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

IV. Digestibility of Meat of Sea Cucumber

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From olden times, sea cucumber (*Stichopus japonicus*) has been eaten as a vinegared food with relish in Japan. When the raw meat of sea cucumber is vinegared, the meat protein is coagulated causing the meat to become hard. It has been a popular impression that the vinegared meat of sea cucumber is indigestible.

The authors have tried to estimate the digestibility of raw meat, vinegared meat, boiled and dried meat, canned meat of sea cucumber, respectively, with pepsin and have compared the digestibility of them. At the same time the authors have also tried to estimate the digestibility of raw flat fish and Atka mackerel meat for the sake of comparison and contrast.

There are methods of testing digestibility which use animal bodies, and also artificial chemical tests using pepsin. There are also many possible methods for use in the artificial chemical test. One of them is a method of estimating the digestibility from the amount of total nitrogen in the sample and nitrogen in the undigested residue of the sample. There are available for example Wedmeyer's method,¹⁾ Wagner's method²⁾ (reformed Wedmeyer's method), Ōshima and Itaya's method,³⁾ and reformed Ōshima and Itaya's method.⁴⁾ The other method is based upon estimates of the amount of total nitrogen in the sample and nitrogen in the filtrate of digested sample. For example the Tomiyama and Ishikawa method,⁵⁾ or the Kimura method.⁶⁾ Those methods are almost equal in their value.

Experimental Part

(1) Sample

As samples, (1) raw meat, (2) vinegared meat, (3) canned meat, (4) boiled and dried meat were employed. As contrasting sample, raw flat fish meat and raw Atka mackerel meat were also employed.

Skin and viscera were removed from two raw fresh sea cucumber bodies (300 g) and the part of so-called meat was crushed. Twenty grams of the crushed meat was employed as the sample.

Vinegared meat of sea cucumber was made from the pickling of four bodies (425 g) in 3% acetic acid solution for a week. The vinegared meat was prepared similarly as the raw meat.

Canned meat which was manufactured by Tanikawa's patented method⁷⁾ was

employed in the same way as the raw meat.

Boiled and dried meat was made from the boiling of 17 raw bodies of sea cucumber (2300 g), which had been viscerated, for 15 minutes. Material was then dried in the sun for 3 days. When the dried bodies are employed as sample, they were soaked in water and then were treated similarly to the manner in which the raw meat was treated.

Raw flat fish and Atka mackerel meat were skinned and boned and then 20 g of treated meat of each fish was employed as samples.

(2) Experimental method

The amounts of water content and protein nitrogen of each sample were estimated. Then 20 g of each sample was put into an Erlenmeyer's flask of 200 cc volume, and then 100 cc distilled water and 1 g of pepsin of "Merck" were poured into the flask and mixed homogeneously to dissolve pepsin completely. Next, 100 cc of N/5 HCl solution was also added to the material in the flask and the flask was left at 37°~38°C for 44 hours. After digestion of the samples, the amount of protein nitrogen in the undigested residue of the samples was estimated.

The digestive effect of the employed pepsin was estimated by the dilution and sedimentation method of Fuld-Lerison.⁸⁾ That is to say, the digestive effect was estimated by ascertaining what volume in cc. of 1% edestin solution can be digested by 10 cc of the definite diluted solution of pepsin at room temperature for 30 minutes. The result obtained for the digestive effect of the pepsin was as follows:

$$P_{30}^{20} = 64 \text{ Units}$$

The digestibility of the samples was calculated by the following equation.

$$\text{Digestibility} = \frac{\left(\begin{array}{c} \text{The amount of} \\ \text{protein-N} \\ \text{in the sample} \end{array} \right) - \left\{ \left(\begin{array}{c} \text{The amount of} \\ \text{protein-N in the} \\ \text{undigested residue} \end{array} \right) - \left(\begin{array}{c} \text{Nitrogen in the} \\ \text{pepsin after the} \\ \text{digestion} \end{array} \right) \right\}}{\text{The amount of protein-N in the sample}} \times 100 (\%)$$

Note: (i) The amount of protein-N was estimated after removing protein by Stutzer's reagent.

(ii) The amount of pepsin-nitrogen was estimated under the same condition of meat digestion as follows: After 100 cc of N/5 HCl and 100 cc of dist. water were added to 1 g of pepsin in a flask, and the mixture was left at 37°~38°C for 44 hours, the amount of protein-N was estimated by removing of protein in the flask by Stutzer's reagent.

(iii) The amount of the total nitrogen in 1 g of original pepsin was estimated by Kjeldahl's method. It was 22.8 mg. The amount of nitrogen in pepsin after the digestion was 5.78 mg by the above described method.

(3) Experimental results

The results obtained are shown as Table 1.

Table 1. Comparative results of digestibility with variously treated sea cucumber meat

Sample	In Sample		Protein-N in residue after digestion (mg.)	Protein-N in pepsin after digestion (mg.)	Digestibility (%)
	Water content (%)	Protein-N (mg.)			
Fresh sea cucumber meat	87.68	206	83	5.78	62.5
Sea cucumber meat with vinegar	86.45	278	23	5.78	86.5
Canned sea cucumber meat	77.47	358	72	5.78	81.4
Dried sea cucumber meat after boiling	67.60	504	76	5.78	85.9
Fresh flat fish	79.57	261	11	5.78	97.9
Fresh Atka mackerel	78.26	263	13	5.78	97.3

As indicated in Table 1, the digestibility of raw meat of sea cucumber is inferior to the raw flat fish meat or raw Atka mackerel meat. However, when the raw meat is converted into vinegared food, canned food or boiled and dried food, the digestibility of the processed meat became better.

If the meat of sea cucumber is boiled to prepare canned food or dried food, the properties of the protein in the meat change and become decomposable by some enzyme such as pepsin. This fact agrees with the results obtained by the senior author⁹⁾ who found that the boiled squid or flat fish meat is more digestible than the raw meat.

It is remarkable that the vinegared meat of sea cucumber is more digestible than has been formerly imagined, since it is known that the protein of meat of sea cucumber is coagulated by vinegar and the meat become hard and uncrisp. This is perhaps due to the fact that the acidified meat of sea cucumber becomes decomposable by an enzyme.

The meat of sea cucumber is rarely eaten as raw food. It is eaten as vinegared food in Japan or as boiled food in China, so there is no fear of indigestion.

From the results of the present experiments it may be concluded that the meat of sea cucumber should be eaten as vinegared food, canned food or boiled food. In a word, the meat of sea cucumber is rather a tasty food than a nutritive food.

Summary

The digestibility of raw meat of sea cucumber, showing a value of about 63%, is inferior to that of fish meat, showing 98%. The digestibility of the meat can be increased by boiling or vinegaring to a degree of 80~86%. That is to say, the meat of sea cucumber is not a very good nutritive food. It is better to treat the meat by boiling, canning or vinegaring.

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