ON THE EFFECT OF DIFFERENT CONCENTRATIONS OF GLUCOSE ADMINISTERED INTO HUMAN STOMACHS ON THEIR GASTRIC ACIDITY, pH, SODIUM, POTASSIUM, CHLORIDES AND CALCIUM CONTENTS[1]

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Effect of glucose in solution when administered into the stomach in quantity of 50 ml and varying concentrations of 20, 30, 40 and 50 per cent, on the gastric acidity, pH, sodium, potassium, chlorides and calcium contents was studied. It was observed that 20 or 30 per cent glucose had no inhibitory effect but these concentrations particularly 30 per cent had a stimulating type of effect on gastric acidity; the higher concentrations, namely, 40 and 50 per cent, had however, a marked inhibitory effect on gastric acidity, when compared to the acidity obtained after alcohol as a test meal. A reciprocal correlation was found to the present between acidity, on one hand and sodium, potassium, and calcium contents on the other, of the gastric samples; whereas a direct relationship was present between acidity and chlorides contents. As could be expected, a reciprocal relation between pH and acidity was observed.

Manville and Munroe (1937) used an indirect method for the determination of the effect of glucose on gastric secretion in dogs, introducing 10 to 25 per cent solutions of glucose into the stomach through an ileogastrostomy. Day and Kumarov (1939) studied in dogs, that, had been subjected to various operations, the effect of intraduodenal or intravenous administration of glucose solutions of different concentrations on gastric secretion. In the present case an attempt has been made to study the effect in human beings of administration of glucose solution of different concentrations introduced into the stomach by a tube, on the gastric acidity, pH and electrolyte concentration as studied in the gastric samples withdrawn at intervals of time. The results of this investigation are set forth in this paper.

METHODS

Twenty healthy adult male medical students of the college were selected as subjects. Their ages ranged between 21 and 29 years.

They were given a physical examination after having enquired that they did not suffer from any digestive troubles at the time of the investigation or

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had suffered from any serious illness before. They were selected as subjects only after their fractional gastric analysis examination with alcohol meal (50 ml of 7 per cent strength) was found to be normal. The usual precautions such as that the subjects came in the resting state after the overnight fast etc. were properly adhered to before performing the test. Specimens were collected from the stomach by the Levin's tube at short intervals of time for a total period of about two and a half hrs. The short interval sampling was necessary to limit back diffusion of ions from the stomach lumen and to exclude bile stained samples from analysis. Salivary contamination was minimized by removing saliva through frequent expectorations.

The gastric samples collected at different intervals of time after alcohol test meal, were examined quantitatively for free and total acidity and qualitatively for presence or otherwise of abnormalities by the methods previously standardized, (Pai 1960a and 1961). The pH in the samples was determined electrometrically using a Beckman pH meter (Pai 1960b). The electrolytes namely sodium, potassium and calcium were estimated in the samples using an Eel flame-photometer (Pai 1962). The chlorides were estimated electrometrically using a potentiometer and compared with the chemical method (Pai, 1960c).

Different concentrations of glucose, namely, 20%, 30%, 40% and 50%, were introduced in the stomach in amounts of 50 ml. each time. The samples were tested chemically for the presence or otherwise of the reducing sugar to know the evacuation of the latter from the stomach.

RESULTS

The total number of gastric analyses for free and total acidity carried out was three hundred and seventy two, each done in duplicate and the average results being taken. The total number of analyses done for pH, sodium, potassium, calcium and chlorides was one hundred and eighty-six for each of these estimations, each analysis having been carried out in duplicate and the average findings being taken thereof.

Glucose was reported to be one of the substances which, when present in high concentration in the duodenum and upper part of the small intestine inhibited both the secretion and the motility of the stomach (Babkin, 1950), The inhibition of gastrict secretion by the ingestion of sugar in various forms has been demonstrated in several investigations in dogs (Manville

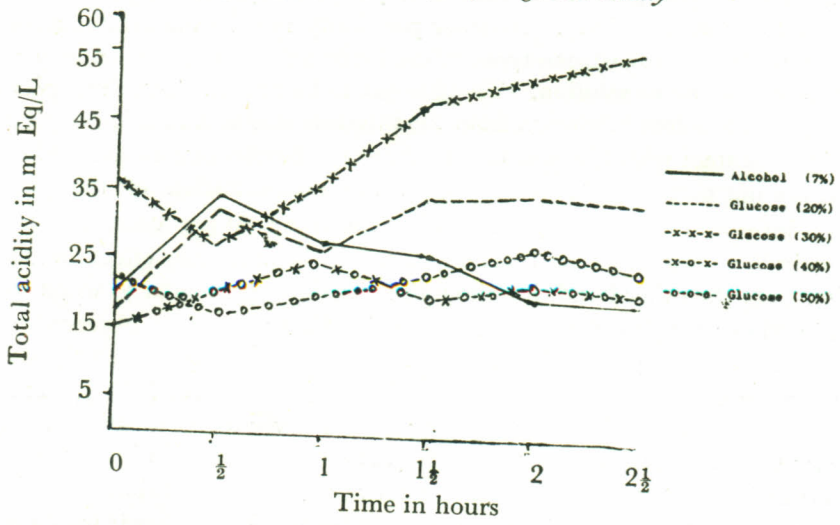
TABLE

The maximum, minimum, mean and standard error values for pH. acidity, sodium, potassium, calcium and chlorides contents of gastric samples. After ingestion of 50 ml. 7 per cent alcohol.

	pH	Free Acidity	Total Acidity	m. Eq,/Lr. Na	K	Ca	Chlorides	No. of Subjects
Maximum	7.34	64.0	71.0	45.5	18.2	4.62	134.0	5
Minimum	1.53	0.0	3.0	10.6	9.4	0.93	32.8	
Mean	3.94	22.3	29.4	25.4	13.2	2.72	69.2	
S.E. ±	0.41	3.61	3.43	1.46	0.62	0.29	7.33	
After ingestion of 20 per cent glucose (50 ml)								
Maximum	7.32	73.5	83.0	40.5	17.8	4.16	113.5	5
Minimum	1.39	0.0	4.0	14.9	9.1	0.91	34.8	
Mean	2,63	32.6	39.2	21.2	11.1	2.44	87.2	
S.E. ±	0.23	2.62	3.02	1.62	0.21	0.17	4.12	
After ingestion of 30 per cent glucose (50 ml)								
Maximum	7.30	55.8	66.0	40.3	16.5	3.86	126.6	5
Minimum	1.25	0.0	5.0	15.4	8.8	0.88	43.0	
Mean	2.51	33.8	41.7	20.9	10.7	1.93	92.1	
S.E. ±	0.33	3.32	3.30	1.15	0.33	0.22	6.72	
After ingestion of 40 per cent glucose (50 ml)								
Maximum	7.18	38.0	48.0	39.5	16.7	3.95	109.5	5
Minimum	1,58	0.0	5.0	17.1	9.6	1.14	33.5	
Mean	3.61	13.0	20.5	27.2	12.5	2.71	64.0	
S.E. ±	0.43	2.34	2.41	0.85	0.43	0.23	5.52	
After ingestion of 50 per cent glucose (50 ml)								
Maximum	7.33	33.5	42.0	33.5	15.8	3.99	108.8	5
Minimum	1.83	0.0	7.0	19.8	9.6	1.96	40.2	
Mean	3.24	13.6	22.3	25.9	11.5	2.93	70.9	
S.E. ±	0.32	2.25	1.68	0.56	0.35	0.28	7.85	

and Murroe 1937); Day and Kumarov (1939). The latter group of workers concluded that inhibition of gastrict secretion took place only when solutions of glucose of the higher concentrations (20 per cent and above) were injected into the duodenum.

Graphs showing the effect of glucose in solution of different concentrations administered into stomach, on gastric acidity



It may be seen from the curves drawn to show the effect of different concentrations of glucose in solution on gastric acidity, that with 20 per cent concentration a rise was observed in the first 1/2 hr and 1 1/2 hr specimens, while a drop was observed in the 1 hr specimen. With 30 per cent concentration, there was an inhibition in the first 1/2 hour specimen. The trend, however, was towards the stimulatory effect of these two concentrations of glucose solutions on the gastric acidity, as compared to the acidity obtained after alcohol, as a test meal. The other two concentrations namely, 40 per cent and 50 per cent, however, did show an inhibitory effect on gastric acidity.

DISCUSSION

The stimulatory and inhibitory effects of sugar solutions on human gastric secretion were demonstrated by Miller, Fowler, Bergeim, Rehfuss and Hawk (1920). Friedman (1939) showed that in a soluble and absorbable form, carbohydrates, (e.g. glucose), also produce a stimulatory effect on the digestive property of the gastric samples.

It was previously reported from this laboratory that milk (100 g) to which 50 g of sugar (cane-sugar) was added, when injested, evoked less acidity in the stomach, (Pai, 1954). The inhibitory effect of glucose given in solution of concentrations of 40 and 50 per cent, and introduced in quantity of 50 ml, on the gastric acidity seen in the present series, may be perhaps explained as due to the hyperglycemic state of blood reached after the absorp-

tion of glucose from the intestinal membrane ; and then it may be the osmotic phenomenon or otherwise interferring with the process of gastric secretion, perhaps glucose acting both centrally and peripherally, resulting in its inhibitory effect on gastric acidity. Another possibility may be the production of a chalone, of the enterogastrone type, in the intestinal mucosa as a result of the presence of glucose in solution. This has yet to be proved. The third possibility may be the reflex inhibition from the intestine due to a solution of glucose coming in contact with the mucous membrane. Either one or more of these factors are not perhaps able to act when the concentration of the glucose solution introduced into the stomach is low i.e. 20 or 30 per cent, and hence glucose in these low concentrations does not exhibit inhibitory effect on gastric acidity. On the other hand, its stimulating action, particularly when it is given in 30 per cent concentration, on gastric acidity which is observed, may be its own stimulatory effect like the stimulating effect of glucose on the digestive property of the gastric samples, as observed by Friedman (1939). It may be possible that this stimulatory effect seen with lower concentrations is overcome by the stronger inhibitory effect of glucose when given in higher concentrations and thus these latter higher concentrations finally exhibiting their inhibitory effect on gastric acidity. It should be admitted that it would have been worthwhile investigating the blood sugar levels to confirm the degree of the hyperglycemic state when reached after the absorption of glucose from the intestine. There was a reciprocal relationship which was found to exist between acidity on one hand and sodium, potassium and calcium contents on the other, of gastric samples and a direct relationship between acidity and chlorides contents, (see Table). These relationships are in reference to the mean values of the results obtained, which have been statistically analysed for finding out standard errors etc. This is in conformity with our findings reported earlier (Pai, 1962). These tables also show the maximum and minimum values obtained. In conclusion it may be stated that these results have a bearing on some pathological conditions e.g. diabetes mellitus. There are clinical indications that prolonged hyperglycemia tends to diminish both the acidity, and the volume of the gastric juice in man (Bowen and Aaron, 1926). To support these conclusions it is necessary to investigate blood glucose levels along with the gastric samples after the administration of glucose in different concentrations, particularly in relation to the studies in diabetes mellitus.

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