage used 5cc of milk and 1.25 gms of powdered white sugar were added, these being ascertain'd to be very nearly the proportions in which the mixture of beverage milk + sugar is usually made. The caecum of the mouse was rapidly coagulated on the addition of the digestive fluid for 20 minutes after the commencement of the process of digestion, the liquid was quite clear but contained floating masses of solid caecine. An experiment with Bovine serum with the proper proportions of milk + sugar was performed to ascertain how much of the dialysable organic...
matter in the results depended on these additions, this experiment being performed without White of Egg, as also were a set with the beverages to ascertain the beverage factors when milk & sugar are used.

On examining the results in Table X, it is seen that the factors for the beverages containing milk & sugar, are, as was to be expected, from the easily digestible nature of the former & the crystallized character of the latter, very high. The factor for Tea with milk & sugar is .077m less than that for water with these accompaniments, on account of the action of the Tea on the digestion of the Casein but with the two other beverages, the results are greater, than in the case of water. In Table V are seen the figures derived from the digestion of 5 gms. of White of Egg, with the three typical beverages with milk & sugar. Of these the
results with coffee appear, for some reason, fallacious unless the clodding action of the coagulated casein has been sufficient to reduce the peptones produced from .462 gm. to .237 gm. In the case of tea, the result is different for the action of the milk on the tea, is to reduce its effect in retarding digestion & so to increase the amount of dialysable organic matter produced from .398 gm. to .426 gm., or from 91.7% to 98.15% compared with the result, when white of egg was digested in presence of water without milk or sugar.

The result of cocoa with milk & sugar is what would be expected for it has been seen that the action of this beverage on artificial digestion is caused more by the clodding action of the suspended solid matter than by the astringency of its acid & when, to the suspended matters of the cocoa, is added the suspended...
Coagulum of Casein, it is not wonderful that the amount of white of Egg peptonised is reduced from 1.64 gm or 37.78% to 0.49 gm or 9.21%. But, as already shown, this clogging action would at any rate be much less in the stomach than in these experiments, on account of the muscular action of that organ mixing the gastric juice more thoroughly with the food. Therefor it is safe to say that of these beverages, tea has much less action in retarding digestion, when mixed with milk & sugar, than without these & that their addition at any rate will increase the nutritive value of all the beverages, even if it has no effect in assisting digestion in presence of Coffee & Cocoa. The last Table to be noticed is Table 2, in which are recorded a large number of Specific Gravities of beverages, filtered & unfiltered.
I digested, alone or with various meats, water at 4 °C being taken as 1000. Those beverages, which contain most sugar, such as cocoa and chocolate, have the highest specific gravities. The specific gravities of the digested beverages, both with and without meat, are those of the filtered wine and do not vary very much, those being the highest, where the meat contained much saline matter, or the beverage much sugar.

The chief points shown by these experiments may be briefly recapitulated here, it being premised that these results must be understood to apply to the experiments, as performed under the standard process or the modifications of it, above described.

Firstly, All infused beverages retard the digestion of albumenoid food stuffs. There are four exceptions
To this rule, two supported by the evidence of various experiments viz.
Egg with Coffee & Ham with Coffee, is two uncertain, because unsupported.
Fish with Cocacina & Fish with Cocoa.
Also the digestion of the meats usually consumed at breakfast, viz., Egg,
Salt Beef & Ham, is less influenced by the action of Tea & Coffee than that
of other meats & the same is true of Roast Beef. With the other
beverages, no such division into a group of "breakfast meats" & group
of others is to be observed.
Secondly, that this retarding action is, as a rule, less with Coffee than
with Tea & less in either case than with beverages of the Cocoa order.
Thirdly, that this retardation is caused, (a) in the case of Tea by
the Tannic Acid, assisted by the Volatile oil, the former precipitating
the uncoagulated albumenoids of the meat, the Syntomic & peptones &
removing the peptin by entangling it
with these precipitates, tannin the gelatinous constituents of the meat, & the latter retarding the action of the pepsin.

(6) In the case of Coffee, the Volatile oil & Caffeine tannic acid retard digestion; & the alkaloid assists it; therefore in those cases where digestion is assisted by coffee this must be the active agent, in producing the result.

(10) In the case of the "Cocoa", the acid Volatile oil & alkaloid, all assist in retarding digestion but, under the conditions of the Standard Process, the clogging action of the suspended matters is the most potent factor.

Fourthly, in retarding the consumption of acid in digestion, Tea has the greatest effect & Coffee has no more effect than water, but Cocoa increases the consumption.

Fifthly, Coffee, & doubtfully Cocoa, cause the peptic digestion of Albumoide to pass on through the stage of
Leptones to the formation of Lecain

Tyrcoeine

Tea acts on the digestion of uncooked meat so as to increase the production of flatus. Coffee has no more effect on its production than water & salted meat, digested in presence of Tea, gives rise to the production of flatus of all the cases examined.

Seventhly, the addition of cream & sugar to the beverage reduces the retarding action of Tea on digestion, but increases that of Coca by adding the clogging action of the coagulated caseine to that of the suspended matters of the Coca. Coffee appears to have its action on the digestion of White of Egg reversed by the addition of cream & sugar but this result is doubtful.

From these experimental results the following practical conclusions, as to the use of these beverages, may be drawn, but it must again

* See Appendix p.160
be clearly stated, that only those
factors producing digestion, which
are represented in the Standard
Process, viz. the action of the acid
and ferment in producing syntonous
peptones are considered. That any
effects of the beverages on the
secretion and quality of the gastric
juice or on any other vital
process in the stomach, are ignored.
In one or two cases, conclusions
may be drawn, with regard to
these vital actions, but, as a
rule, they cannot.
It has been seen that, if at any
meal containing albumenoid
matters, one of these beverages be
drank instead of water, a
reduction, in the amount peptoned,
so as to be fit for absorption into
the circulation, the further changes
to be undergone there, will be caused
if the proportions of beverage
meat and gastric juice, the other
conditions are similar to those
of the standard experiment, this reduction will be in the proportion of the percentage results in Table II, as compared with what would have been rendered fit for absorption, had water been used as the beverage. Now it is evident that a person making such a meal must either be content to suffer this loss, or he must take more nitrogenised food, than he would have required had he drunk water only. Therefore infused beverages should never be partaken of, at any meal containing much albumenoid matter, by either the very poor, to whom every milligramme of animal food is of importance, from its cost, or by the dyspeptic, who cannot afford to have his delicate stomach irritated by undigested food. Indeed the only class of people, who can find this action of infused beverages beneficial will be those, who habitually consume
Too much animal food, which, if absorbed into the blood, would, by causing too great a strain on the kidneys, induce gout or some renal complaint; but, which, if precipitated by the tannic acid & rendered insoluble, will be thrown off without absorption.

In considering these cases more particularly, that of the poor may be taken first.

Dr. Pavy quotes from Dr. Playfair* the following as an example of a "substance" diet & points out a London sempstress as an example of the class of person living on it.

**Nitrogenous Matter** 2.33 oz. = 65.95 gms

**Fat** 0.84 oz. = 23.8 gms

**Carbohydrates** 11.69 oz. = 331.74 gms

The food being reckoned as dry solids. This diet excluding the fats would be represented by

Bread, 19.3 oz or 550 grms,
Meat, 10.5 oz or 300 grms.

reckoned as they appear, as articles
of diet containing water.
It is quite safe to premise that,
this woman would drink at
any rate the '75 pint or 425ccs.
of infused beverage, which falls
to her share under the average
for the United Kingdom, or indeed
that she would considerably
exceed this amount; also it may
be safely said that tea of an
inferior astringent quality would
be the beverage used.

Now Schmidt estimated the
hourly secretion of gastric juice,
during digestion, at the large amount
of 580 grms, say about 600ccs, the
amount of tea, supposing a large
cupful, (about 800ccs) was taken,
would give the exact proportion
(2:1) of gastric juice & beverage
of the standard experiment.

Supposing she made her meal

[* Freij's Histology, Barker. Churchill, 1874.
  p.483.]
accompanied by this cup of tea entirely of bread, it has been seen (Table C), that the effect of the admixture with the digestive fluid of half its bulk of tea, is to reduce its peptonising power on the albumenoids of bread to 89.23% as compared with the power, where water took the place of tea. Thus her 550 gms of bread would only yield the dialysable albumenoids of 490.76 gms, if enough tea was taken to act according to the standard experiment on the whole 550 gms, that is 2750cc. But this is a very large allowance of tea & taking 4250cc as indicated by the average, as the real amount consumed by her, this would act on 85 gms of bread, reducing the peptones produced from them to the same amount as if only 75.8 gms had been eaten. This would necessitate an addition in the former case of 60 gms of bread to her daily allowance, & in the
latter of nearly 10 grams. It must be noticed that only the nitrogenous matter of the bread is here referred to, as any action of the beverage on the digestion of the hydrocarbonaceous matter, by the saliva, &c. has yet to be ascertained. If the tea were taken at a meal, containing meat, for example beef, & only the 425 ccs of tea were taken this would act on 85 grams of beef, reducing the leptones produced to what they would have been, with water as the beverage, had only 81.9 grams of beef been eaten (i.e. 96.4% of the result with water as the beverage; see Table C), necessitating an addition of 3.7 gms to her daily allowance. But if a member of the group, more acted upon by tea, had been eaten, for instance fish, the 425 ccs of tea would act on the digestion of 85 gms of fish so as to reduce the leptones produced to the same amount, as would have been derived from 75 gms.
with water as the beverage + an additional 10gms of fish would be required in the daily diet.

Sea is asserted by Lehman* to reduce tissue waste. Though Dr. E. Smith† asserts that it has the opposite action. If the latter is correct, this only increases the total harmfulness of Infused Beverages. But accepting Lehman's view as correct, the question is whether the loss of food caused by the action of the beverage on digestion, is not compensated for by the smaller requirements of the tissues? If not, it is evident that a person, who drinks an infused beverage at a meal containing albumenoid matter will require more of this material, than one, who only drinks water. And even if the smaller requirements of the tissues did compensate for the loss of albumenoid matter.

†do. p 354
from the smaller amount of peptones produced, it would evidently be more economical, as the tea would reduce tissue waste, whenever it was taken, to drink the tea when the stomach was empty, then less food would be required at the meal time & there would be no loss by precipitation of albumenoids. The "cocoa" yields more nourishment from their own constituents, than other beverages & it may be believed that they retard the digestion of albumenoids in the stomach, as little as any of the beverages, on account of the powerful mixing action of the muscular walls of the stomach, hence, for the poor, they are the best infused beverages. The "coffee", in most cases, retard peptic digestion & those cases, where they appear to assert it, are really as disadvantageous as the others, for they seem to carry some of the albumenoids through the peptone stage, to that
of Leucine & Tyrosine & thus force-producing matter is lost to the body. With the floor the risk of infused beverages is, that they may cause loss of nutritive material but in the case of the dyspeptic the retardation of digestion is to be avoided, not on account of the loss it causes, so much as on account of the discomfort or even pain. With a person suffering from this state of stomach, besides the action of these beverages in precipitating albumenoids, which are thus placed beyond the reach of the action of the digestive fluid, there are other actions to be noticed. If the form of dyspepsia be chiefly of the flatulent kind, tea should be avoided, when unsalted animal food is taken, on account of the increased flatus produced by their digestion together, but it seems from Table IV that salt
meat does not produce so much flatus, when digested in presence of tea as unsalted does; Coffee & water have about the same effect on the production of flatus & as far as this action alone is concerned Coffee appears to be the best infused beverage for the dyspeptic.

If the dyspepsia is of the acid form from overacidity of the gastric juice or over secretion, Tea is the worst beverage for it has been seen that the consumption of acid is reduced by it, while Coffee has the same effect as water & Cocoa increases the consumption. This last would therefore appear to be the best beverage in this form of dyspepsia but, if there is any tendency to the lactic acid fermentation, going on in the stomach, Cocoa from the sugar contained in it should be avoided; for
though Dr Garrod states that in America sugar is considered to lessen acidity, that, taken as pure cane sugar, it has been shown not to increase but rather to diminish the amount of uric acid formed, yet he is careful to state that this applies only to pure sugar and not to sweetened fruits or thick-like substances among which last cocoa may be included.

In many cases coffee will be found to disagree; it is too heavy. Therefore in cases of flatulent dyspepsia if coffee does not suit, all infused beverages should be interdicted; in acid dyspepsia, if it be caused by over-secretion of acid, cocoa will be the best beverage; if from lactic acid formation, coffee, if not rendered unsuitable by other causes, in which case all infused beverages should be

forbidden. For those dyspeptics, whom Coffee suits, Ham or Bacon will be the best meat to take with it, for not only is its digestion assisted by the beverage, but, also it is itself very easily digested.

Turning, now, to the case of those, who habitually eat too much nitrogeneous food; Tea will be the best beverage for them, as by its action some of the albumenoid matter is withdrawn entirely from the action of the specific ferments probably rejected undigested, while Coffee in the cases, where it increases digestive action causes the production of phenol. Tyrosine, which have to be further decomposed and eliminated by the kidneys as much as, if no beverage had been used.

Having considered the bearing of the retarding action on digestion of the ill effects produced by it.

* Food & Dietetics, Pavy 2nd. Edition, p. 149
it will be well to look at some of the redeeming features of infund beverages.
Considered from the point of view of their nutritive values beverages differ widely. From Tables C and X, it is seen, that taking the figures called "nutritive values" to represent the amount of nutritious matter yielded to digestion by 25 ccs of the beverages, which is, however, giving too high a value to the beverage, as such substances, as the alkaloid & digested tannic acid, whatever their other actions, can yield but little, either of nutrition or force producing matter, but taking these figures as approximately correct, they are found to vary from .034 gms in the case of Tea, to .867 gms in that of Chocolate, both without milk or sugar; + from the result with Tea with Milk & Sugar 1.083 gms, to that with Cocoa with the same wig 1.485 gms.
These latter figures for 25 ccs of
beverage, with 5 ccs of milk and 1.25 pms of sugar, indicate that no small amount of nourishment is contained in a cupful of the beverage.
The total organic dialysable matter derived by a digestion of 6 hours from 25 ccs of cocoa without milk nearly approaches that derived from 5 gms of White of Egg under the same length of digestion, whilst that from 25 ccs of chocolate doubles this amount, in the cases of cocoa and Coffee, with milk and sugar this quantity is tripled.
To some people Cocoa is difficult of digestion but, where this is not the case, it affords a very large amount of nourishment in a portable form & indeed all the infused beverages, when used with milk & sugar act as vehicles for the nourishment contained in these additions.
So these points in their favour
Considered solely from the point of view of their actions on digestion, may be added the action of coffee in assisting the digestion of Egg & Ham.

Infused beverages whether their action be beneficial or the reverse have taken such a hold on public estimation that they would not easily be dislodged; nor indeed does this appear altogether desirable for from the results (Table F) of the digestion of Beef & White of Egg with undiluted digestive fluid, it is evident that in the process of digestion in the stomach some diluent is desirable to dissolve the peptones as formed & assist in their absorption. Water would of course be the best, but if infused beverages were denied to them, many people would supply their place by beverages, more harmful in many ways.
Therefore, finding infused beverages in favour, it will be better to direct their use to the most physiologically scientific manner and time, than to attempt to abolish it altogether.

They should manifestly, from Tables X and Y, be used with cream and sugar and the habit of drinking them as mere watery infusions should be discouraged, both on account of the astringency of the beverage, and of the loss of the nutritive matter supplied by these additions.

As regards the times of using them, at meals, which consist largely of animal food they should be avoided.

This requirement, whether by accident or design, has come to be followed out among all except the poorest classes, with their exception most people only make this undesirable combination at breakfast, & it has been shown that the usual breakfast
Meats are those which suffer least
in their digestion from the action of
Tea & Coffee; Coffee has been seen
to exert less deleterious action
on the digestion of these meats,
Than tea & should therefore be
used at breakfast, when not
rendered unsuitable by other
effects. The meal of Tea when
arranged in the Yorkshire fashion
is but a repetition of breakfast
with the addition of many cakes
& sweets not used at the earlier
meal & which do not tend to
increase the digestibility of the
latter. If Tea be made a meal,
the model of breakfast should be
followed, or the solid food should
consist entirely of bread & other
vegetable food stuffs, so as to
have as little nitrogenised matter,
to be acted on in digestion by
the beverage, as possible.
The cup of Coffee after dinner may
have some effect on secretion or
May be useful to neutralise the effects of other potions, but on digestive grounds, it has little to recommend it; the same applies, but in a much higher degree, to the cup of tea coming about an hour later, just when the process of peptide breakdown has reached its highest development and there is the largest amount of vitreous matter in solution to be precipitated by the tannic acid of the tea. The ladies have one meal, which has been much maligned, viz., "5 o'clock Tea", but, all things considered, this is perhaps just the best time of all for the enjoyment of what must be considered, at any rate, from a digestive point of view, as a harmful beverage. For early lunch has, by 5 o'clock, had more than its full 3 hours to disappear from the stomach and get beyond the reach of the tannic acid of the tea, while the time
Intervening before dinner will amply suffice for the removal of the slight amount of solid matter said to be eaten at "Kettledrum". Again this is just the time, after the afternoon's occupations are over, when the stimulant action of the tea will be useful to carry the energies on to the time of their full refreshment at dinner.

The worst habit of all, one which cannot be too strongly condemned, is that of continually drinking tea, whether the stomach be full or empty, which leads to imperfect digestion of whatever food the tea may encounter, its flatulency, if not its more serious gastric troubles.

These are the conclusions warranted by the results of the experiments, on which this paper is founded.

For the complete elucidation of
the subject further inquiry is necessary, as to the action of infused beverages, on the secretion of the gastric juice, its quantity and quality, on the movements of the stomach, on the absorption of the peptones; also on the diastatic action of the saliva, on the diastatic and proteolytic actions of the pancreatic secretion, as well as, on the quantity and quality of these secretions, and on the further digestion of the food in the intestines, as on the absorption and composition of the chyle.

When these inquiries have been made and satisfactory results obtained, the action of infused beverages on digestion, will be fully worked out, when the actions on the nervous system and on the kidneys and skin, ascertained by the experiments of Lehman and others, are taken into consideration.
and any other actions on the
other systems of the body, not
examined by them, are
detected —, when these results
are considered along with
those of the experiments on
digestion already made & yet
to be made —, then the complaint
of irregularity will not be
made any more about the
advice given by the medical
profession respecting the use of
Infused Beverages.
Appendix

M. Guimares* stated that the action of Coffee on dogs whether well fed or starving is to cause increased excretion and disassimilation while moderate quantities in the course of a few days cause an augmented assimilation.

The results in this paper showing that Coffee increases the pepsinising power of the digestive fluid on White of egg also causes the production of Decoecine & Tyrosin. The action of the Pepsine are in support of these results of M. Guimares.

Lancet Vol. I, 1883 p. 656