THE ACTION OF MEAT EXTRACTS AND RELATED SUBSTANCES AS GASTRIC STIMULANTS IN MAN

BY

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Meat extracts cause a profuse secretion of gastric juice in animals, as was first shown in Pavlov's laboratory by Lobassoff (1897). He worked with dogs, equipped with a Pavlov pouch, and showed that the presence of Liebig's extract in the main stomach produced a marked secretion in the miniature stomach. Similar observations have since been made by numerous authors, all on Pavlov-pouch dogs or on comparable surgical preparations (Popielski, 1902; Gross, 1906; Lönnqvist, 1906; Orbeli, 1906; Kryszkowski, 1913; Zeliony and Sawitsch, 1911; Zeliony, 1913; Edkins and Tweedy, 1909; Ciminata, 1925 and 1926; Lim, Ivy, and McCarthy, 1925). But it does not appear to be accepted that similar effects are found in human beings. In many textbooks of physiology and nutrition statements such as the following are met with: "Commercial meat extracts are possibly of value as gastric stimulants."

Experimental Tests

A series of experiments on medical students has been carried out in order to establish this point. The technique of the fractional test meal introduced by Rehfuss (1914) was adopted. Bergeim, Rehfuss, and Hawk (1914) state that water is a strong gastric stimulant in humans, whereas Pavlov (1910) says that water was devoid of any stimulant action in his animal experiments. Apart from this no significant difference between the reaction of the human and the animal stomach has been recorded. It was not anticipated, therefore, that any marked difference in the reaction to meat extracts would be found.

The various test meals were given to the subject on different days and the responses compared. Ryle (1926) has shown that the gastric response of the individual to the same test meal on different days is essentially the same. This was confirmed in several subjects, and therefore any dissimilarity noted in the results from the substances examined is due to their varying stimulating power. The oatmeal gruel meal described by Ryle was used as the standard. The response to this is very constant for each subject. Using water as a standard is unsatisfactory, as the results vary greatly.

The following substances were examined. (1) Beef powder, prepared from dried lean beef. (2) Extracted beef: this is the residue of the meat after the water-soluble extracts have been removed in the manufacture of commercial meat extracts. (3) Direct extract: this is made by extracting meat completely with water and concentrating the resulting liquor. (4) The commercial meat extract known as bovril. (5) Sodium glutamate. This substance has a meaty taste and is used as a flavouring agent. It is not present in meat.

Technique

The tests were performed on a fasting stomach, in the morning before breakfast or in the afternoon after an early breakfast. If the stomach was found to contain more than a trace of food the test was postponed. After intubation the residual contents were removed and the stomach washed out with 200–300 c.cm. of warm water and the test meal administered. Samples were withdrawn as soon as the meal was finished, and subsequently at fifteen-minute intervals until the stomach was empty. In some tests warm water slightly less in volume than the usual bulk of the meal was given, and the substance under examination administered in a concentrated solution through the stomach tube. In this way any stimulation due to the taste of the extracts was avoided. There were no significant differences in the response obtained after administration of the extract in this manner and when the subject was allowed to taste the material.

The following determinations were made on each sample. The free hydrochloric acid and the total acid, and the pepsin, were estimated. In titrating the samples for the estimation of the free acid, *p*-dimethyl-amino-azobenzene, Töpfer's reagent (1894), mixed with half of its weight of methylene-blue, was used as the indicator. The mixed indicator exhibits a magenta colour on the acid side of the change point, a bright green colour on the alkaline side, and a neutral shade of pale grey at *p*H 2.9. The total acid was estimated by titrating to the change point of phenolphthalein. Pepsin was estimated by a modification of Mett's method. The tubes were prepared by the method of Christiansen (1912), and successive batches standardized before use against the preceding batch. 0.5 c.cm. of the unfiltered sample was mixed with 9.5 c.cm. of a phosphate buffer of *p*H 6.8 left overnight, and filtered to remove the mucus and protein matter as recommended by Ege (1924). The *p*H of the filtered material was adjusted to 1.2–1.3 by the addition of concentrated hydrochloric solution. The resulting solution was incubated with the Mett tubes at 35° C. for a varying period, depending on the strength of the pepsin solution. Weak solutions were left for several days. All calculations were based on the length digested in twenty-four hours. Four measurements were made on each sample. According to Patterson and Adler (1932) the pepsin is proportional to the cube of the length of fibrin digested. This measure was used in the present test. The results are shown in Tables I, II, and III.

Results

Table I contains the average HCl values as produced by the various substances. The figures indicate cubic centimetres of decinormal HCl. In Table II are given the

TABLE I.—*Table of Average HCl Values*

	Resting juice	15 min.	30 min.	45 min.	60 min.	75 min.	90 min.
Gruel ..	0	0.6	13.4	30.0	17.3	18.5	13.0
Beef powder	2	1.0	11.5	24.5	26.5	37.75	32.0
Extracted beef ..	0	0	5.0	10.6	14.2	10.8	16.4
Direct extract ..	0.1	1.0	11.0	29.0	18.0	20.0	8.0
Bovril ..	0	1.0	14.0	37.0	49.0	—	—
Sodium glutumate	0	0	7.0	—	—	—	—

TABLE II.—*Table of Emptying Times of Stomach*

	Average	Expressed as percentage of gruel
Gruel	97 minutes	100
Beef powder	107 „	123.6
Extracted beef	84 „	96.5
Direct extract	92 „	104
Bovril	63 „	74.2
Sodium glutamate	36 „	44.6

figures for the emptying times of the stomach. In the first column the average figures are shown, and in the second column the figures are expressed as percentages. The emptying time with gruel was called 100 per cent. in each separate experiment. For each individual the time taken for the stomach to empty with the different substances used was expressed as a percentage of that taken with gruel. The results were averaged, and, as will be seen, are not quite the same as the average times. In Table III the average pepsin values are given.

TABLE III.—*Table of Average Pepsin Values*

	Resting juice	15 min.	30 min.	45 min.	60 min.	75 min.	90 min.	105min.
Gruel ..	0.43	8.3	9.5	9.2	11.3	35.3	11.4	—
Beef powder ..	1.08	1.2	8.8	23.9	30.0	63.4	82.8	42.5
Extracted beef ..	0.5	1.75	7.7	7.8	18.4	7.1	15.8	—
Direct extract ..	0.7	0.17	3.75	4.7	6.9	10.0	5.3	—
Bovril ..	0.15	2.3	7.1	8.7	19.7	—	—	—
Sodium glutamate ..	0.025	1.1	24.2	—	—	—	—	—

Beef powder, which represents whole meat, produces a marked secretion of HCl over a long period. The watery extract is not so powerful, producing a secretion not much greater than that of gruel. But the extracted beef is even less efficient. The most effective stimulant is bovril. Sodium glutamate leaves the stomach so quickly that its effect on HCl secretion is negligible. Beef powder delays the emptying time considerably as compared with gruel. Extracted beef and direct extract are not significantly different in their emptying times from that of gruel. Bovril shortens the time by one-third. Sodium glutamate makes the stomach empty very quickly. The extracted beef produced a very marked flow of mucus; in one case this was so great as to block the stomach tube.

The secretion of pepsin is high when beef powder is administered. Of the substances examined that was the only one which stimulated the gastric mucosa to secrete pepsin. The other substances do not differ greatly from one another in their effect on pepsin secretion, sodium glutamate being a possible exception.

Commentary

In conclusion it can be stated that meat extracts act as stimulants of the gastric mucosa. The gastric secretion so produced is normal in HCl content. Bovril produces a marked stimulation of the gastric mucosa with a stimulation of HCl which at sixty minutes after administration is nearly three times greater than that produced by gruel. It reduces the emptying time by approximately 30 per cent. as compared with gruel. Sodium glutamate causes such rapid emptying of the stomach that it is impossible to draw any definite conclusions as to its effect on gastric secretion.

These results have some clinical significance. Following acute illnesses there is commonly a depression of gastric secretion. The gastric juice is poor in HCl, but there is rarely any deficiency of pepsin. In such cases meat extracts, by stimulating the mucosa to an increased flow of HCl, restore the gastric juice to normal.

Conclusions

1. Meat extracts have a stimulant action on the gastric mucosa.

2. The water-soluble fraction of meat is almost as efficient in stimulating a flow of HCl as whole meat.

3. The secretion of HCl is greater with bovril than with any other substance examined, including whole meat.

4. Whole meat in the form of beef powder is the only substance examined which stimulated a flow of pepsin.

5. The emptying time of the stomach is less with meat extracts than with whole meat. Bovril reduces the time by 60 per cent. as compared with beef powder.

6. Sodium glutamate has little or no stimulant action. The stomach empties very rapidly when this substance is given.

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The annual report for 1936 of the Health Department of the municipality of Singapore records a continued heavy incidence of enteric fever. During the year 461 cases, including six of paratyphoid, were notified, compared with 424 in 1935. Of these cases, eighty-two were in school children. The notifications were more or less evenly spaced over the months, and there was no localized outbreak. The spread of infection is attributed to carriers among those engaged in preparing food sold by hawkers in the streets, and there is strong presumptive evidence that the hawking of ice-cream and iced drinks is often responsible. More arbitrary powers for dealing with food hawkers have recently been granted, but their full application will not be feasible until the passing of the new Food and Drugs Regulations. With regard to malaria, the report states that anti-mosquito work has been continued on a large scale. The chief undertaking during the year was the cleaning up of the breeding grounds of *A. sundaicus* in three river basins, following a sharp outbreak of malaria in the latter part of 1935. The greater part of the breeding grounds was dissipated by breaking down the containing bunds of numerous fish ponds, thus admitting tidal water. Those still out of reach of the tide were either filled in with debris from the demolished bunds or were connected together by deep drains, with a discharge to bigger drains protected by tidal flaps at their exits in the bunds. Nearly 200 fish ponds and over 500 vegetable ponds were treated by these methods.