Biological assessment of king crabs' meat quality

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Abstract. We studied the quality of meat of the king crab Paralithodes camtschaticus depending on its biological condition through biotesting using infusoria Tetrahymena pyriformis. It was found that the actual biological value of the meat of crabs of the I and IV molting categories is lower by 8.6%-14.2% than the meat of crabs of the II and III categories. It is caused by the negative influence of calciferous substances existing in blood and muscular tissue and necessary for formation of a new crust of the crab after molting.
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Introduction

Marine invertebrates are the raw material for producing delicacies, the quality of which and the biological accessibility of their feedstuff are influenced by various factors including biological condition of the objects. One of the expensive marine objects is the king crab, the products of which are of great consumer demand in the market.

However, it seems impossible to assess the edibility of the raw materials and to obtain valid aggregate assessment with conventional methods of inspection, which raises the necessity to search for alternative approaches. It is known that simultaneous determination of the toxic and physiological effects of a product is possible using biological methods involving protozoans, the most suitable and prospective one of which is the ciliated Tetrahymena pyriformis infusoria [1-4].

A typical feature of infusoria is high intensity of metabolism, which provides for their quick chemoattractant-elicited or anabolic response to deterioration of the product quality, change of its chemical composition, or presence of xenobiotics [5-10]. Because of the fact that generational change of infusoria during one day takes place 4-6 times, application of Tetrahymena at biotesting allows determining the remote effect of the product on the genetic apparatus of live cells. The biological method of determination of the aggregate physiological influence of edible raw materials and products allows carrying out any number of simultaneous observations, starting with 30 and more, which provides for obtaining valid results.

The objective of this research was to study the meat of the king crab depending of its biological condition.

Objects and methods of the research

The research objects were specimens of the king crab (Paralithodes camtschaticus) of various biological conditions. Choice of this species of commercial marine loricate invertebrates is determined by the fact that every period of their yearly life cycle considerably differs by typical biological attributes. The crust change is typical of crabs and precisely determines categories of the molting state: Category I – after molting, categories II and III – during the inter-molting period, and category IV – before molting. For the purposes of the research, specimens of king crabs of all molting categories were simultaneously selected from the same commercial landings, which categories were determined by the following attributes [12]:

- crabs of the I category (after crust change) had soft pure crust without any fouling, the crust of rosettes was white, the filling of limbs was not full;
- crabs of the II category had hard crust with slight fouling and scratches, the crust of rosettes was yellowish, the filling of limbs was normal;
- crabs of the III category had hard fouled crust with multiple scratches, the crust of rosettes was brown, the filling of limbs was normal;
- crabs of the IV category (before change of the crust) had heavily mudded and fouled crust, the crust of rosettes was dark and heavily scratched, dark scratches created black stains, the filling of limbs was lower.

Determination of organoleptic and physical-chemical values of the quality of the king crab meat was carried out in accordance with State Standard GOST 7636-85 "Fish, marine mammals, marine invertebrates, and products of their processing. Methods of analysis" and State Standard GOST 7631-2008 "Fish, shellfish and algae, and products made of them. Methods of determination of organoleptic and physical values". The amino-acid

composition of the crabmeat was determined using the L-8800 amino-acid analyzer (made in Japan). The relative biological value was determined through the recommended method of biotesting using the ciliated Tetrahymena pyriformis infusoria [11]. With this purpose, the weighed quantity of a homogenized sample of the crab meat containing 0.6 mg of nitrogen was put in three parallel flasks containing carbohydrate salty yeast medium. After heating it in a water bath for inactivation of the microflora, 0.02 ml of the three-day culture of infusoria was put in the samples. The control samples were flasks with the casein medium containing adequate quantity of nitrogen. Cultivation of infusoria in the control and experimental samples was carried out during four days at the temperature of 25 ^{o}C. For better aeration, the samples were shaken up daily. After four days, in order to obtain the average result, we counted the quantity of grown-up infusoria in 10 squares of the Fuchs-Rosenthal counting chamber. The relative biological value index was determined by the comparison of the quantity of cells grown-up in the experimental sample to the quantity of grown-up infusoria in the control sample with casein, which was expressed in percentage.

Body of the work

Determination of organoleptic indexes (smell, color, taste) of the muscular tissue of king crabs of various categories did not reveal any considerable differences except for the watery consistency in the I category meat sample.

The results of study of the chemical composition of king crabs of various molting categories (Table 1) showed that the content of main food components in their muscular tissue is not constant, but changes depending on the biological condition. The meat of crabs of the II and III categories was described with high content of protein, and the meat of crabs of the I and IV categories – with high content of minerals. The muscular tissue of crabs of the III category contained slightly more carbohydrates, which corresponded to the slightly acid flavor of its meat.

Table 1. Chemical composition of muscular tissue of crabs depending on their biological condition

Components	Content (in %) in crabs of molting categories			
	I	II	III	IV
Water	83.8±2.6	80.8±2.0	78.8±1.8	82.5±1.9
Protein	12.9±1.5	16.0±2.2	17.1±2.0	14.3±1.1
Fat	0.4±0.05	0.5±0.1	0.6±0.1	0.3±0.06
Carbohydrates	1.0±0.2	1.4±0.05	2.1±0.5	1.2±0.03
Minerals	1.9±0.2	1.3±0.1	1.4±0.1	2.7±0.2

Table 2 contains results of study of amino-acid composition of muscular tissue of crabs of various categories.

Table 2. Amino-acid score of muscular tissue of crabs of various molting categories

Indispensable amino acid	WHO/FAO scale		Crabs category							
			I		II		III		IV	
	A	S	A	S	A	S	A	S	A	S
Leucine	7.0	100	8.2	117.1	10.0	142.8	10.0	142.8	9.3	132.8
Phenylalanine + tyrosine	6.0	100	6.6	110.0	8.1	135.0	8.0	133.3	7.9	131.7
Lysine	5.5	100	6.1	110.9	6.8	123.6	6.9	125.5	6.8	123.6
Valine	5.0	100	4.0	80.0	4.5	90.0	4.5	90.0	4.6	92.0
Isoleucine	4.0	100	3.9	97.5	4.1	102.5	4.3	107.5	4.0	100.0
Threonine	4.0	100	4.8	120.0	4.4	110.0	4.434	110.0	4.6	112.5
Methionine + cysteine	3.5	100	4.1	117.1	4.3	122.9	4.4	125.7	4.4	125.7
Tryptophan	1.0	100	1.1	110.0	1.2	120.0	1.2	120.0	1.2	120.0
Total amount of indispensable amino acids	36.0		38.8		43.4		43.7		42.8	

Designation: A – quantity of indispensable amino acid, g/100 g of protein; S – score value, %

Despite the category of king crabs, the amino-acid score of proteins of their muscular tissue is close to the WHO/FAO scale. The limiting amino acid of the crabmeat protein of all categories is valine. The meat of crabs of the I category is distinguished for lower content of certain amino acids, than the meat of crabs of the II-IV categories. However, the quantity and the proportion of indispensable amino acids in the crabmeat of all categories were not less than the levels set by the WHO/FAO scale. This allows describing their proteins as complete.

Biotesting of the muscular tissue of king crabs of all molting categories (refer to the figure) showed that their biological value differs considerably. The highest relative biological value of the muscular tissue was typical of crabs of the III molting category, and this value is quite lower for the crabs of the II category. Compared to them, crabs of the I category had the relative biological value lesser by 8.6% and the crabs of the IV category – lesser by 14.2%.

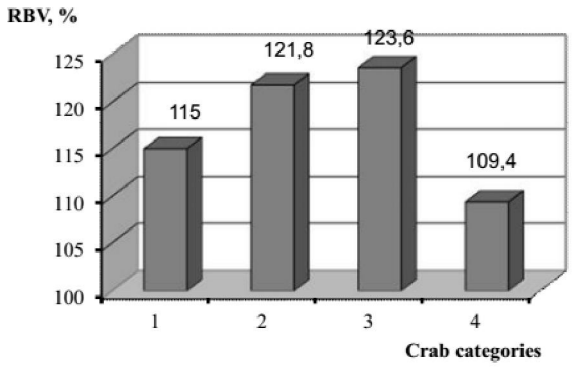

Figure 1. The relative biological value (with respect to casein) of the muscular tissue of king crabs of various molting categories

The lower actual biological values of the crabmeat of the I and IV categories are caused by the negative effect of calciferous substances, which are "anti-nutritional" factors decreasing assimilation of the protein component. It is a known fact that during the period of preparation for molting, the calciferous substances of crabs of the IV category move from crust to blood and muscular tissue [12]. Their accumulation in the internal medium seems to affect negatively the quality of meat of the loricate invertebrates. The calciferous substances of the I category crabs move from blood and muscular tissue to the new soft crust, but some residual quantity of them also influences on assimilation of proteins.

Conclusions

The results of the fulfilled research show that the quality of king crabs meat depends on their biological condition. During certain periods of the life cycle, the blood and the muscular tissue of king crabs accumulate calciferous substances necessary for formation of a new crust, which considerably reduces assimilation of protein of their meat.

The method of biotesting using Tetrahymena pyriformis infusoria allows valid aggregate assessment of the quality of crab fishery objects related to the physiological changes in various periods of their yearly life cycle.

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