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# DIGESTION OF SUGARS

IN SOME

DISEASED CONDITIONS OF THE BODY.

BY

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## DIGESTION OF SUGARS IN SOME DISEASED CONDITIONS OF THE BODY.

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IN my preceding paper I endeavoured to show the manner in which cane and invert sugar are digested and fitted for absorption in healthy individuals. In the present paper the results of an experimental investigation regarding the digestion of these sugars in some diseased conditions of the body, either general or local, are given.

### I. CHRONIC GASTRIC CATARRH (*Gastritis glandularis chronica*).

The patient who suffered from this complaint was a blacksmith, aged 47. For two years he had been much troubled with heaviness, flatulence, and drowsiness after partaking of food. In his case there was no dilatation of the stomach.

*Nature of the Gastric Secretion.*—In the first place I examined the normal condition of his gastric secretion, by giving him 250 c. c. of cooked minced steak, after thoroughly washing out the stomach.

(1.) One hour subsequently I drew off 57 c. c. of turbid brownish-red fluid. The total acidity of this was equal to 0.3 per cent. hydrochloric acid. This acidity consisted of inorganic acid chiefly, though organic acids were also present. Peptones were present in large amount, and fibrin was digested by this fluid in three-quarters of an hour without the addition of any acid. The polariscope showed a rotation of  $-4^{\circ}$ .

(2.) Two hours after the injection 84 c. c. of fluid similar to that just described were drawn off. The patient felt great relief after his stomach had been washed out, and experienced but little discomfort from the minced meat which he had eaten.

The total acidity was equal to 0.32 per cent. hydrochloric acid, and consisted of inorganic and organic acids in large amount; polariscope gave  $-2.6^{\circ}$ ; peptones were present, but the reaction was not so marked as after the first hour. Fibrin was digested in sixty-five minutes without the addition of any acid.



*Inversion of Cane Sugar by Gastric Secretion.*

It is said that in unhealthy stomachs containing much mucus the gastric juice is very active in changing cane sugar into glucose, and that this power seems to be due to a special ferment existing in the mucus. In order to see if this were so, I performed a set of experiments on this patient similar to that on the healthy individual. At 8 A.M. he had breakfast of bread and milk. At 10 A.M. the stomach was thoroughly washed out, and three ounces of dilute Liquor Caffyn were injected. One hour later a specimen of his gastric contents was drawn off and filtered. Its initial acidity was equal to 0.06 per cent. hydrochloric acid, I then plated in a warm bath equal volumes of this gastric fluid, water, and 20 per cent. cane sugar solution, and kept all at 38° C. In one hour invert sugar was present, and at the end of two hours it amounted to 0.35 per cent.

10 c. c. gastric fluid	} At 38° C. =	{ In 2 hours—
10 c. c. water		
10 c. c. 20 p. c. cane sugar solution		
	0.02 p. c. HCl	0.35 p. c. invert sugar.

To determine whether this unhealthy gastric secretion was more active in causing the inversion of cane sugar than a pure acid solution of similar strength, I made a solution of hydrochloric acid of a strength equal to that of this gastric fluid, viz., 0.06 per cent. Equal volumes of this, water and cane sugar solution, were kept at 38° C. There was a good reduction of copper in one hour, and after two hours at 38° C. Fehling's solution showed that there was 0.434 per cent. of reducing sugar present.

10 c. c. solution of HCl=0.06 p. c.	} At 38° C. =	{ After 2 hours—
10 c. c. water		
10 c. c. 20 p. c. cane sugar solution		
	0.02 p. c. HCl	0.434 p. c. invert sugar.

This last experiment shows that with the fluid from a case of chronic gastric catarrh there is less inversion of cane sugar than with a solution of hydrochloric acid of the same degree of acidity. This would agree with Foster's statement, but then it has happened with abnormal gastric juice and not with normal, as he implies. Still less does it show that in cases of gastric catarrh there is an increased inversion, as Schiff states.

*Absence of Inversive Ferment from Gastric Secretion.*

In order to confirm my denial of the presence of an inersive ferment in the gastric mucus, I modified the preceding experiment as follows:—To kill any inersive ferment which might be present, I boiled the gastric fluid for a few minutes. I then took as before equal volumes of this fluid, water, and cane sugar solution, and kept all at 38° C. There was a reduction of copper in one hour, and after two hours it amounted to 0.35 per cent.



10 c. c. boiled gastric juice = 0.06 p. c. HCl	} At 38° C. =	{	In 2 hours—
10 c. c. water			
10 c. c. 20 p. c. cane sugar solution			
	0.02 p. c.		0.35 p. c.
	HCl		invert sugar.

The amount of invert sugar produced in this experiment is exactly the same as when unboiled gastric fluid was used. This and the following experiment prove undoubtedly, I think, that the inversion of cane sugar which takes place outside the body is not due to the presence of ferments, for the amount of invert sugar produced is the same before and after boiling the gastric fluid. There is no more inversion than can be accounted for by the acidity.

I then neutralized carefully a similar mixture of catarrhal gastric fluid, water, and cane sugar solution, and heated all on the water-bath at 38° C. There was no reduction produced in the copper solution after one hour's heating, while after two hours there was a slight reduction, but too faint to be estimated quantitatively.

10 c. c. catarrhal gastric fluid	} At 38° C.	{	After 2 hours—
10 c. c. water			
10 c. c. 20 per cent. cane sugar solution			
	carefully		faint trace of
	neutralized.		invert sugar.

These results are similar to those obtained with healthy gastric fluid.

#### *Digestion of Cane Sugar in Chronic Gastric Catarrh.*

In the first place, I would remark that the nature of the fluid which was injected into the stomach was quite unknown to the patient, and therefore it is the more necessary to pay attention to his statements regarding pain or discomfort, or the reverse, after the reception of the sugary solutions.

(a.) Having washed out the stomach thoroughly, I then injected 250 c. c. of a 20 per cent. solution of cane sugar (= 50 grammes cane sugar). One hour afterwards 70 c. c. of thick whitish fluid were drawn off. This filtered with difficulty, as it was mixed with much mucus. The total acidity amounted to 0.2 per cent. hydrochloric acid. Organic and inorganic acids were present, including lactic acid. Fehling's solution showed that the sugar inverted in the stomach amounted to 0.98 per cent.

After inverting artificially 25 c. c. of this gastric fluid by heating it for two hours on a water-bath, the invert sugar present amounted to 2 per cent. Soon after receiving this sugary solution into his stomach the patient felt very sick, and vomited several times during the day. The vomit was very acid, putting his teeth "on edge," and rendering his tongue and gums tender. Pain over the region of the stomach was severe, while heartburn and flatulence were much worse than usual.

(b.) *Same Patient.*—At 10 A.M., on a subsequent day, I washed out his stomach. He had partaken of no food since 5 A.M., when he had some milk; yet much white curdy material came through the elastic syphon tube. This shows how slow the processes of digestion are in such cases, and for how long a time food remains



in the stomach. I then injected 250 c. c. of 20 per cent. cane sugar solution.

(1.) One hour afterwards 83 c. c. of viscid white fluid, containing shreds of mucus, were drawn off. The total acidity, estimated as hydrochloric acid, was 0.133 per cent., and was due chiefly to inorganic acids; organic acids also present, lactic acid included. Invert sugar amounted to 1.47 per cent. Twenty-five c. c. of this gastric fluid were heated for two hours, to invert any cane sugar remaining. At the end of this time much of the organic acid had been driven off by the heat. The reducing sugar then amounted to 5.9 per cent.

(2.) Two hours after receiving the injection 130 c. c. of whitish fluid were drawn off. This was not so viscid as after the first hour. The total acidity was equal to 0.175 per cent. There was much more inorganic acid present than after the first hour, and lactic acid was also present. Sugar inverted in the stomach formed 1.7 per cent. After artificial inversion the invert sugar had increased to 4.3 per cent.

The patient suffered much after this fluid was injected from pain in the stomach, and heartburn, with much flatulence, and was not relieved till he had produced emesis by thrusting his finger down his throat.

(c.) *Same Patient.*—250 c. c. 20 per cent. solution of cane sugar injected into empty stomach.

(1.) One hour afterwards 65 c. c. of turbid white fluid were drawn off. A much greater quantity came through the tube, but I returned at once much of it back to the stomach. Total acidity equal to 0.07 per cent. HCl, chiefly inorganic; no lactic acid reaction. Invert sugar present in the stomach, 1.04 per cent. After inversion on water-bath, the invert sugar had increased to 6.6 per cent.

(2.) Two hours after injection 125 c. c. of fluid similar to the last were drawn off. Total acidity = 0.131 per cent. HCl, and was almost wholly due to inorganic acids; no lactic acid was present. Sugar inverted in stomach amounted to 0.9 per cent. After inversion outside, 4.3 per cent. of invert sugar was present.

(d.) *Same Patient.*—250 c. c. 20 per cent. cane sugar solution injected into empty stomach.

(1.) One hour after 72 c. c. turbid white fluid were drawn off. Total acidity = 0.09 per cent. HCl, chiefly inorganic. Small amount of organic acids, but no lactic acid present. Sugar inverted in stomach formed 0.56 per cent. After inversion by heating, the invert sugar had increased to 3.57 per cent.

(2.) Two hours after injection 83 c. c. of fluid similar in character to the preceding were drawn off. Total acidity as HCl = 0.134 per cent. Inorganic and organic acids were present in nearly equal amounts. No lactic acid. Sugar inverted in stomach amounted to 0.56 per cent., while after inversion outside, invert sugar formed 3.44 per cent.



(e.) *Same Patient*.—He says that he has felt very ill for the last three days, or since this treatment was commenced (*i.e.*, washing out stomach and injection of cane sugar solution). He had had only milk and bread for breakfast, yet on washing out the stomach there was much evolution of sulphuretted hydrogen. 250 c. c. of 20 per cent. cane sugar solution were injected.

(1.) One hour later 75 c. c. of turbid white fluid were drawn off. Total acidity, estimated as HCl, formed 0.109 per cent. A large amount of mineral acid was present; organic acid in small amount. No lactic acid reaction. The amount of sugar inverted in stomach was 0.392 per cent. After inversion outside, invert sugar formed 5.26 per cent.

(2.) Two hours after injection, 100 c. c. of thick fluid were drawn off. Total acidity now equal to 0.094 per cent., due chiefly to inorganic acids; no lactic acid present. Sugar inverted in stomach formed 0.9 per cent.; after inversion outside, invert sugar increased to 5 per cent.

He suffered much pain till he induced emesis.

(f.) *Same Patient*.—Injected 250 c. c. cane sugar solution.

(1.) One hour later 100 c. c. thick white fluid drawn off. Total acidity = 0.105 per cent., principally mineral; no lactic acid. Sugar inverted in stomach, 1 per cent.; after inversion outside, invert sugar 5.5 per cent.

(2.) Two hours afterwards 75 c. c. of fluid similar in character were drawn off. Total acidity, 0.116 per cent. as HCl; trace of organic but no lactic acid. Sugar inverted in stomach 0.6 per cent. After inversion on water-bath, invert sugar 2.3 per cent.

*Digestion of Cane Sugar in Chronic Gastric Catarrh.*

Series.	Time during which Cane Sugar was in the Stomach.	Number of Cubic Centimetres syphoned off.	Total Acidity as per cent. HCl.	Presence of Inorganic Acids.	Presence of Organic Acids.	Invert Sugar.		Remarks.
						Per cent. formed in Stomach.	Per cent. formed outside Body.	
I.	Hours. 1	70	0.2	+	+	.98	2.	Had much pain; acid vomit; heartburn; flatulence.
II.	1	83	0.133	++	+	1.47	5.9	Pain; heartburn; flatulence severe, not relieved till emesis produced.
	2	130	0.175	+++	+	1.7	4.3	
III.	1	65	.07	++	+	1.04	6.6	Pain severe.
	2	125	0.131	+++	+	0.9	4.3	
IV.	1	72	0.09	++	+	0.56	3.57	Pain severe.
	2	83	0.134	++	++	0.56	3.44	
V.	1	75	0.109	++	+	0.392	5.26	Much pain till he vomited.
	2	100	0.094	+++	+	0.9	5.	
VI.	1	100	0.105	++	+	1.	5.5	...
	2	75	0.116	++	+	0.6	2.3	



If we compare this table with that of the healthy digestion of cane sugar, we see that the acidity is very much alike in both. There has been a tolerably large amount of inversion in the case of this dyspeptic, but the sugar has been retained in the stomach along with a large amount of fluid, and has not been absorbed or passed on as in the healthy individual. This case demonstrates well the tardy nature of the digestive and absorptive processes in catarrhal conditions of the gastric mucous membrane.

The patient made constant complaint of pain, heartburn, and flatulence after the injection of the cane sugar solution; while the healthy man only once mentioned that he had very slight pyrosis.

*Digestion of Invert Sugar in Chronic Gastric Catarrh.*

The next set of experiments deals with the gastric digestion of *invert sugar* in the same patient suffering from chronic gastric catarrh.

(g.) 250 c. c. 20 per cent. solution of invert sugar injected into stomach.

(1.) One hour later 80 c. c. of thick viscid fluid resembling saliva were syphoned off. Total acidity equal to 0.153 per cent. as HCl. Inorganic acids form the largest part of the acidity, though organic acids also are present. Invert sugar 5.26 per cent.

(2.) Two hours after injection 120 c. c. fluid, not so viscid as before, were drawn off. Total acidity 0.094 per cent., principally inorganic; no lactic acid. Invert sugar 1.54 per cent.

He made no complaint of pain, nor had heartburn or flatulence after receiving this injection, till about 4 P.M., or six hours after the invert sugar solution had been introduced, and obviously not at all due to the saccharine fluid.

(h.) *Same Patient.*—250 c. c. 20 per cent. solution of invert sugar injected.

(1.) One hour afterwards 65 c. c. thick whitish fluid were drawn off. The total acidity amounted to 0.091 per cent. as HCl; small amount of organic acid present (no lactic acid), but much inorganic. Invert sugar 5 per cent.

(2.) Two hours after injection 62 c. c. fluid drawn off. Total acidity equal to 0.138 per cent. HCl; characters similar. Invert sugar 2.6 per cent.

Patient had no discomfort of any kind.

(i.) *Same Patient.*—250 c. c. invert sugar introduced.

(1.) One hour later 52 c. c. turbid thick fluid obtained. Total acidity 0.122 per cent. HCl, due chiefly to inorganic acid. Invert sugar 5.5 per cent.

(2.) Two hours after injection 42 c. c. of fluid similar in character to the preceding were drawn off. Total acidity, estimated as HCl, 0.113 per cent., chiefly inorganic; no lactic acid. Invert sugar 1.2 per cent.



Patient felt very comfortable.

(j.) *Same Patient*.—250 c. c. invert sugar injected.

(1.) One hour later I drew off 68 c. c. turbid white fluid. Total acidity equal to 0.116 per cent.; small amount of organic acid present, but chiefly inorganic; no lactic acid. Invert sugar 4.76 per cent.

(2.) Two hours afterwards 100 c. c. of similar fluid drawn off. Total acidity equal to 0.102 per cent. HCl, chiefly inorganic; no lactic acid. Invert sugar 3.7 per cent.

(k.) *Same Patient*.—250 c. c. 20 per cent. invert sugar injected.

(1.) One hour afterwards 75 c. c. of turbid fluid were drawn off. Total acidity 0.109 per cent., due chiefly to inorganic acids; no lactic acid. Invert sugar 4.35 per cent.

(2.) Two hours after injection I drew off with difficulty 30 c. c., the stomach being almost empty. Total acidity equal to 0.07 per cent. as HCl, chiefly inorganic. Invert sugar 0.8 per cent.

On neither of the two latter occasions did the patient make any complaint, but said that he had felt better during the last few days, or during the time he had been getting invert sugar. It is interesting to compare this with the statement made by him after the cane sugar injections.

These results may be tabulated as follows:—

*Digestion of Invert Sugar in Chronic Gastric Catarrh.*

Series.	Time during which Invert Sugar was left in Stomach.	Number of Cubic Centimetres drawn off.	Total acidity as HCl per cent.	Presence of Inorganic Acids.	Presence of Organic Acids.	Invert Sugar per cent.	Remarks.
	Hours						
I.	1	80	0.153	+++	+	5.26	} No discomfort.
	2	120	0.094	+++	+	1.54	
II.	1	65	0.091	+++	+	5.5	} ...
	2	62	0.138	+++	+	2.6	
III.	1	52	0.122	+++	+	5.5	} ...
	2	42	0.113	+++	+	1.2	
IV.	1	68	0.116	+++	+	4.76	} ...
	2	100	0.102	+++	+	3.7	
V.	1	75	0.109	+++	+	4.35	} ...
	2	30	0.07	+++	+	0.8	

This table shows how great a reduction has taken place in the percentage of invert sugar during the second hour as contrasted with the first. If we compare this with the digestion of the same sugar in health (see *Edinburgh Medical Journal* for September, page 208), we are struck by the fact that in the healthy stomach there is very little invert sugar left after two



hours, while in the dyspeptic, though the amount has been greatly reduced, there is still a large proportional amount. The absorption or emptying of the stomach is much less rapid in this catarrhal condition than in health, but the difference in behaviour of the sugars experimented with—cane and invert sugar—is strikingly evident on looking over the two tables showing the digestion of cane and invert sugar in the case of this patient with catarrhal dyspepsia. In the first table we see how large an amount of unchanged sugar was still in the stomach even at the end of two hours, while in the case of invert sugar the amount still retained at the end of this period was proportionally very small. The great and important clinical point to note, however, is that with invert sugar there was no pain or discomfort, while with cane sugar on nearly every occasion the patient suffered much from heartburn, flatulence, or even actual pain over the stomach. It is evident that in this case invert sugar was much more easily borne than cane sugar.

## II. DIGESTION OF CANE SUGAR IN PERNICIOUS ANÆMIA.

The next patient in whom I carried on a similar set of experiments was a labourer, aged 45, suffering from pernicious anæmia. Six months previously his symptoms began by him experiencing a heavy, dull weight over the stomach after taking food. This increased in severity, till at the time when I had him under observation, this pain was very intense; he suffered severe headache soon after taking food, with waterbrash and even vomiting.

What was the nature of the gastric juice in such a case, and how would it behave towards sugar?

*Nature of the Gastric Secretion.*—To investigate the first of these questions, I gave him 250 c. c. of cooked minced steak to eat, after having first washed out his stomach thoroughly.

(1.) One hour afterwards I drew off 76 c. c. of muddy light yellow fluid containing very small fragments of muscular tissue, which formed an almost amorphous deposit. Fat was floating on the surface in tolerably large round masses. The total acidity equalled 0.016 per cent. hydrochloric acid; no lactic acid was present. The acidity was so feeble that we might almost have said it was neutral in reaction. No peptone reaction. Fibrin was soon digested after adding dilute hydrochloric acid.

(2.) Two hours after eating the mince-meat 30 c. c. of pale yellow fluid were drawn off. It also contained a fine powder of muscular fibre. On the surface the fat floated in one large mass. Total acidity was equal to 0.006 per cent.; faint trace of lactic acid present. Polariscopes—1.1 per cent. No peptone reaction. Fibrin was soon digested after acidification with hydrochloric acid.

This gastric secretion has, therefore, hardly any acidity. There is no lack of pepsin, as is shown by the ready digestion of fibrin after the fluid has been acidified.



*Gastric Digestion of Cane Sugar in Pernicious Anæmia.*

(a.) 250 c.c. of a 20 per cent. solution of cane sugar were injected into the empty stomach.

(1.) One hour later I drew off 25 c.c. yellow coloured fluid. The total acidity as hydrochloric acid amounted to 0.0018 per cent.; no lactic acid present.

None of the cane sugar had undergone any inversion in the stomach, as evidenced by the inability of the secretion to reduce Fehling's solution. After inversion outside of the body the fluid contained 0.43 per cent. invert sugar.

(2.) Two hours after injection 38 c.c. of fluid, paler in colour than the previous, were drawn off. The total acidity was practically *nil*—being 0.0007 per cent. as hydrochloric acid. Invert sugar was absent from the fluid when withdrawn, and also after having been acidified and heated for two hours. In fact, after the lapse of two hours the stomach contained absolutely no sugar of any kind.

This patient had been accustomed to have his stomach washed out, and he told me that hitherto after such treatment he felt "light" and comfortable, but this time (after having the solution of cane sugar injected) he had felt very heavy and had a "gone feeling" over the region of the stomach, similar to what he experienced after taking a good meat diet.

(b.) *Same Patient.*—250 c.c. of a 20 per cent. solution of cane sugar injected.

(1.) One hour after I drew off 50 c.c. of yellow fluid with many mucous flocculi in it. The total acidity amounted to 0.021 per cent. HCl. Sugar inverted in stomach, none; after inversion on water-bath, invert sugar amounted to 4.17 per cent.

The patient stated that he felt "very bad indeed," and headache was severe.

(2.) Two hours after injection there was no fluid in the stomach, and when it was rinsed out with pure water the rinsings contained no sugar of any kind.

*Gastric Digestion of Cane Sugar in Pernicious Anæmia.*

Series.	Time during which Cane Sugar was in Stomach.	Number of Cubic Centimetres syphoned off.	Total Acidity as per cent. HCl.	Per cent. Invert Sugar formed in Stomach.	Per cent. Invert Sugar formed outside.	Remarks.
	Hours.					
I.	1	25	0.0018	0	0.43	} Much pain and discomfort.
II.	2	38	0.0007	0	0	
III.	1	50	0.021	0	4.17	} Felt very ill.
IV.	2	0	0	0	0	



Practically the gastric juice of this patient had no acidity. This accounts for there being no inversion of the cane sugar during its stay in the stomach. The probability is that after staying in the stomach unchanged for some time the cane sugar was simply passed on through the pyloric orifice into the duodenum.

*Behaviour of Invert Sugar in the Stomach in case of Pernicious Anæmia.*

(c.) *Same Patient.*—250 c. c. of 20 per cent. invert sugar solution introduced into stomach. Fifteen minutes afterwards 150 c. c. syphoned off. Total acidity equalled 0.0036 per cent. HCl; invert sugar 18.2 per cent.

(d.) *Same Patient.*—250 c. c. invert sugar solution given.

(1.) One hour later 52 c. c. greenish yellow fluid drawn off. Total acidity amounted to 0.0145 per cent. HCl. No lactic acid present. Invert sugar was present to 8.7 per cent.

Patient stated that he felt no discomfort that day, and that he experienced the same "light" feeling which he formerly had after having his stomach washed out. He had no flatulence or water-brash.

(2.) Second hour after injection 54 c. c. pale fluid drawn off. Acidity *nil*—it being neutral in reaction. No invert sugar was present.

(e.) *Same Patient.*—250 c. c. invert sugar introduced.

(1.) One hour later 23 c. c. drawn off. Total acidity equalled 0.01 per cent. as HCl. Invert sugar 3.7 per cent.

(2.) Two hours after injection there was no fluid in the stomach, and when rinsed out, no sugar was detected in the rinsings.

*Behaviour of Invert Sugar in Pernicious Anæmia.*

Series.	Time during which the Invert Sugar was left in Stomach.	Number of Cubic Centimetres drawn off.	Total Acidity as per cent. HCl.	Per cent. Invert Sugar.	Remarks.
	Hours.				
I. {	1	52	0.0145	8.7	No discomfort.
II. {	2	54	0	0	...
III. {	1	23	0.01	3.7	...
IV. {	2	0	0	0	...

In this patient the conduct of the stomach to both cane and invert sugar has been similar. It has simply emptied itself very quickly. There may have been some absorption of invert sugar through the gastric walls, but more probably the greater part has simply been passed through the pyloric orifice into the duodenum.



### III. DIGESTION OF CANE SUGAR IN ALCOHOLIC DYSPEPSIA.

This patient was a seafaring man, aged 54. His complaints were morning vomiting, weight, fulness and uneasiness over stomach; very troublesome flatulence, and want of appetite.

(a.) 250 c. c. cane sugar solution (20 per cent.) were injected into his empty stomach.

(1.) One hour later 45 c. c. of turbid ropy fluid, containing much mucus, were drawn off. Much flatus escaped also through the tube. Total acidity amounted to 0.0145 per cent. as HCl. Traces of lactic acid were present. The amount of sugar inverted in stomach was 0.208 per cent. After inversion on water-bath the invert sugar had increased to 5 per cent.

He stated that flatulence became very severe after the injection of the cane sugar.

(2.) Two hours after injection 30 c. c. of thick viscid fluid were drawn off. The total acidity was equal to 0.0036 per cent. HCl. Sugar inverted in stomach amounted to 0.089 per cent. After inversion outside, invert sugar formed 0.213 per cent.

(b.) *Same Patient.*—250 c. c. cane sugar solution injected. One hour later 50 c. c. thick viscid blood-stained fluid syphoned off. The total acidity was here 0.01 per cent. as HCl; no lactic acid was present. Fehling's test showed that the cane sugar had undergone no inversion in the stomach. After inversion on water-bath the invert sugar formed 1.56 per cent.

#### *Gastric Digestion of Cane Sugar in Alcoholic Gastric Catarrh.*

Series.	Time during which Cane Sugar was in the Stomach.	Number of Cubic Centimetres syphoned off.	Total Acidity as per cent. HCl.	Per cent. Invert Sugar formed in Stomach.	Per cent. Invert Sugar formed outside.	Remarks.
	Hours.					
I.	1	45	0.0145	.208	5.	Flatulence severe.
II.	2	30	0.0036	.089	.213	...
III.	1	50	0.01	0	1.56	...

In this case the acidity is very slight, and the amount of inversion in the stomach proportionally small. This experience is quite opposed to the usual statement that in diseased conditions of the mucous membrane of the stomach, with the secretion of much mucus there is a great inversion of cane sugar, due to a special ferment which is said to exist in the mucus, and which is allied to ptyalin.

The preceding experiments show that in certain diseases invert sugar is very quickly passed on into the duodenum, and that the



absorption of this sugar through the walls of the stomach seems to be very slight. That this is so is shown by the table of the events in the digestion of cane sugar in cases of chronic gastric catarrh. From it we see that the relation which the amount of invert sugar bears to cane sugar remains very much the same at the end of the first or second hour. Had there been much absorption through the gastric walls this relation would have been changed.

In all cases we find that invert sugar has been much more easily borne than cane sugar, and this appears to me a most important point clinically. In almost every case those patients made complaint of weight, pain, heartburn, flatulence, etc., after the solution of cane sugar had been introduced into the stomach, while there was an almost entire absence of disagreeable sensations after the same amount of invert sugar had been injected.

In the cases of chronic gastric catarrh cane sugar was retained in the stomach for a lengthened period, but did not undergo any marked degree of inversion. When invert sugar was, however, given to these patients it very rapidly disappeared from the stomach, though not so quickly as in the case of normal digestion. In the case of pernicious anæmia, owing to the want of acidity of the gastric juice, cane sugar underwent no inversion while in the stomach, even after an interval of two hours. It caused, likewise, much pain and discomfort. The solution of invert sugar, on the contrary, caused no such symptoms, and disappeared rapidly from the stomach.

I am convinced, from these experiments, that cane sugar lingers in the stomach for a much longer period than invert sugar, and is consequently much more liable to undergo fermentative changes. It is, however, an easy matter to give invert sugar instead of cane sugar to persons in whom digestion proceeds slowly or is deranged.







