STUDIES ON THE NUTRITIVE VALUE OF THE MEAT OF SEA CUCUMBER (*STICHOPUS JAPONICUS* SELENKA)

II. Seasonal Changes of Chemical Components of the Meat of *Stichopus japonicus*

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It is important to take into consideration the variation of chemical components of the sea cucumber in preparing various forms of food from sea cucumber.

The chemical components of animal bodies varies clearly with the development of the gonads and conditions of feeding. The present authors have analysed monthly the chemical components of bodies of *Stichopus japonicus* which are caught in the sea near Hakodate.

Experimental Part

(1) Sample

As samples many individuals of *Stichopus japonicus* were employed, of a length of about 15 cm and as nearly alike as possible. Because it is impossible biologically to judge the age of sea cucumber, it follows that there was no certainty that sea cucumbers of the same age were used. The length of sea cucumbers caught from January to March was about 10 cm, since sea cucumbers of that season are very small owing to the hibernation. The difference of male and female also cannot be judged except in the spawning season of July and August[1]. The samples used in these experiments were without distinction of sex. The samples of sea cucumbers which were caught in the early part every month were analysed.

(2) Method of experiment

The sample of living sea cucumber was split on ventral side, then part of belly cavity wall and part attached to surface skin were cut off as shown in Fig. 1.

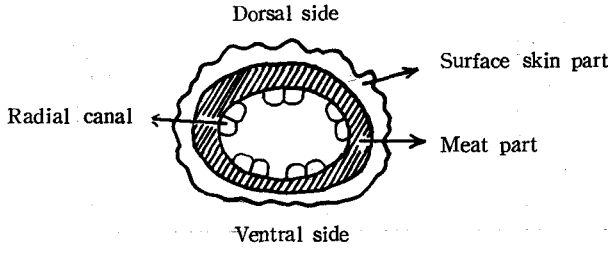

Fig. 1. Sample used

The part of meat was taken and crushed with a sharp knife into very small pieces; the amounts of water-content, ash, total nitrogen, protein-nitrogen and crude fat were estimated by the usual methods.

The amount of protein-nitrogen was estimated by Kjeldahl's method using precipitated protein substance with

10% trichloracetic acid solution. The crude fat was estimated by using Soxhlet's extractor. The samples of every month were the crushed meat prepared from several bodies of sea cucumber of the same size.

(3) Experimental results

Experimental results obtained are shown in Table 1, 2 and Fig. 2

Table 1. Seasonal change of proximate composition of sea cucumber meat (Per cent in raw material)

Experimental articles / Date	Water content	Ash	Total-N	Protein-N	$\frac{\text{Protein-N}}{\text{Total-N}}$	Crude fat
1953 May 19	88.85	2.28	1.35	0.64	47.4	0.88
June 9	89.10	1.12	1.38	0.47	34.1	1.14
July 7	91.19	0.82	1.15	0.44	40.0	0.56
Aug. 15	90.20	1.37	1.23	0.40	32.5	0.76
Sept. 16	88.50	1.93	1.30	0.70	53.8	0.98
Oct. 16	87.76	1.89	1.36	0.83	61.0	1.01
Nov. 4	88.86	2.13	1.15	0.70	60.8	1.22
Dec. 4	87.42	2.16	1.04	0.67	64.4	0.80
1954 Jan. 5	84.89	2.73	0.97	0.50	51.5	1.44
Feb. 8	90.01	1.32	1.05	0.57	54.3	2.32
Mar. 12	90.80	0.20	0.71	0.35	49.3	0.60
April 7	91.30	1.35	1.03	0.57	55.3	0.44
Average	89.08	1.61	1.14	0.57	50.4	1.01

The average calorie value during one year of 100 g of sea cucumber is 38. 7cal.

Table 2. Seasonal change of proximate composition of sea cucumber meat (Per cent in dried material)

Experimental articles / Date	Ash	Total-N	Protein-N	Crude fat
1953 May 19	20.5	12.09	5.74	7.88
June 9	10.3	12.67	4.30	10.45
July 7	9.3	13.04	4.99	6.70
Aug. 15	14.0	12.52	4.08	7.76
Sept. 16	16.8	11.26	6.09	8.50
Oct. 16	15.0	11.12	6.78	8.25
Nov. 4	19.1	10.32	6.28	10.90
Dec. 4	17.2	8.26	5.33	6.36
1954 Jan. 5	18.1	6.42	3.31	9.52
Feb. 8	13.2	10.49	5.69	23.20
Mar. 12	2.2	7.73	3.79	6.52
April 7	15.5	11.82	6.54	5.06
Average	14.3	10.64	5.16	9.26

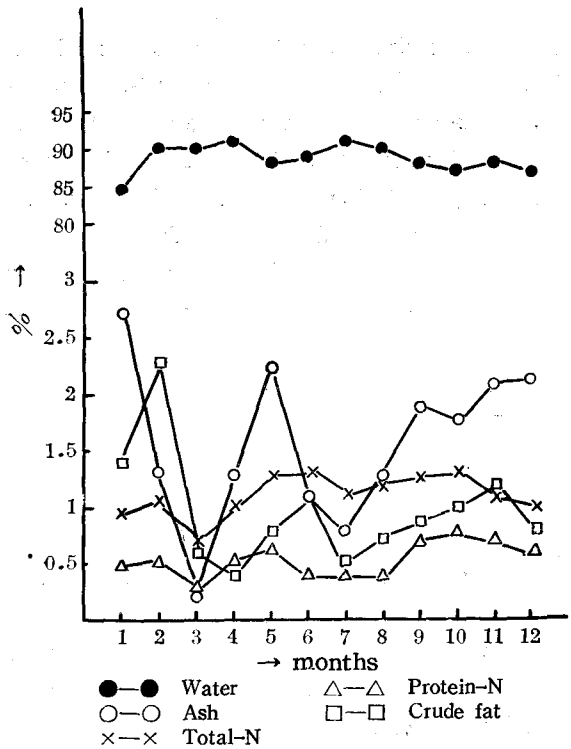

Fig. 2. Seasonal change of proximate composition of sea cucumber meat (Per cent in raw material)

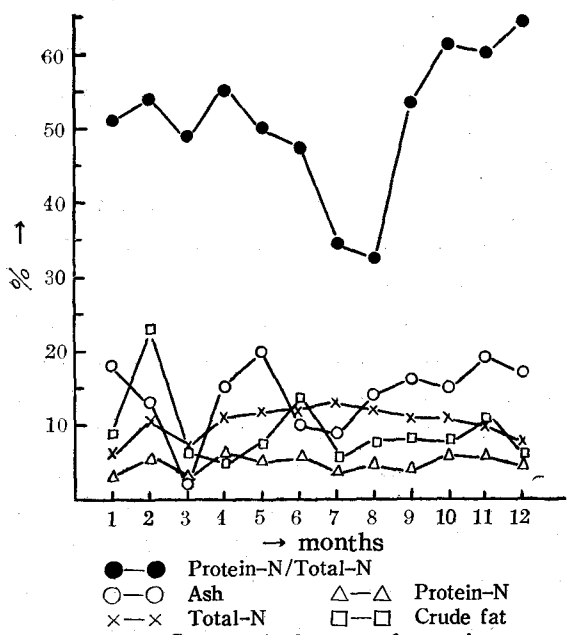

Fig. 3. Seasonal change of proximate composition of sea cucumber meat (Per cent in dried material)

As seen in Fig. 2, the amount of water content varied from the minimum of 85% in January to the maximum of 91% in July. That is to say, the amount of water content which showed the maximum value in July, decreased to a minimum in January of the next year. From February the amount of water content increased again gradually, but there was no remarkable variation between February and May. The amount of fat content varied from the minimum of 0.56% in July to the maximum of 2.3 % in February. Amounts of water content and fat content were relatively just the opposite.

In fatty fish meat, e. g., sardine[2)3)4)] and herring[5,6)], there can be seen remarkable variation of the amount of fat content in relation to the growth of the gonads. In the meat of sea cucumber, there is also a variation of the amount of fat content in relation to the growth of gonads, but the amount of fat content is not very large in comparison to the other fish. The amount of fat content increased gradually from September to January, and then the amount decreased from February to May. The amounts of crude and pure proteins also showed nearly the same variation. In the variation of the amount of ash content, it showed the minimum value of about 1% in July and August, while in other months the amount of the

ash content varied between 2 and 3%.

As seen in Fig. 3 showing the percentages of each chemical component of the dried matter, the variation of those percentages of fat, ash and pure protein was the same as the variation of the percentages of the original matter. The amount of the crude protein showed the minimum value in January, then it increased slowly to exhibit the maximum value from June to August, followed by a gradual decrease from September. Therefore, the percentage of protein nitrogen in relation to total nitrogen showed the minimum value from June to August, and it increased gradually from September to December, but it decreased slowly with the falling of the water temperature.

Discussion

As stated above each component has generally some variation from July to August and from January to February as the zeniths. Considering from the habit and the food of sea cucumbers, as studied by Kinoshita and Shibuya[7] of Hokkaido Fisheries Station, the breeding season in Hokkaido is from early August to early September in the district of Okushiri Island, from the end part of June to early August in the district of Mashike, from the end of June to the end of July in Yagishiri Island, from the end of July to the end of August in the district of Wakkanai, from the end of June to the end of August in the district of Muroran, and from early in July to the end of August in the district of Shikabe, respectively. General speaking, the breeding of sea cucumber is done in water of 13°~20°C from July to August.

As to the habit of sea cucumbers, Mitsukuri[8] has found definitely that sea cucumbers estivate for about two weeks in the middle of July in Kanazawa Bay, Kanagawa Prefecture. He found that during that estivation they do not take food, and the digestive organs contract to line shape.

According to Kinoshita and Tanaka[9], the kind and the quantity of the contents in the stomachs of sea cucumbers about Hokkaido are quite the same from early May to mid-September, and there may not be any estivation. According to Kinoshita and Shibuya[7], sea cucumbers of Hokkaido may enter a period of dormancy something like estivation after the middle of September; during that period they hide in caves. They creep out temporarily in about January of the following year as "winter sea cucumber", but again hide in caves. Then with increase of water temperature they creep out for the summer after the end of April. The contents of the stomach of the sea cucumbers were confirmed to be 60 kinds of diatoms, 14 kinds of such abiogenesis as plankton and frequently larvae of sardine and other fish or algae.

Considering comparatively from studies on the habits and feeding of sea cucumbers and the results of the present authors' experiments, the fact that the amounts of fat, crude protein and ash in the meat of sea cucumber are at a minimum of

comparatively small quantity in from July to August, may be due to the consumption thereof in the course of breeding. After the breeding in September, each component lost will be restored by active taking of food to prepare for hibernation. Consequently each component of the meat increased, and the amount of water content in the meat will decrease relatively.

During the dormancy in the period from mid-September to December the components accumulated, but especially fat and protein will be consumed again. They creep out temporarily in about January to take supplementary food. Sea cucumbers which creep out temporarily in this season are customarily called "winter sea cucumber".

From March to April, the amounts of fat and protein in the meat may test out small owing to the consumption of the components in the body during the period from February to early April. From the end of April to June, the amounts of fat and protein will increase gradually on account of active taking of food following permanent creeping out from their caves to prepare for breeding.

Summary

The amounts of the chemical components in the meat of sea cucumber (*Stichopus japonicus*) vary from July to August and in January. The variation which occurs from July to August is due to the breeding, and the variation in January is due to the taking of food as a habit.

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