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Thesis on Gastric Juice

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The Gastric juice is secreted in the Stomach by a vast number of follicles contained in the mucous membrane of that organ. These follicles are closely applied one to the other and vary slightly in form; the most common form is where there is a wide orifice leading to a depression filled with cylindrical epithelium similar to that which lines the general surface of the Stomach; from the bottom of this depression, two or three or more passages branch off, which, are also lined by Epithelium of the same form. These again subdivide into the proper glandular cæca.

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which caca are composed of a delicate basement membrane infleeted over a number of globular cells - containing granular matter; between the rows of cells, there is a space which is lined by a layer of small epithelium. Between the follicles there is a plexus of minute vessels which are sent up from the submucous tissue on which their bases rest.

The caca which are connected with one of the follicles are bound together and completely separated from those belonging to other tubuli, by a layer of areolar tissue; this tissue at the same time dips in, in thin layers, between, & surrounds the individual caca.

Near the Pylorus however there is a different type of gland - presenting the following characters - 1st there is a wide orifice leading to a depression of greater depth & length, than in the first mentioned tubuli. This depression is also lined with epithelium.

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from its lower end, which is towards the submucous tissue of the containing organ. Several short follicles branch off. all lined with cylindrical epithelium, but entirely wanting in globular cells.

The first type of gland is supposed to secrete the active part of the Gastric fluid; for Kolliker has found in the Stomach of the Pig. that only the follicles with the globular cells furnish a fluid possessing an acid reaction & a solvent power over protein compounds, whilst on the other hands, those near the Pylorus and lined only by epithelium & not containing globular cells, furnish a fluid exactly similar to ordinary mucus. destitute of the acid reaction & solvent power so characteristic of the true Peptic gastric gland.

Bernard Homenen in one of his experiments. viz. where he injected a solution of cyanide of potash into one jugular vein of a dog, and the

Proto-sulphate

Prots. sulphate of Iron into the vein of the opposite side. on examining the Stomach he found, that the mucous membrane was of a normal colour except near the Pylorus + over the Hepatic portion, where it was of the deep blue of the Prussiate of Iron, the result of the union of the two substances, in the gastric juice as it was poured out. and from this he thinks that the glands in the part so coloured, are those which secrete the Gastric juice proper. but in this experiment he does not state whether there was any thing in the Stomach to excite the flow of the Gastric juice, and as we know that, this fluid is never poured out except when there is something in the Stomach to excite its flow, we would expect if the organ was empty, that the part of it most abundantly supplied with mucous glands, would be the part coloured & that part is the part near the Pylorus.

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and from this fact the glands first described are most probably the true secreting organs of the Gastric Juice. When the Stomach is empty, the true peptic glands have their orifices completely blocked up by columnar epithelium which fills them, and this is forced out when the secretion of the fluid commences.

II. The nature and composition of the Gastric Juice -

This important secretion is according to Dr Beaumont is "a clear, transparent fluid, inodorous, a little saltish, and very perceptibly acid. Its taste is similar to that of thin mucilaginous water slightly acidulated with Muriatic acid. It is readily diffusible in water, wine, or Spirits. effervesces slightly with alkalis & is an effectual solvent of the materia alimentaria. It possesses the property of coagulating albumen in an eminent degree; is powerfully antiseptic checking the putrefaction of Meat & effectually

restoratives

restorative of healthy action when applied to old fetid sores & foul ulcerating surfaces;
An examination of it under the microscope shows only a few of the cells which are cast off from the interior of the gastric follicles and a fine molecular matter arising from the disintegration of these cells—
The amount of solid matter and of pepsine present in the Gastric Juice varies very much in that of different animals, as seen in the following analyses of that fluid in the Dog & Sheep, and in that of man by Grunewaldt & Schroeder.

	Dog. mixed with Saliva	Sheep mixed with Saliva	Man mixed with Saliva.
Water	973.062	971.171	994.404
Solid Residue	28.829	13.853.	5.596
Ferment or Pepsine	17.336	4.055	3.195
Inorganic matters	11.493	9.798	2.401
Free Muriatic acid	00 ..	..	0.200
Chloride of Potassium	2.377	1.234	0.550

	Dog	Sheep	Man
Chloride of Sodium	1.073	1.518	1.464
------ Calcium	3.147	4.369	0.062
——— Ammonium	1.661	0.114	—
Phosphate of Lime	0.537	0.473	
---- Magnesia	2.294	1.182	
——— Iron	0.323	0.577	0.125
Potash united with organic matters	0.121	0331	

The Gastric Juice as seen by the above stated analyses is decidedly acid. A great diversity of opinion exists with regard to the nature of the acidifying element.

1st Is there a free acid present in the fluid? or

2. Does its acidity depend entirely on the presence simply of an acid salt?

According to Blondlot there is no free acid, he argues that the acidity is dependent on the presence of the super-phosphate of Lime, he gives

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as his reason for this opinion that when he added Carbonate of Lime to the Gastric Juice, no effervescence took place, which ought to have occurred if a a free acid were present in the fluid. In this opinion he has been proved to be wrong by Bernard & Barreswille, who account for there being no effervescence on the addition of a Carbonate, by the great dilution of the acid in the Gastric fluid, they having found that when the juice is concentrated & the Carbonate of an alkali added, that then effervescence took place Dumas denies the presence of the Super-phosphate of Lime in the Gastric fluid.

The next question that arises, is. What is the free acid present in the Gastric Juice? on this point chemists differ widely in opinion some saying that it is Lactic, others that it is Muriatic & again others have asserted it to be Acetic acid.

Bernard and others deny the existence of free Hydrochloric acid; they affirm that when it is found, its presence is owing to the decomposition of the chlorides, by some other principle as the Lactic acid; they given as a proof of this that on the addition of a small quantity of Oxalic acid a white precipitate of oxalate of Lime is thrown down, which would not be the case if even the smallest trace of Muriatic acid were present: and again when they distil a quantity of water containing Chloride of Sodium with a small quantity of Lactic acid added, the last few drops give a white precipitate on the addition of Nitrate of Silver thus showing the presence of H Cl. Prout however says that Hydrochloric acid is present in the free state, he says that the juice has a distinct smell of Muriatic acid & Prof: Graham has also come to the same conclusion he having obtained it in a different way from

from that by distillation. He is of opinion that the principal acid is Muriatic acid and that Lactic acid exists only in very small quantity. However Chevreul & Bernard, maintain that Lactic acid is the free acid and argue from the following facts viz. that the acid (whatever it may be) forms soluble salts of Lime and Copper. and again that Muriatic acid is too strong an acid to exist in the free state in the human or any other Stomach, whilst the Lactic acid is weaker and milder, and, as any acid is equally efficacious in promoting digestion, they think it more natural that the milder acid (Lactic) should be present. The strongest evidence seems to be in favour of the presence of Muriatic acid, and according to Carpenter it is the chief source of acidity in man, whilst Lactic is that in Dogs. & Pigs &c.

Schmidt held that the acidity depended on a combination of Pepsine with Muriatic

acid

acid, and not on the existence of any free acid, but this seems to be denied by most of the greatest chemists The next thing that we require to consider is the Organic ferment of the Gastric juice. viz. Pepsine. first obtained in a free state by Wasmann It is procured in the following way. when a piece of the mucous membrane of the Pig or other animal be is digested in warm water, many of the substances besides Pepsine are dissolved out but after a time if the same piece of membrane be put into Cold water then only the Pepsine is dissolved out. when the solution thus obtained is evaporated to dryness, a greyish brown viscid mass remains, like an extract and with the smell of glue. If some of this is dissolved in water. the solution is thick and turbid and retains in a slight degree. the solvent power of Pepsine when strong alcohol is added to this solution a white flocculent

precipitate

precipitate is thrown down, which when dried forms a grey solid - When Pepsine is mixed with an acid such as Muriatic acid its solvent powers are greatly increased -

According to Schmidt the ultimate composition of this organic ferment is. Carbon 35.0 - Hydrogen 6.7 - Nitrogen 17.8 - Oxygen 22.5 %.

Before entering upon the actions of this important fluid, we shall give a few particulars regarding its mode of secretion. The latter does not differ materially from the manner in which any other substance is removed from the blood.

The mechanism is as follows.

We find bloodvessels ramifying on the exterior of the basement membrane of the gastric glands and lining the interior of this structure a number of common secreting cells, spheroidal in form

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these by their vital properties of absorption and selection draw their peculiar materials from the blood and by a process undergone in their interior. the latter ~~does~~ is converted into that substance which possesses such a remarkable action on sanguineous compounds viz. the Gastric Juice.

When the Stomach is stimulated into action by the presence of foreign matter in its interior, these cells commence to secrete, and discharge their contents rapidly, and they are the better enabled to perform this function, from the great vascularity of the mucous membrane during digestion, and consequently the increased supply of blood afforded for secreting purposes.

When the cells containing the gastric juice are full they either must discharge their contents, or else are carried up, and mixed with the food in the process of chymification.

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when perhaps their cell walls now empty and collapsed may afford the ferment necessary for the commencement of the solution of the albuminous principles.

The result of the action of the Gastric fluid on the food, is the conversion of the latter into a thick pultaceous mass called chyme. The facility with which this effect is produced depend upon the state of division, moisture and tenderness of the materials, introduced into the stomach. That it is through the agency of the Gastric juice that this digestion is effected has been proved by many experiments. amongst others, by that of passing into the stomach perforated metallic tubes. filled with alimentary substances when it is found that the tubes may be withdrawn in an empty state, or with half digested matter in their interior, after the lapse of some time. More accurate results were afterwards obtained by feeding

dogs with various substances, and killing them after some hours have passed. But the most interesting and reliable facts have been obtained from the experiments of Dr Beaumont upon his patient St Martin. and to them we shall now look for some information upon this subject. First with regard to the mode in which he has found the Gastric juice to flow. On the introduction of food into it, the stomach becomes deeply injected, and then the fluid appears drop by drop. Getting faster and faster and at last flowing out in an uninterrupted or perhaps continuous stream till chymification is complete.

With regard to the comparative digestibility of albumen, fibrine & gelatine. the three principles of animal food. much argument has taken place. but the truth seems to be that if they are taken into

into the Stomach slightly or not at all coagulated they are as easily chymified as any other article of food; but if they be in the coagulated form, and swallowed in large masses. they solution and digestion will be very protracted, Vegetable food says Beaumont Generally speaking requires more time, and probably greater power of the gastric organs than any other; division and tenderness however, as in the case of animal matter greatly facilitate digestion. The length of time consumed in the operation of digestion varies greatly according to the nature of the food but the medium may be calculated about three hours and a half. A definite proportion of aliment only can be perfectly digested in a given amount of Gastric Juice; like all chemical agents, this fluid dissolves or decomposes, and after combining unites a fixed and definite amount of

of matter its action ceases. When the juice becomes saturated it refuses to dissolve more; and if an excess of food have been taken, the residue remains in the Stomach or passes into the bowels in a crude state, and frequently becomes a source of nervous irritation, pain, and disease for a long time, or until the "vis medicatrix naturæ" restores the vessels of that viscus, to their natural and healthy actions, either with or without the aid of medicine. Overburthening the Stomach produces acidity, and retards the solvent action of the Gastric juice.

General febrile irritation seems entirely to suspend its action and renders the villous coat, dry, red, and irritable.

Such are the conclusions come to by Dr Beaumont as the result of his observations on the mode

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of this secretion and action of the Gastric juice.

The view taken by Dr Gregory of the phenomenon of dijestion, seems to be that it is a process analogous to fermentation, in the conditions under which it takes place. Viz. a certain temperature, moisture, and contact with azotized matter in a state of decomposition, differing however from the usual forms of fermentation in its mode of action, no gas being discharged and its chief result being the solution of an originally insoluble matter.

Schwann asserts that the ferment in this case is the detached epithelium; Dr Gregory does not verify this statement, but thinks that the ferment is a soluble one. It appears from the experiments of M. Wasmann that the Muriatic acid of the Gastric juice, is the true solvent of the

materials

materies alba, and that the action of the Pepsine is limited to that of disposing the whole to dissolve in the acid; Pepsine he says replaces the effect of a high temperature which is not possible in the Stomach; the latter statement being deduced from the fact that Muriatic acid dissolves albumen by ebullition just as it does under the influence of Pepsine.
The same experimenter has also remarked that the Pepsine of the Stomach of the Pig is entirely destitute of the power of coagulating Milk although the Pepsine of the Stomach of the Calf possesses this function in a high degree from which he is led to suppose that the power of the latter depends upon a particular modification of Pepsine, or perhaps upon another substance accompanying it which ceases to be formed when the young animal is no longer nourished

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by the milk of its mother.

The quantity of Gastric juice poured forth has been variously estimated. Lehmann considers that four pounds daily would suffice whilst Bidder & Schmidt think that fourteen or fifteen pounds daily will be required.

After the Gastric juice has chymified the materials introduced into the Stomach few tissues can be recognised under the microscope, but Bernard states that muscular fibre, nerve tubules, and cells can be distinguished without difficulty.

The Gastric juice is not the only agent required for digestion the movements of the Stomach, and the temperature at which the process goes on having important function in that act.

The Gastric juice has no action on saccharine, starchy.

or

or Pleagmous principles, the azotised substances being the only class affected by it, and these it reduces to a low form of albumen, which is easily absorbed in the small intestine.

We shall now turn to the connection between the secretion of Gastric juice and the nervous system of the stomach. The latter organ receives its principal nervous supply from the Pneumo-gastric division of the eighth pair; the filaments of that nerve being distributed all over the different aspects of the Stomach.

Dr John Reid in verification of Longet's experiments has ascertained that section of the Vagi in quadrupeds neither arrests the secretion nor the acidity of the Gastric juice.

Arnold in his experiments upon hens and pigeons found that the Gastric juice secreted after section of the Vagi, was acid, that it was not perceptibly diminished in quantity, and that it was capable of converting the food into chyme.

"There is much reason to believe" says Dr Carpenter "that the secretion of Gastric juice is affected in the same manner as that of saliva, by the impressions made by food upon the senses; for it has been ascertained by Bidder and Schmidt that it is copiously effused into the Stomach of dogs that have been kept fasting when flesh or any other attractive food has been placed before them. That the secretion on the other hand is entirely suspended by powerful mental emotion seems certain from the

the well-known influence, which this has in dissipating the appetite for food and in suspending the digestive process when in active operation. As a cheerful state of feeling on the other hand seems to be decidedly favourable to the performance of the digestive function. It exerts probably a beneficial influence as to both quantity and quality of the secretion of the Gastric juice."