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THE EFFECT OF VARIOUS COOKED PREPARATIONS OF  
HADDOCK (Melanogrammus aeglefinus) AND LOBSTER (Homarus americanus)  
ON THE GASTRIC SECRETION.

by

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# BIOLOGICAL BOARD OF CANADA

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It is important to know for the complete evaluation of the nutritional values of fish, as of any other food, not only its content of protein, carbohydrate, fat and vitamins but also its effect on the gastro-intestinal tract. Food, in turn, will be properly digested and prepared for absorption only if the secretory and motor apparatus function adequately. Palatability of the food and the possession of certain chemical (extractives, etc.,) and physical (solids, liquids, etc.,) properties are very necessary to the adequate function of the gastric glands and proper motor activity of the stomach. Products of the digestive disintegration of food substances (peptones from meat) also are known to influence the motility of the stomach (Babkin 1928). Data are scarce concerning the effect of different fish and of different fish preparations on the secretion of the gastric glands Gorderoff (1906) using a dog with a Pavlov Pouch, compared the effect of salted herring and of herring from which the salt had been previously washed, on the gastric secretion. The former stimulated three times as large a secretion, although given in equal amounts as the latter. The salt-freed herring also was shown to possess strong secretagogue properties because it stimulated a secretion equal to that on an equivalent amount of raw meat. Boldyreff, working on pavlov-pouch dogs, demonstrated that his fish extract ("fish bouillon") stimulated a much greater secretion of gastric juice than his meat extract ("meat bouillon"). The same he showed, to be true of the products of fish and meat digestion and also true of

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equivalent amounts of meat and fish. Böldyreff observed an especially large secretion when he introduced, a small fish, *Cottus gobio*, or a fish "bouillon" from this and other small fish into the stomach of a dog. "Bouillon" from the larger species possessed a smaller secretagogue power than that of the small species. This decrease is possibly explained by the fact that there was a smaller proportion of skin on the raw food from which the extract was prepared. Komarov in 1931 using a dog with a Pavlov Pouch obtained an 85% increase in volume of gastric secretion on haddock broth to which the skin was added as compared with meat broth or haddock broth without skin. An investigation was carried out by Alley (1932) on the effect of various fish (cod, haddock, mackerel, lobster) and beefheart on gastric secretion. The juice was collected from a pouch built from the lesser curvature region of a dog's stomach (Armour 1930). The Armour Pouch was used rather than the Pavlov Pouch because it was thought important to know the type of juice with which the mucous membrane of the lesser curvature region would come into contact. Such knowledge is important for the understanding of both the normal and pathological conditions of the stomach. Only the second or chemical phase of the gastric secretion was studied by introducing the different foods directly into the stomach through the gastric fistula. It was found that the fish (cod, haddock and mackerel) was as strong a stimulus of the acid and fluid of the gastric secretion as beef heart while lobster was a much stronger

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stimulus. The peptic power of the juice secreted on haddock and lobster was higher than that on cod and beef and much higher than that on mackerel which was probably due to the high content of fat in the mackerel. Cod, haddock and lobster remained in the stomach as long as beefheart while mackerel remained longer. Results from the above experiments gave us a fair understanding of the effect of these substances on the secretory and motor functions of the stomach. Their value for dietetics, however, was not complete as only the chemical phase of gastric secretion was studied and the fish was ingested in a raw state. It was decided in the present investigation to give the fish to the dog by mouth and to prepare it according to different culinary procedures.

Method:

#### METHOD.

A dog with a pouch from the lesser curvature region (Armour Pouch) was used. The food given was boiled, baked, fried and smoked. Haddock boiled, lobster, and raw beefheart (control), 250 grams were given broken in small pieces approximately 5 c.cm. in size. The haddock was prepared by baking in an oven at 360°F for half an hour, or boiling in water for 7 minutes, or frying in butter a centimeter deep in a pan for 15 minutes. For the smoked haddock, finnan haddie was used. The lobster was boiled for one half hour.

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The beefheart was minced and all visible fat removed. The experiment always started when the gastric glands were resting, i.e., no secretion flowed from the pouch. The secretion from the Armour Pouch was collected hourly and filtered immediately. The free and total acidity was determined by titration, Topfers reagent and phenolphthalein respectively being used as indicators. Hirenstein and Schiffs modification of Mett's method was used for the determination of peptic activity. The content of dissolved mucin was determined by the increase in the reducing power of the gastric juice after it had been hydrolyzed by boiling with 2 Normal H<sub>2</sub>SO<sub>4</sub> for 2½ hours. Hagedorn and Jensen's method was used for determining the reducing power. The amount of glucose (read from the Hagedorn and Jensen tables) multiplied by eight gives the content of dissolved mucin (Webster and Kosarov 1932). Between experiments the animal was fed on a constant diet of oatmeal porridge, raw beefheart, milk, cod liver oil, salt and water.

RESULTS.

The course of the volumes of secretion after the different preparations of haddock, showed some striking variations. The first hour secretions were v-ry close, being within 1 cc. of each other. The second-hour secretions however varied greatly; that of boiled haddock showed a considerable drop, baked and fried fish a smaller drop while that of smoked fish remained quite high. Throughout the

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remaining three hours there was a continual fall in secretion with all preparations except in the third hour of boiled haddock which remained the same as in the second hour. The baked fish gave the highest total volume and boiled fish the lowest. The durations of secretions varied considerably, that of baked fish being the largest. The secretion on boiled lobster was remarkably different from that on boiled haddock (Table 1). The powerful effect of the lobster may be observed from the fact the volume of secretion in the second hour remained high while that of boiled haddock dropped greatly in that period. The raw beefheart gave less secretion in the first hour shorter duration and less total volume than the cooked fish.

The total acidity (Table 2) was the highest with lobster and smoked fish while baked fish gave the lowest. It is of interest to note that lobster fried and smoked fish gave relatively low free acidities.

The pepsin (Table 3) is seen to be the highest after boiled lobster in both power and output followed closely by baked fish. Salted and fried fish gave somewhat lower but fairly similar figures for pepsin. Boiled fish gave the smallest output even though the concentration was not the lowest.

Dissolved mucin (Table 4) followed a course similar<sup>lar</sup>

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to that of pepsin but did not show such a respectively great increase with lobster as a stimulus.

#### DISCUSSION

From the above results it will be seen (Table 5) that the various preparations elicited very different responses from the gastric glands. Of the haddock preparations the baked muscle was such the strongest stimulus giving a secretion of the greatest duration and volume and highest pepsin and mucin content. The free acidity of the baked fish secretion was the lowest. The boiled fish with its water soluble constituents greatly reduced became a weaker stimulus than baked haddock, the secretion showing a decrease in volume, pepsin and mucin. The smoked fish caused a greatly increased total acidity but lower peptic power and mucin content. The effect of the fried fish was not greatly decreased by the butter causing a low free acidity and somewhat reduced pepsin and mucin. Boiled lobster is shown to be a much more powerful stimulus of the gastric gland than boiled haddock as demonstrated by its higher volume, total acidity, pepsin and mucin of the secretion.

Our present knowledge of the action of different

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secretagogues on the gastric glands can only explain in part the difference in effect of the various fish preparations. Fish during the process of boiling loses its water soluble constituents such as inorganic salts and other extractives substances which are powerful stimulants of the gastric glands and with their loss a somewhat diminished secretion occurred as compared with that of the other fish preparations. During the baking of fish roast products are formed which not only stimulate the taste but probably also act as secretagogues to the gastric glands which may explain the greater secretion on baked fish. The secretion on fried fish seemed to be little affected by the fat present, as the free acidity, peptic power or concentration of mucin were slightly depressed. The effect of the smoked fish may be chiefly explained by the presence of salt which not only increased the secretion but also lowered the peptic power of gastric juice (Gordaleff). In spite of the fact that a great deal of juice was lost on opening the shell of boiled lobsters, this food was still a very strong stimulus and much stronger than boiled haddock. It is known to have a much higher ash content than haddock (McLester 1931). The duration of secretion was much shorter after lobster than after haddock.

It is believed that the data reported in this in-

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vestigation may be of use in the elaboration of proper diets when a decrease or increase of gastric secretion is desired to aid various disorders of gastric function, and especially those of the lesser curvature.

#### SUMMARY.

It is seen that haddock muscle prepared in various ways stimulated different types of gastric secretion. Baked haddock was the strongest stimulus, especially for fluid, pepsin and mucin. Of the three remaining preparations, boiled, fried and salted haddock, boiled haddock stimulated a lower volume and smaller pepsin output, although the secretion was somewhat longer in duration. Little inhibition was noticed from the fat of the fried fish. Smoked fish was a strong stimulus for fluid and acid but weak for pepsin and mucin concentration. Lobster, in spite of the secretion being of shorter duration was a much stronger stimulus for the volume of secretion as well as acid, pepsin and mucin content than the boiled haddock.

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TABLE 1

Volume of secretion in cc. for successive hour and half-hour periods following ingestion of food

Hours	Haddock boiled		Haddock baked		Haddock fried		Haddock smoked		Lobster boiled		Beefheart	
	Per hour	Per half hour	Per hour	Per half hour	Per hour	Per half hour	Per hour	Per half hour	Per hour	Per half hour	Per hour	Per half hour
1	5.4	13.9	4.6	13.3	5.5	13.2	6.0	14.3	5.4	14.4	4.2	11.4
2	8.5	5.4	8.5	8.9	7.7	8.1	8.3	11.4	9.0	11.3	7.2	8.
3	3.1	5.4	5.3	6.2	4.3	6.8	5.3	6.3	7.2	4.9	4.5	5.
4	2.3	5.4	3.6	4.8	3.8	2.6	4.0	3.3	4.1	1.3	3.1	2.
5	2.9	4.0	3.4	2.2	3.4	1.6	2.3	0.9	2.6	0.2	2.3	0.
	2.5	1.2	2.8	0.6	2.0	1.0	0.7	0.8	1.1	-	1.7	0.
	1.7	1.2	1.8	0.6	1.6	0.2	0.1	0.8	0.2	-	1.0	0.
	1.0	1.2	1.6	2.2	1.0	1.2	0.7	0.8	-	-	0.3	0.
	0.2	1.2	0.6	2.2	0.2	1.2	0.1	0.1	-	-	-	0.
Total Volume	29.9		26.4		32.9		35.0		32.4		28.4	
Duration of Secretion	4 h. 40 mins		4 h. 55 mins.		4 h. 25 mins.		4 h. 23 mins		3 h. 45 mins		4 h. 15 mins	

TABLE 2  
 Total and free acidity; average concentration of acid in milli-equivalents per litre for successive hourly periods

Hours	Haddock boiled		Haddock baked		Haddock fried		Haddock salted		Beef Heart raw		Lobster boiled	
	Total	Free	Total	Free	Total	Free	Total	Free	Total	Free	Total	Free
1	146	108	144	103	146	102	152	101	142	102	152	100
2	147	108	147	105	150	100	159	113	147	105	157	115
3	145	101	140	97	142	93	146	97	136	98	139	91
4	134	94	130	89	126	79	134	85	124	81	115	67
Average Acidity	144	105	142	101	144	97	148	100	142	105	147	101

TABLE 3

Peptic power and output of pepsin calculated from Metts units for successive hourly periods

Hours	Haddock boiled		Haddock baked		Haddock fried		Haddock salted		Beef heart raw		Lobster boiled	
	Power	Output	Power	Output	Power	Output	Power	Output	Power	Output	Power	Output
1	252	3574	256	3404	277	3666	264	3672	258	2943	295	4247
2	198	1067	258	2708	203	1656	181	2096	261	2213	296	3353
3	199	1019	293	1816	189	1879	191	1206	253	1381	443	2137
4	236	926	324	1571	285	1009	244	748	329	852	570	723
Total Output		6616		9096		7610		7722		7389		10460
Average Power	220		272		240		225		262		223	

TABLE 4

Concentration of dissolved mucin in mg. per cent and its output in mg. for successive hourly periods.

Hours	Haddock boiled		Haddock baked		Haddock fried		Haddock salted		Beefheart raw		Lobster boiled	
	Conc.	Output	Conc.	Output	Conc.	Output	Conc.	Output	Conc.	Output	Conc.	Output
1	96.8	12.7	100.8	14.0	84.8	11.1	59.2	8.4	93.6	10.2	96.0	13.0
2	82.4	4.0	99.2	8.8	96.0	7.7	74.2	8.5	86.4	7.4	102.4	11.1
3	92.8	4.7	106.4	6.6	104.8	6.6	68.8	4.4	105.6	5.3	160.0	8.8
4	96.8	4.0	121.2	6.0	152.8	6.6	52.8	1.6	112.0	3.8	192.0	2.8
Total Output		26.4		35.3		31.0		22.9		25.7		35.7
Average Concentration	93.6		103.2		97.6		67.2		95.2		104.0	

Average figures for the secretion during four hours after ingestion of the different food substances.

Food	No. of Experiments	Duration Average hrs. mins.	Volume Total Ave. c.c.s.	Acidity		Gastric Secretion			
				Average	Total	Pepsin		Mucin	
						Free	Calculated from Mott's units	Concen.	Output
		m.eq./lit		mg. %		mg.			
Haddock: Boiled Baked Fried Salted	3	4 40	22.9	144	108	230	661	93.6	26.4
	3	4 26	36.4	142	101	272	9096	103.2	26.3
	3	4 25	35.9	144	97	240	7310	97.6	31.0
	2	4 23	35.1	148	100	225	7723	67.2	22.9
Lobster: Boiled	2	3 45	35.4	147	101	323	10450	104.0	36.0
	3	4 15	29.4	142	105	262	7569	96.2	26.7

