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MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No. 194.

Report on Investigations carried out at the Atlantic
Biological Station, St. Andrews, N. B.

1. The Effect of Scallop, Lobster, Salmon and Haddock
on the Gastric Secretion.
2. The Effect of Water Soluble Extractives of Lobster
and Beef-Heart Muscle and also the Respective Muscle
from which the Extractives were prepared.

by

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FISHERIES RESEARCH BOARD OF CANADA

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ON THE GASTRIC SECRETION.
2. THE EFFECT OF WATER SOLUBLE EXTRACTIVES OF LOBSTER
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MUSCLE FROM WHICH THE EXTRACTIVES WERE PREPARED.

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1935 (?)

Investigations previous to those presented in this report have been carried out on an Armour-pouch dog concerning the effects of the gastric secretion on different raw sea foods fed by gastric fistula and also of various cooked preparations of haddock and lobster fed by mouth (Alley 1933, 1934). In the present work the above investigations were continued by repeating some of the previous experiments on lobster and haddock on a Pavlov-pouch dog and also determining the effect of salmon and scallop muscle on the gastric secretion. The repetition of the lobster and haddock experiments were considered necessary in order to increase the number of experimental animals used and also to compare the secretion of the pouch from the lesser curvature region (Armour) with that from the fundic region (Pavlov). In addition a comparison was made of the effects, on a Pavlov-pouch secretion, of bouillon made from beef heart with that made from lobster, and of the beef heart and lobster from which the bouillon was made. It was thought that this procedure might give some clue as to what part of the lobster was responsible for a much greater stimulation of secretion than occurred with meat.

Method

The haddock, salmon, lobster and scallop were chopped into pieces approximately .5 ccm. in size and boiled for six minutes in 100 c.c. of water in a double boiler. The dog ate the food as well as the water in which it was boiled. It was believed necessary to cook the food in order that it resemble more closely that eaten by man and also to give the water in which the food was

boiled as it contained extractives which have very important effects on the gastric secretion. The bouillon was prepared by simmering 200 grams of beef heart or lobster previously chopped into .5 ccm. pieces, under direct heat for one-half hour in 400 c.c. of water, followed by cooking in a double boiler for a second half hour. The bouillon was strained through cheesecloth which allowed some sediment to pass. Four hundred c.c. of the bouillon was given by mouth and if water was lost during the cooking the volume was made up to 400 c.c. by adding water. The remaining meat or lobster was also given to the dog in order to compare these foods when most of the water soluble substances were extracted. All the above were warmed to approximately 30°C. before feeding. The experiments were started when no secretion occurred from the pouch or when approximately .5 c.c. was obtained in 15 minutes. The secretion was collected hourly and recorded every 15 minutes. The peptic activity was determined by Nirenstein and Schiff's modification of Mett's method and the free and total acidity by Toppers reagent and phenolphthalein respectively. A day of normal feeding with the last meal given at 12:00 a.m. always occurred the day before an experiment. The constant diet of the dog consisted of raw minced beef heart, oatmeal porridge, cod liver oil, powdered yeast, milk, salt and water. Four experiments were performed on most foods; in some cases extremely similar results were obtained and only three experiments were performed. The secretion on raw beef heart (control) was determined approximately every three weeks.

Results

Table 1. Gastric secretion on haddock stimulation.

Aug. 1	Fluid		Acidity		Pepsin		July 22		Fluid		Acidity		Pepsin	
	per ½ hr.	per hr.	Total	Free	Power	Output	per ½ hr.	per hr.	Total	Free	Power	Output		
16.2)	35.1	152	110	256	8985	17.1)	35.1	154	120	154	5405			
18.9{						118.0{								
9.5)	15.2	153	128	282	4236	11.5)	16.8	156	124	225	4230			
5.8{						7.3{								
2.8)	3.4	140	103	400	1360	2.7)	4.3	144	104	400	1720			
.9						1.6{								
.7)	.8	-	-	576	456	1.2)	1.7	136	92	676	1149			
.1{						.5{								
total	54.5					59.9								

In table 1 it will be seen that these two experiments on haddock stimulation express fairly similar results with the highest secretion occurring in the first hour and second half hour and the highest acidity in the second hour. The peptic power increased as the secretion proceeded while the output decreased.

Table 2. Gastric secretion on salmon stimulation

June 29						July 22					
Fluid		Acidity		pepsin		Fluid		Acidity		pepsin	
per ½ hr.	per hr.	Total	Free	Power	Output	per ½ hr.	per hr.	Total	Free	Power	Output
11.2)	29.2	149	121	144	4204	10.7)	25.4	151	123	154	3911
18.0{						14.7{					
11.7)	20.2	156	124	117	2363	11.3)	20.8	159	131	134	2787
8.4{						7.8{					
7.0)	11.9	149	119	181	2153	5.5)	9.6	150	122	256	2459
4.9{						4.1{					
3.0)	4.6	134	95	576	2649	3.0)	4.6	134	104	505	2323
1.8{						1.6{					
total	.5	68.45				.5	.5	60.9	Total		

In comparing the experiments in table 2 on salmon with those of table 1 on haddock it will be seen that although salmon produces a greater volume, the course of secretion is similar to that of haddock with the highest volume in the first hour and second half hour. The secretion on salmon does not fall off as rapidly as that on haddock as with the former there is only an average 21% drop in volume in the second hour while with the latter there is an average 51% drop in this hour. The highest total and free acidities also occurred in the second hour of salmon secretion. The pepsin course differed somewhat from that with haddock as a stimulus in that the lowest peptic activity occurred in the second hour and on the whole the peptic activity was not so great.

Table 3. Gastric secretion on scallop stimulation.

Aug. 19						Aug. 21					
Fluid per 1/2 hr.	Acidity per hr.	Acidity		Pepsin		Fluid per 1/2 hr.	Acidity per hr.	Acidity		Pepsin	
		Total	Free	Power	Output			Total	Free	Power	Output
17.2)	43.2	154	118	196	7457	19.3)	46.8	154	122	181	8470
28.2(						27.5(
19.9)	29.9	161	122	245	7375	21.9)	31.4	158	120	222	8854
13.0(						9.5(
5.5)	7.5	150	110	484	3630	3.5)	5.4	142	113	500	2700
2.1(						2.4(
1.0	1.0			753	753	1.3)	1.5	116	72	722	1083
						.2					
Total	81.6						85.1				

The secretion produced on scallop stimulation (table 3) was much greater in volume than either haddock or salmon, especially in the first two hours. The output of pepsin was also extremely high and particularly so in the second hour.

Table 4. Gastric secretion on lobster stimulation.

July 10						July 18					
Fluid per ½ hr.		Acidity		Pepsin		Fluid per ½ hr.		Acidity		Pepsin	
per hr.	hr.	Total	Free	Power	Output	per hr.	hr.	Total	Free	Power	Output
18.7)	41.1	156	124	162	6658	16.2)	41.2	152	117	196	8075
22.4(						24.9(
16.2)	24.9	160	132	249	6200	17.1)	25.9	156	120	209	5413
8.7(						8.8(
4.5)	6.9	148	123	384	2649	4.1)	6.1	152	119	400	2440
2.4(						2.0(
1.2(	2.2	104	74	734	1748	1.3)	2.3	117	84	615	1414
1.0)						1.0(
.2	.2					.1	.1				
	75.3						75.6				

Lobster (table 4) is seen to stimulate a secretion similar to that of scallop with a very copious secretion of high acid and pepsin output in the first two hours and an abrupt fall in volume in the last two hours.

Table 5. Gastric secretion on raw beef heart stimulation.

July 2						Aug. 24					
Fluid per ½ hr.		Acidity		Pepsin		Fluid per ½ hr.		Acidity		Pepsin	
per hr.	hr.	Total	Free	Power	Output	per hr.	hr.	Total	Free	Power	Output
11.2)	24.4	136	119	144	3513	10.6)	24.2	140	120	164	4368
13.3(						12.3(
9.2)	16.6	152	124	209	3469	9.3)	17.3	152	124	225	3122
7.4(						7.7(
3.3)	6.0	144	108	345	2070	3.6)	5.0	144	107	437	2185
2.7(						2.1(
2.1)	2.8	124	99	564	1635	1.5)	2.1	127	94	684	1448
.7(						.4(
Total	49.6						47.5				

In table 5 two of the control experiments on raw beef heart are given to demonstrate the normal behaviour of the gastric glands at these two periods. Although the course of secretion after beef heart is generally similar to that on the other foods noticeable differences in certain respects can be seen, such as the much smaller volume of fluid produced. A similar comparison, however, cannot be made as the food was simply in a raw minced state.

Table 6. Average figures for volume, acidity and pepsin of gastric secretions on haddock, salmon, scallop, lobster and beef heart.

Food	Total Volume	Acidity		Pepsin		Duration	
		Total	Free	Power	Total output	Hours	Minutes
	I	II	III	IV	V	VI	
Scallop	82.2	151	116	272	22835	3.35	
Lobster	77.5	153	122	220	17011	4.10	
Salmon	63.5	151	115	160	10009	4.15	
Haddock	56.5	152	117	238	13451	3.43	
Beef Heart	47.5	144	117	217	10294	4.00	

In table 6 the foods are arranged in order of the greatest average secretion. The figures, obtained by averaging the respective figures of all the experiments carried out with each food, represent in the case of acidity and peptic power the average concentration per c.c. of the total juice secreted in four hours. For example, the concentration of a sample of juice is multiplied by the respective volume of juice secreted during the respective hour, thus obtaining the output. The outputs for four hours in each experiment are totalled giving the total output.

The total putput is then divided by the total secretion for four hours obtaining thereby the average concentration per c.c. of juice.

The average peptic powers of haddock, beef heart and lobster do not differ greatly while that of scallop is decidedly higher and that of salmon lower. The peptic output increases with the increase in secretion volume with the exception of salmon. The low concentration and output of pepsin with salmon may be due to the high content of fat in the fish. A further possible effect of the fat may be demonstrated in the small difference between the first and second hour secretions of salmon (6-8 c.c) as compared with those of the other foods - haddock (18.4 c.c); lobster (15.7 c.c.) and scallop (14.4 c.c.). Thus, these figures indicate that the dog either received less nervous stimulation from the food or there was an inhibition from the fat present. It was most likely the latter case. The average acidities did not vary greatly except that lobster showed a very high free acidity and raw beef heart a low total acidity.

Discussion

The above results show that scallopp is decidely the strongest stimulus for gastric secretion among the foods given as evidenced by the greater output of acid and pepsin. Next in strength as a stimulus comes lobster although it did not stimulate a comparative increase in the peptic power. Haddock and salmon are weaker stimuli and salmon especially so for pepsin.

Meat Bouillon

July 29

July 25

Volume per 15 min.	Acidity		Pepsin		Volume per 15 min.	Acidity		Pepsin	
	Total	Free	Power	Output		Total	Free	Power	Output
3.7	120	96	576	2131	4.9	125	98	400	1960
11.9	151	120	108	1265	12.7	155	121	117	1485
2.9	152	125	245	711	2.5	152	124	117	295
1.0	144	100	576	576	.6			500	345
.4					.3				
19.8					20.2				

Beef heart and lobster bouillon stimulate secretions which are similar in many respects (table 7). After the first fifteen minutes there is a sudden increase in volume. In the third fifteen minutes there is a quick fall in volume with beef heart bouillon while the secretion on lobster bouillon remains high. With both beef heart and lobster bouillon the total and free acidity, with exceptionally low values for the first fifteen minutes, rise to a high value in the second quarter of an hour and maintain a high level. The courses of the peptic powers are also similar with the highest values at the beginning and end of the secretory period. The peptic output values differ, however, with the highest peptic outputs for lobster occurring in the fourth fifteen minute period.

Table 8. Gastric secretion on lobster or beef heart muscle from which water soluble substances have been extracted.

Lobster

July 27

Volume		Acidity		Pepsin	
per ½ hr.	per hr.	Total	Free	Power	Output
12.5)	21.5	148	114	282	6063
9.0(
6.5)	10.8	152	114	338	3582
4.1(
2.0)	3.4	124	91	576	1958
1.4(
.7	.7			784	548
	36.2				

Aug.17

Volume		Acidity		Pepsin	
per ½ hr.	per hr.	Total	Free	Power	Output
10.0)	17.8	152	102	243	4225
7.8(
7.0)	12.2	150	119	245	2989
5.2(
2.5)	4.7	124	88	550	2585
2.2(
1.4)	1.6	112	64	784	1354
.2(
	36.3				

Beef Heart

Aug.11

Volume		Acidity		Pepsin	
per ½ hr.	per hr.	Total	Free	Power	Output
9.5)	16.9	140	112	669	11306
7.4(
6.1)	11.0	144	119	422	4642
4.9(
4.3)	8.0	132	100	376	3008
3.7(
2.0)	3.5	114	96	722	2527
1.5(
.6	.6				
	40.6				

Aug.8

Volume		Acidity		Pepsin	
per ½ hr.	per hr.	Total	Free	Power	Output
10.2)	16.8	142	107	535	8868
6.5(
5.7)	11.6	144	114	456	5289
5.9(
4.5)	7.0	128	100	456	3192
2.5(
1.9)	3.3	104	72	744	2455
1.4(
.2	.2				
	38.9				

Lobster and meat with some of their water soluble extractives removed by boiling (table 8) stimulate fairly similar types of secretion with the exception that the peptic power in the

first hour after meat is exceptionally high. In general also the course of secretion is similar to that obtained when all the extractives are present and differs greatly with that of the extractives alone.

Table 9. Average figures for gastric secretion for lobster and beef heart bouillon and lobster and beef heart with and without some water extractives removed.

	Volume	Acidity		Pepsin		Duration in hrs. and minutes
	Total Average	Total	Free	Power	Output	
Beefheart (raw)	47.5	144	117	217	10294	4.00
Beef bouillon	18.8	141	113	233	4310	1.15
Beef with water extractives removed.	39.5	137	105	478	18498	4.15
Lobster	77.5	153	122	290	17011	4.10
Lob.bouillon	32.3	154	121	107	6272	1.45
Lobster with water extractives removed.	36.8	143	107	354	3027	4.00

In comparing these average figures (table 9) it will be seen that the most striking effect of the removal of salts was to lower both the acidity and volume of secretion and increase the peptic concentration. The peptic output was increased in the above case only after beef-heart.

The lobster extractives produce a greater secretion (32.3 c.c.) than those of meat (18.8 c.c.) whereas lobster and meat with the extractives removed produce dose volumes of 39.5 c.c.

and 36.8 c.c. respectively. It appears then that greater capacity to stimulate fluid lies in the salt content. According to McLester the ash () is greater in lobster than in beef heart. In addition it may be observed that the secretion stimulated by the lobster and beef heart extractives resembles in many respects that produced by stimulation of a subcutaneous injection of histamine in the same dog. For example, there is a similar rise in volume in the second fifteen minute period, high maximal total and free acidity and comparatively low peptic concentration. Thus, it seems that the higher the salt content the greater is the output of this copious secretion of high acid and low pepsin as in histamine stimulation which in turn dilutes or modifies the secretion produced by the part of the muscle which is not extracted with the water. Also it may be observed that with the extractives removed beef heart stimulates a much greater power and output of pepsin than with the extractives present. Lobster, however, does not behave similarly.

Table 10

May 17 Histamine .7 mg.	Volume per 15 minutes	Acidity		Pepsin	
		Total	Free	Power	Output
	3.3	106	70	225	742
	10.1	150	112	16	161
	3.8	148	106	56	212
	.9			92	82
	18.1				

Conclusions

Experiments carried out on a Pavlov-pouch dog show that:-

1. Of scallop, lobster, salmon and haddock, scallop is the strongest stimulus for the gastric secretion, especially so with regards to fluid and pepsin. The other foods decrease in effectiveness as stimuli in the order named. The effect of fat is seen on salmon stimulation where the pepsin is comparatively low. The acidities varied little, the free acidity on lobster being exceptionally high.

2. It appears that the greater stimulating capacity of the lobster over that of beef heart lies in the water soluble extractives of the muscle as extracts of the former produce approximately twice the secretion as those of the latter when extracted from equal weights of the respective muscle, and as lobster muscle with some of the extractives removed produces almost the same volume as beef heart with similar extractives removed.

