

ON THE COMPOSITION OF PANCREATIC JUICE¹.

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INASMUCH as there were no analyses of pancreatic juice more recent than those published by Carl Schmidt² and Hoppe-Seyler³, and at the present day, with the aid of secretin, a large quantity of material could be obtained without difficulty, the propriety of making some fresh observations was suggested to me by Prof. Starling. And I must express my thanks to him for his advice during the execution of the task.

Methods. In every instance the dog was well fed on meat on the eve of the experiment. In the morning he was given $\frac{1}{8}$ gr. morphia, and anæsthetised with A.C.E. mixture. Cannulæ were then tied into the main pancreatic duct and into the jugular vein. Analyses were made of juice obtained by injecting (1) secretin, and (2) pilocarpin, into the vein.

Secretin juice. Large quantities were obtained by injecting 5 c.c. of secretin at intervals of 10 or 15 minutes. On more than one occasion, when the dog was killed at the end of the day after yielding about 120 c.c. of juice, the process of secretion was still active. In those animals which possessed two or more ducts of almost equal calibre, when only one of these was tapped, the free influx of juice into the duodenum through the others caused an intense enteritis, with death from collapse in a few hours. This was prevented by ligaturing, or in suitable cases tying a cannula into, the other duct or ducts.

Pilocarpin juice. This was collected by injecting 0·3 c.c. of 1 p. c. pilocarpin nitrate into the jugular vein at intervals of about an hour. Larger or more frequent doses diminished the flow and even caused death. 30 c.c. was the largest quantity obtained from one dog.

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² Quoted by Maly, *Hermann's Handb.* v. 189.

³ *Physiol. Chemie*, p. 95.

Heads of Analysis.

Specific gravity. This was ascertained in one instance with a urinometer.

Cryoscopy. Several observations were made of the freezing-points of juice and of serum from the same dog. The ordinary apparatus with a Beckmann's thermometer was employed.

There was no appreciable difference of freezing-point. Thus in one experiment the following were the depressions below the zero of distilled water:—

$$\text{juice } \left. \begin{array}{l} \cdot 61^\circ \\ \cdot 62^\circ \end{array} \right\} \quad \text{serum } \left. \begin{array}{l} \cdot 62^\circ \\ \cdot 63^\circ \end{array} \right\} .$$

Alkalinity. 5—10 c.c. of secretin juice, or 2 c.c. of pilocarpin juice was boiled in a large flask with excess of decinormal H_2SO_4 . The alkalinity was then determined by titration with decinormal NaOH . Phenolphthalein was used as the indicator.

Total solids. 2—5 c.c. of juice was put in a porcelain or platinum crucible and heated to 90° , with the occasional addition of a few drops of absolute alcohol to prevent the formation of a glassy substance difficult of dehydration. The temperature was then raised to 105° , and the heating continued till the crucible was of constant weight.

Total proteids. These were precipitated with excess of 10 p.c. trichloroacetic acid. The precipitate was washed on the filter with ether and alcohol, and then dried.

Heat coagulation. In a beaker of water was suspended a large test-tube surrounded by a stirrer; and within this was a small tube containing the juice and a thermometer. There was also a thermometer in the outer jacket of water. The juice was acidulated with acetic acid and heated gently, more acid being added from time to time as the CO_2 was evolved. When the thermometer in the juice indicated 55° the coagulum was filtered off. The filtrate was next heated to 75° , and the coagulum again filtered. On further heating of the filtrate an opacity was produced which it would have been impossible to weigh.

Total nitrogen. This was estimated by the Kjeldahl process.

Ash. The crucible containing total solids was placed on an Argand burner, with the flame turned down till it was blue, and kept there for a few days. The total ash was then weighed, and the chlorides estimated by Volhardt's method.

Nucleo-proteids were not estimated quantitatively, but on acidulating with HCl and digesting with a glycerin extract of pig's stomach, a better

marked precipitate of nuclein was obtained with pilocarpin than with secretin juice.

The following are some of the results :

	A	B		C	D	
		(a)	(b)		(1)	(12)
Alkalinity:						
No. of c.c. $\frac{N}{10}$ NaOH } equal to 10 c.c. juice }	12.7	12.4	9	5.5*	13.5	14
<i>i.e.</i> in terms of Na in } 100 c.c. }	.2921	.2852	.2587	.1166		
Total solids in 100 c.c.	1.6 } 1.56 }	2.25	1.5	6.38 } 6.40 }	1.62	1.04
Total proteids ,,	0.5			4.8	.63	{ Coagulum under 55°C. = .38 ,, between 55° and 75° = .19 { Opacity over 75°
Ash ,,	1.00 } 0.92 }	1.00	1.00	1.3	1.00	.98
Chlorides ,,	.2808 } .2966 }			.2695		
Total nitrogen				.735		

A. Secretin juice from 3 dogs. Sp. gr. 1014. Feb. 11, 1903.

B. Secretin juice. Specimen collected at beginning (a), and at end (b). Mar. 11, 1903.

C. Pilocarpin juice. May 8, 1903.

D. Secretin juice collected in successive 10 c.c. (1) first 10 c.c.; (12) twelfth 10 c.c. June 6, 1903.

After 60 c.c. had been collected 60 c.c. of 3 p.c. Na_2CO_3 was injected.

After 70 c.c. ,, ,, 50 c.c. ,, ,, ,,

After 110 c.c. ,, ,, 30 c.c. ,, ,, ,,

* The alkalinity of pilocarpin juice was not always so low. In one case it was equivalent to $\frac{N}{10}$ NaOH.

SUMMARY.

1. The alkalinity of secretin juice is as a rule greater than that of pilocarpin juice.
2. The alkalinity tends to diminish as the secretion progresses.
3. It can be maintained or increased by injecting Na_2CO_3 into the blood.
4. Pilocarpin juice contains about 4 times as much of solids as secretin juice.
5. The solids diminish as the secretion continues.

6. The variations in the solids are almost entirely due to variations in the quantity of proteids.

7. The mineral matter is fairly constant, about $\frac{1}{4}$ of it consisting of chlorides.

8. Of the proteids nearly $\frac{2}{3}$ is coagulated by a temperature under 55° C. Most of the remainder came down under 75° C.

9. There is no appreciable difference between the freezing-points of serum and of juice.

10. There is a larger quantity of nucleo-proteid in pilocarpin than in secretin juice, probably from a toxic effect on the cell-substance.