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QUALIMETRY OF INNOVATIVE PRODUCTS WITH THE ADDITION OF THE SHRIMP *PALAEMON ADSPERSUS*

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Abstract. Crustaceans of the Azov–Black Sea basin, in particular, the shrimp *Palaemon adspersus*, are a type of raw material easily available in the domestic market, because the large volumes of its industrial production in the Azov–Black Sea basin make it inexpensive and abundant. That is why we have suggested innovative products with the addition of *Palaemon adspersus* meat: dumplings (pelmeni) and fish fingers. We selected the following main recipe components of these dumplings: *Palaemon adspersus* meat, Azov–Black Sea goby meat, unleavened dough, and those for fish fingers: *Palaemon adspersus* meat, Azov–Black Sea goby meat, egg powder. To enhance the taste and aroma, Svanetian salt was added to the minced meat in the model compositions of the products developed. To substantiate the rational content of the recipe components in the model compositions of products with *Palaemon adspersus* meat added, the method of qualimetric analysis of the sensory parameters was used. According to the results of qualimetric evaluation, it has been found that for dumplings, the best ratio of *Palaemon adspersus* meat, Azov–Black Sea goby meat, and unleavened dough is 1:2.7:3, and for fish fingers, the most practical ratio of *Palaemon adspersus* meat, Azov–Black Sea goby meat, and egg powder is 2.5:6.5:1. The obtained results of qualimetric analysis of the model compositions have been confirmed by mathematical calculations using multiple linear regression with initial determination of criterial factors of influence. According to the mathematical calculations performed, the highest value of the parameter (y_1=0.93) has been obtained for the model composition of dumplings with *Palaemon adspersus* meat added with the ratio of the recipe components 1:2.7:3. For fish fingers, the highest value of the parameter (y_4=0.8) has been determined for the model composition where the ratio of the recipe components was 2.5:6.5:1. These calculations confirm the objectivity, efficiency, and practicality of the chosen method of qualimetric analysis of the model compositions under study.

Keywords: *Palaemon adspersus* shrimp, qualimetric analysis, sensory characteristics, dumplings, fish fingers.

Introduction. Formulation of the problem

One of the priority directions of development of the Ukrainian fish industry is the manufacture of food products and biological additives from the shrimp *Palaemon adspersus* of the Azov–Black Sea region of the predictive quality.

In Ukraine there are no modern systematic scientific studies (the last ones date back to 1960–1970s) of the technology of food products and biologically valuable additives from shrimp in the Azov–Black Sea area [1]. Given the above, we suggest innovative products: dumplings and fish fingers with the addition of *Palaemon adspersus* shrimp.

The quality of *Palaemon adspersus* shrimp products should be determined on the basis of their characteristic properties, which include the sensory ones, too. Sensory analysis quickly and objectively gives a general impression of the quality of products. Besides, it allows you to control all stages of their production, in particular, when determining the most practical ratio of recipe components.

Also, the accuracy of organoleptic parameters is increased and the data obtained are generalised by qualimetric evaluation of the results. This method of quality assessment consists in the quantitative comparison of the studied product with the standard. As a standard, either an existing product is taken or a notional one, which is considered to be ideal according to modern requirements for nutrition. Qualimetric analysis is considered to be the most objective way to evaluate products by formalising the quality criteria, i. e. presenting the parameters as an array of digital data. To confirm or refute the results of qualimetric analysis of organoleptic parameters, we used multiple linear regression with initial determination of the criterial parameters.

Analysis of recent research and publications

A number of scientists have contributed significantly to solving the problem of improving the quality and developing biologically valuable fish products in accordance with scientifically sound principles of nutrition science and the functional nutrition requirements. Among these are the works by Lebska T. [2], Pivovarov P. [3], Bezusov A. [4], Dobrobabina L. [5], Sidorenko O. [6], Fedorova D. [7], Dabadé D., Kim S., Jung E., Putri S., Suantika G., Heu M., Fernandes T., da Silva J., . Oliveira da Cavalherio J., Bingol E., Bostan K.

Domestic scientists have studied the sensory, mechanostructural, biochemical, microbiological properties, and safety parameters of aquatic organisms of the Azov–Black Sea area [8-10]. The researchers have developed various mathematical models that allow not only predicting the quality of the raw materials studied and products from them, but also optimising the conditions and parameters of technological processes, determining the dynamics of individual quality parameters and products' shelf life. For example, O. Sidorenko [6] used mathematical models to predict changes in the quality of fish products. These models describe the kinetics of changes in the critical parameter of optimisation, the strength of the structure of food products during goods movement, and allow predicting the shelf life. Dobrobabina L. [5], Pivovarov P. [4], and Fedorova D. [7] in their scientific works described modern technologies of manufacturing food products from aquatic organisms and prospects of using them.

Analysing the scientific publications by foreign scientists, we can conclude that they have studied the sensory, physicochemical, biochemical, and microbiological quality characteristics of the whiteleg shrimp (*Litopenaeus vannamei*) known as the Pacific white shrimp, or king prawn [11,12], as well as the tropical shrimp *Penaeus notialis* and the black tiger shrimp (*Penaeus monodon*) also known as the giant tiger prawn [13]. In their works, Bingol E. and Bostan K. [14] studied the sensory and microbiological properties of the pink shrimp *Parapenaeus longirostris* of the Marmara Sea. Gonsalves A. [15], Imran A. [16], and Tsironi T. [17] described changes in the quality of the shrimp *Litopenaeus vannamei* during storage.

Janas U. and Bruska O. [18] investigated the calorific value of *Palaemon adspersus* and *Palaemon elegans* common in the Baltic coastal waters. Also, Bilgin S. and A. Suat Ates described the seasonal distribution of *Palaemon adspersus* in the southern Black Sea [19], and Bat L. and Bilgin S. studied the toxicity of cadmium, copper, and lead to *Palaemon adspersus* [20, 21].

The scientists Fernandes T., da Silva J., da Silva A., Oliveira da Cavalherio J. *et al* [22, 23] developed and studied the sensory properties of powder based on the shrimp *Litopenaeus vannamei* and products from it (soup, dough).

However, the shrimp *Palaemon adspersus* from the Azov–Black Sea region is a valuable raw material little-studied by domestic scientists. This type of shrimp has not been sufficiently studied by foreign scientists either, because it inhabits mainly the north-western part of Europe and has small size and mass characteristics.

It should be noted that in our previous publications, we have studied the organoleptic, mechanostructural, biochemical, and microbiological properties of *Palaemon adspersus* and the safety indicators for the content of heavy metals, including toxic elements [24].

Thus, the analysis of scientific sources indicates lack of research on products from *Palaemon adspersus*, so this paper considers qualimetric analysis as a method to determine the sensory characteristics of innovative products with the addition of *Palaemon adspersus* meat.

The purpose of the work is to study, by qualimetric analysis, the organoleptic characteristics of model compositions of products with *Palaemon adspersus* meat added (dumplings and fish fingers).

To achieve this purpose, the following **objectives** were set:

– formation of model compositions of dumplings and fish fingers containing *Palaemon adspersus* meat, and determination of their nutritional and calorific value;

– qualimetric evaluation of the sensory parameters of the model compositions;

– determination of the most advantageous ratio of the recipe components by qualimetric and mathematical analysis.

Research materials and methods

The study used boiled-frozen *Palaemon adspersus* shrimp and model compositions of products with the addition of *Palaemon adspersus* meat: semi-finished products (dumplings) and finished product (fish fingers). The recipe components of the dumplings: meat of the shrimp *Palaemon adspersus*, Azov–Black Sea goby meat, fresh dough from top-grade flour (the ratio of the ingredients 1:2.7:3); fish fingers: meat of the shrimp *Palaemon adspersus*, Azov–Black Sea goby meat, egg powder (the ratio of the ingredients 2.5:6.5:1).

Boiled-frozen shrimp *Palaemon adspersus* were obtained from Dzharylgach Island, and minced meat of the Azov–Black Sea goby [25], deboned and descaled, from LLC "Basic Azov Fish-Processing Complex" (Berdyansk, Zaporozhye Region).

To form fish mince with the addition of *Palaemon adspersus* shrimp, the Azov–Black Sea goby was chosen as the raw material. This type of fish raw material is affordable and available all year round on the domestic market. Besides, it has a low fat content (1–2.5%), a fairly high content of complete proteins

(16–18%) and mineral elements (calcium, potassium, phosphorus).

Top-grade wheat flour was chosen to form fresh dough. Its chemical composition includes 12.0% of proteins, 0.9% of fats, and 70.0% of carbohydrates.

An important ingredient of fish fingers containing *Palaemon adspersus* shrimp meat is egg powder used as a natural plasticiser. It contains 45% of protein, 35% of fat. Besides, to enhance the taste and aromatic properties of dumplings and fish fingers, Svanetian salt was added. It is a dry mixture of spices that contains table salt, blue fenugreek, garlic, dill seeds, coriander seeds, red chilli pepper, wild caraway, Imeretian Saffron (dried and ground petals of French marigold flowers).

A reference to compare the studied products with was a notional ideal product complying with modern dietary requirements [26].

Organoleptic evaluation was performed in several stages. We rated the sensory parameters on a 5-point scale developed by us, taking into account the weight coefficient: 5 points – excellent quality, 4 points – good quality, 3 points – satisfactory, 2 points – unsatisfactory, 1 point – the product is of poor quality.

The summarised quality indicator for the sensory parameters was calculated by the formula:

$$Q = \sum_{i=1}^{n} x_1 k_1 + x_2 k_2 + \dots + x_n k_n \qquad (1)$$

$x_1, x_2, \dots, x_n$ – average values of the sensory quality parameters, points;
$k_1, k_2, \dots, k_n$ – weight coefficient.
n – the number of sensory quality parameters.

The moisture content in the samples was determined in accordance with DSTU 8029:2015.

The rational concentrations of *Palaemon adspersus* meat and Azov–Black Sea goby meat were determined taking into account the organoleptic assessment of the quality and chemical composition of the minced meat depending on the concentration of the ingredients. When preparing the model compositions of dumplings, *Palaemon adspersus* meat was used in the concentration 15–30%, and for fish fingers, its concentration was 10–25%. Dumplings without *Palaemon adspersus* shrimp added were selected as a reference.

The calorific value was calculated according to the conventional method based on the content of proteins, fats, and carbohydrates.

Standard methods of statistical, correlation, and regression analysis were used to process the research results obtained.

Regression analysis was used for mathematical modelling and description of the linear and nonlinear dependence and for evaluation of the adequacy of the results obtained.

Correlation analysis was used to establish the relationship among the variables under study and to determine the coefficients that reflect the strength of this relationship.

The research results were mathematically and statistically processed with a computer using Microsoft Excel. When processing the experimental data, the following statistical criteria were used: Student's criteria to establish the significance of the coefficients of the regression equation, and *F*-test to determine the adequacy of the equations in relation to the experimental data.

Results of the research and their discussion

The nutritional and biological value of fish products can be improved by modelling the composition of minced fish mixtures with the addition of *Palaemon adspersus* meat. The development of these mixtures will expand the range of fish products with improved amino acid composition, a high content of macro- and micronutrients and vitamins.

Previous studies of the meat of *Palaemon adspersus* shrimp allowed determining its biological value and proved its application potential in the food technology [15,16].

The development of a mixture of minced fish with the addition of powder from *Palaemon adspersus* shrimp or their meat seems no less promising.

It should be noted that adding less than 15 and 10% of shrimp meat, respectively, is impractical for increasing nutritional and biological value, and more than 30 and 25% of it leads to a significant deterioration in the sensory quality of finished products. The amount of egg powder added to the model compositions of minces for fish fingers ranged from 10 to 25%.

The model compositions of fish dumplings containing the meat of *Palaemon adspersus* shrimp added in the concentrations 15 to 30% are given in Table 1.

Table 1 – Nutritional and calorific value of the model compositions of fish dumplings with the addition of the meat of *Palaemon adspersus* shrimp

Model compositions	Ratios of shrimp meat/goby meat/dough, %	Protein, %	Fat, %	Carbohydrates, %	Calorific value, kcal/100 g
Reference	0:55:45	14.20	0.96	31.5	183.57
Sample 1	15:40:45	15.15	0.82	32.1	188.36
Sample 2	20:35:45	15.10	0.78	32.3	188.55
Sample 3	25:30:45	15.05	0.73	32.5	188.65
Sample 4	30:25:45	15.00	0.69	32.7	188.84

Analysing the results of calculations (Table 1), we can conclude that in the recipe of the components of dumplings, the mass fraction of unleavened dough was 45% for all tests. When the concentration of shrimp meat increased from 15 to 30% of the weight of the mince from Azov–Black Sea goby meat, the mass fraction of protein increased by 1.01%, fats decreased by 18.8%, and the calorific value of the semi-finished product increased by about 1%. Besides, as compared with the reference sample, on adding *Palaemon adspersus* meat, the calorific value of the samples increased by an average of 2.6% due to an increase in the mass fraction of protein by about 8.4%. Therefore, the addition of shrimp meat increases the biological value of the samples.

The model compositions of fish fingers containing the meat of *Palaemon adspersus* shrimp added in the concentrations 10 to 25% and *Palaemon adspersus* shrimp powder in the range 5 to 20% are given in Table 2.

Analysing the results of the calculations (Table 2), we can conclude that with an increase in the concentration of egg powder from 10 to 25%, the calorific value of dry fish fingers increased, on average, by 11.13%, that of protein by 5.4%, that of fat by 18.1%, when egg powder increased by 5%. Besides, adding shrimp meat increased the calorific value of the fish finger samples from 3.7 to 6.4%, as compared with the samples, due to an increase in the protein content from 5.7 to 8.3%.

The next stage of research was a qualimetric assessment of the organoleptic quality parameters of the experimental model compositions on the 5-point scale developed by us. The following organoleptic parameters were taken into account: appearance, colour, consistency, taste, smell.

During the qualimetric evaluation of the sensory parameters of the model compositions under study, a hypothetical model composition was selected as a reference. This composition meets the highest evaluation criteria on a 5-point scale for dumplings and fish fingers. The results of qualimetric sensory evaluation of the quality of dumplings are presented in Table 3.

Table 2 – Nutritional and calorific value of the model compositions of fish fingers with the addition of the meat of *Palaemon adspersus* shrimp

Model compositions	Ratio of shrimp meat/goby meat/dough, %	Protein, %	Fat, %	Carbohydrates, %	Calorific value, kcal/100 g
Reference 1	0:90:10	18.90	4.40	–	115.20
Sample 1	10:80:10	20.60	4.31	0.4	122.69
Sample 2	15:75:10	20.55	4.27	0.6	122.88
Sample 3	20:70:10	20.50	4.22	0.8	122.98
Sample 4	25:65:10	20.45	4.18	1.0	123.17
Reference 2	0:85:15	20.35	6.10	–	136.30
Sample 5	10:75:15	21.95	6.01	0.4	143.39
Sample 6	15:70:15	21.90	5.97	0.6	143.58
Sample 7	20:65:15	21.85	5.92	0.8	143.68
Sample 8	25:60:15	21.80	5.88	1.0	143.87
Reference 3	0:80:20	21.80	7.80	–	157.40
Sample 9	10:70:20	23.30	7.71	0.4	164.09
Sample 10	15:65:20	23.25	7.67	0.6	164.28
Sample 11	20:60:20	23.20	7.62	0.8	164.38
Sample 12	25:55:20	23.15	7.58	1.0	164.57
Reference 4	0:75:25	23.25	9.50	–	178.50
Sample 13	10:65:25	24.65	9.41	0.4	184.79
Sample 14	15:60:25	24.60	9.37	0.6	184.98
Sample 15	20:55:25	24.55	9.32	0.8	185.08
Sample 16	25:50:25	24.50	9.28	1.0	185.27

Table 3 – Qualimetric evaluation of the sensory characteristics of dumplings with the meat of *Palaemon adspersus* added (n=3; P ≤ 0.05)

Parameters	Weight coefficient, a(i)	p_i (ref)	P_i (def)	Sample 1		Sample 2		Sample 3		Sample 4	
				q_i	Q_i	q_i	Q_i	q_i	Q_i	q_i	Q_i
Appearance, points	0.18	5	2	4.8	0.86	4.5	0.81	4.5	0.81	4.4	0.79
Cross-sectional view, points	0.20	5	2	4.6	0.92	4.3	0.86	4.2	0.84	4.2	0.84
Taste, points	0.22	5	2	4.7	1.03	4.4	0.97	4.3	0.95	4.1	0.90
Smell, points	0.20	5	2	4.7	0.94	4.4	0.88	4.4	0.88	4.1	0.82
Consistency, points	0.20	5	2	4.8	0.96	4.6	0.92	4.6	0.92	4.3	0.86
Comprehensive sensory indicator					**0.94**		**0.89**		**0.88**		**0.84**

Analysing the sensory evaluation of the studied samples of model compositions of dumplings containing meat of the shrimp *Palaemon adspersus*, we can conclude that with a concentration of shrimp meat over 15% there was a decrease in the values of the sensory parameters. Thus, according to the results of qualimetric evaluation, the quality level of the model compositions of dumplings with *Palaemon adspersus* meat added was 0.84–0.91. The model composition of shrimp meat-containing dumplings (Sample 1) was had the highest value (0.94), due to its balanced taste and aromatic properties and optimised ratio of the components. Thus, according to the results of organoleptic quality assessment, the optimal concentration of the ingredients in the mince for dumplings is: meat of *Palaemon adspersus* shrimp (15%), meat of Azov–Black Sea goby (40%), unleavened dough (45%).

In the qualimetric evaluation of the model compositions of fish fingers with *Palaemon adspersus* shrimp added, the physical parameter moisture content (%) was taken into account, as it affects the characteristics of tastiness (consistency, taste, smell). The qualimetric assessment of the quality parameters of shrimp meat-containing fish fingers is given in Table 4.

Analysing the organoleptic evaluation data on the studied samples of model compositions of dry fish fingers containing meat of the shrimp *Palaemon adspersus*, we can conclude that with the egg powder concentration more than 10%, the values of the organoleptic parameters decreased. Increasing the concentration of *Palaemon adspersus* meat to 25% improves the colour of the model compositions of fish mince and noticeably enhances the shrimpy taste and smell.

Table 4 – Qualimetric assessment of the quality of fish fingers with the meat of *Palaemon adspersus* shrimp added (n=3; P≤0.05)

Parameters	**Weight coefficient, a(i)**	**p_i (ref)**	**P_i (def)**	**Sample 1**		**Sample 2**		**Sample 3**		**Sample 4**	
				q_i	**Q_i**	**q_i**	**Q_i**	**q_i**	**Q_i**	**q_i**	**Q_i**
Appearance, points	0.16	5	2	4.4	0.70	4.4	0.70	4.7	0.75	5.0	0.80
Consistency, points	0.18	5	2	4.3	0.77	4.5	0.81	4.7	0.85	4.7	0.85
Taste, points	0.20	5	2	4.2	0.84	4.5	0.90	4.5	0.90	4.8	0.96
Smell, points	0.18	5	2	4.1	0.74	4.4	0.79	4.4	0.79	4.8	0.86
Colour, points	0.14	5	2	4.3	0.60	4.4	0.62	4.4	0.62	4.7	0.66
Moisture content, %	0.14	5	2	3.7	0.52	4.5	0.63	4.5	0.63	4.8	0.67
Comprehensive quality indicator					**0.70**		**0.74**		**0.76**		**0.80**
				Sample 5		**Sample 6**		**Sample 7**		**Sample 8**	
Appearance, points	0.16	5	2	4.8	0.77	4.7	0.75	4.5	0.72	4.1	0.66
Consistency, points	0.18	5	2	4.7	0.85	4.5	0.81	4.5	0.81	4.0	0.72
Taste, points	0.20	5	2	4.8	0.96	4.7	0.94	4.3	0.86	4.0	0.80
Smell, points	0.18	5	2	4.6	0.83	4.7	0.85	4.0	0.72	4.0	0.72
Colour, points	0.14	5	2	4.6	0.64	4.5	0.63	4.0	0.56	4.0	0.56
Moisture content, %	0.14	5	2	4.7	0.66	4.6	0.64	4.3	0.60	4.3	0.60
Comprehensive quality indicator					**0.78**		**0.77**		**0.71**		**0.68**
				Sample 9		**Sample 10**		**Sample 11**		**Sample 12**	
Appearance, points	0.16	5	2	4.1	0.66	4.0	0.64	3.9	0.62	3.9	0.62
Consistency, points	0.18	5	2	4.0	0.72	4.1	0.74	3.9	0.70	4.0	0.72
Taste, points	0.20	5	2	3.9	0.78	3.9	0.78	4.0	0.80	4.0	0.80
Smell, points	0.18	5	2	4.0	0.72	3.9	0.70	3.7	0.67	4.0	0.72
Colour, points	0.14	5	2	4.6	0.64	4.3	0.60	3.6	0.50	4.0	0.56
Moisture content, %	0.14	5	2	4.7	0.66	4.3	0.60	4.3	0.60	4.3	0.60
Comprehensive quality indicator					**0.70**		**0.68**		**0.65**		**0.67**
				Sample 13		**Sample 14**		**Sample 15**		**Sample 16**	
Appearance, points	0.16	5	2	4.0	0.64	4.0	0.64	3.9	0.62	3.9	0.62
Consistency, points	0.18	5	2	4.0	0.72	3.9	0.70	3.9	0.70	3.6	0.65
Taste, points	0.20	5	2	4.0	0.80	3.7	0.74	3.7	0.74	3.5	0.70
Smell, points	0.18	5	2	3.7	0.67	3.7	0.67	3.7	0.67	3.5	0.63
Colour, points	0.14	5	2	4.6	0.64	4.0	0.56	3.8	0.53	3.5	0.49
Moisture content, %	0.14	5	2	4.3	0.60	4.3	0.60	4.3	0.60	4.3	0.60
Comprehensive quality indicator					**0.68**		**0.65**		**0.64**		**0.62**

Besides, the results of qualimetric evaluation of shrimp meat-containing fish fingers (Table 4) show that the conprehensive indicator for the model compositions under study ranged from 0.62 to 0.80. The highest quality level of fish fingers with *Palaemon adspersus* shrimp added was that of test sample 4 (0.80). It should be noted that the lowest value of the integrated quality indicators of the samples is due to the non-optimised (too high or too low) meat content in the recipe component, which affects the organoleptic characteristics. Thus, according to the results of qualimetric quality assessment, the optimal concentrations of minced meat ingredients for fish fingers are: meat of *Palaemon adspersus* (25%), Azov–Black Sea goby meat (65%), egg powder (10%).

In order to substantiate mathematically the best ratio of the recipe components of the studied samples, multiple linear regression was used, with the initial determination of the criterial factors of the relationship between the sensory parameters and the mass fraction of the components.

The criterial factors determined during the calculations for model compositions of shrimp meat-containing dumplings were (Table 5): content of *Palaemon adspersus* meat (x_1), content of Azov–Black Sea goby meat (x_2).

$$y_n = 0{,}686 + 0{,}0062\, x_2 \qquad (2)$$

y_n – estimated value of the comprehensive sensory quality indicator;

R^2 – coefficient of determination for dumplings with the addition of *Palaemon adspersus* meat, R^2=0.946.

According to the calculations, it has been found that the content of unleavened dough (x3) is not a significant factor influencing the change in the sensory characteristics due to its equal mass fraction (45%) in all model compositions.

The calculations for the model compositions of dumpling samples 1–4 with *Palaemon adspersus* meat added resulted in the following values: y_1=0.93, y_2=0.9, y_3=0.77, y_4=0.84. This allows concluding that sample 1 had the highest value. Hence the ratio of the recipe components (meat of *Palaemon adspersus*, meat of Azov–Black Sea goby, and unleavened dough) 1:2.7:3 is the most practical. This confirms the results of qualimetric evaluation of the sensory parameters.

According to the results of mathematical substantiation of the most practical ratio of the recipe components in the model compositions of shrimp meat-containing fish fingers, the criterial factors have been determined individually for model compositions with different egg powder contents: from 10 to 25%. According to the calculations, the significant factors have been established (Tables 6–9): the content of *Palaemon adspersus* meat (x_1), the content of Azov–Black Sea goby meat (x_2).

The calculated value of the comprehensive sensory quality indicator for samples 1–4:

$$y_{1..4} = 1.214 - 0.0064\, x_2 \qquad (3)$$

The calculated value of the comprehensive sensory quality indicator for samples 5–8.

$$y_{5..8} = 0.249 + 0.0072\, x_2 \qquad (4)$$

The calculated value of the comprehensive sensory quality indicator for samples 9–12:

$$y_{9...12} = 0.525 + 0.0024\, x_2 \qquad (5)$$

The calculated value of the comprehensive sensory quality indicator for samples 13–16:

$$y_{13...16} = 0.429 + 0.004\, x_2 \qquad (6)$$

According to the model (2), calculations were performed for the model compositions of samples 1–4 of shrimp meat-containing fish fingers with 10% of egg powder: y_1=0.7, y_2=0.73, y_3=0.77, y_4=0.8. For samples 5–8 containing 15% of egg powder, the calculations were performed according to the model (4): y_5=0.79, y_6=0.75, y_7=0.72, y_8=0.68; for samples 9–12 with 20% of egg powder, according to the model (5): y_9=0.69, y_{10}=0.68, y_{11}=0.67, y_{12}=0.66; for samples 13–16 with 25% of egg powder, according to the model (6): y_{13}=0.68, y_2=0.66, y_3=0.64, y_4=0.62.

Analysing the results of the calculations, we have found that the model composition of sample 4 of shrimp meat-containing fish fingers had a high calculated value. This suggests that the practical ratio of *Palaemon adspersus* meat, Azov–Black Sea goby meat, and egg powder is 2.5:6.5:1 (sample 4). This means that the mathematical calculations obtained confirm the results of qualimetric evaluation of the model compositions of fish fingers with the addition of *Palaemon adspersus* meat.

Table 5 – Results of determining the most practical ratio of the recipe components in the model compositions of dumplings with the meat of *Palaemon adspersus* shrimp added

		Y	**x_1**	**x_2**	
Estimated values of correlation dependence	Y		-0.97304	0.973035	
	x_1			-1	
	x_2				
Estimated values of linear regression		b_2	b_1	b_0	
		0.0062	0	0.686	
	Sb_1	0.001039	0	0.034271	**S_{b0}**
	R^2	0.946798	0.011619	#Н/Д	**E**
	F	35.59259	2	#Н/Д	**n-k**
	$S_{2рег}$	0.004805	0.00027	#Н/Д	**$S_{2зал}$**
Validity of the model		F table	10.12796		
		t crit. table	3.18245		

Table 6 – Results of determining the most practical ratio of the recipe components in the model compositions of fish fingers with the meat of *Palaemon adspersus* shrimp added at the egg powder concentration 10%

Estimated values of correlation dependence		**Y**	**x_1**	**x_2**	
	Y		0.992278	-0.99228	
	x_1			-1	
	x_2				
Estimated values of linear regression		b_2	b_1	b_0	
		-0.0064	0	1.214	
	Sb_1	0.000566	0	0.041134	**Sb_0**
	R^2	0.984615	0.006325	#N/A	**E**
	F	128	2	#N/A	**n-k**
	S_{2per}	0.00512	0.00008	#N/A	**S_{2bal}**
Validity of the model		F table	7.70865		
		t crit. table	2.77645		

Table 7 – Results of determining the most practical ratio of the recipe components in the model compositions of fish fingers with the meat of *Palaemon adspersus* shrimp added at the egg powder concentration 15%

Estimated values of correlation dependence		**Y**	**x_1**	**x_2**	
	Y		-0.96909	0.969087	
	x_1			-1	
	x_2				
Estimated values of linear regression		b_2	b_1	b_0	
		0.0072	0	0.24900	
	Sb_1	0.001296	0	0.08779	**Sb_0**
	R^2	0.93913	0.014491	#N/A	**E**
	F	30.85714	2	#N/A	**n-k**
	S_{2per}	0.00648	0.00042	#N/A	**S_{2bal}**
Validity of the model		F table	7.70865		
		t crit. table	2.77645		

Table 8 – Results of determining the most practical ratio of the recipe components in the model compositions of fish fingers with the meat of *Palaemon adspersus* shrimp added at the egg powder concentration 20%

Estimated values of correlation dependence		**Y**	**x_1**	**x_2**	
	Y		-0.744208	0.744208	
	x_1			-1	
	x_2				
Estimated values of linear regression		b_2	b_1	b_0	
		0.0024	0	0.525	
	Sb_1	0.001523155	0	0.095577	**Sb_0**
	R^2	0.553846154	0.017029386	#N/A	**E**
	F	12.482758621	2	#N/A	**n-k**
	S_{2per}	0.00072	0.00058	#N/A	**S_{2bal}**
Validity of the model		F table	7.70865		
		t crit. table	2.77645		

Table 9 – Results of determining the most practical ratio of the recipe components in the model compositions of fish fingers with the meat of *Palaemon adspersus* shrimp added at the egg powder concentration 25%

Estimated values of correlation dependence		**Y**	**x_1**	**x_2**	
	Y		-0.98116	0.981156	
	x_1			-1	
	x_2				
Estimated values of linear regression		b_2	b_1	b_0	
		0.004	0	0.429	
	Sb_1	0.001	0	0.030569593	**Sb_0**
	R^2	0.963	0.00591608	#N/A	**E**
	F	51.571	2	#N/A	**n-k**
	S_{2per}	0.002	7E-05	#N/A	**S_{2bal}**
Validity of the model		F table	7.70865		
		t crit. table	2.77645		

Besides, the calculation results (Table 5–9) show that the expression $F_{calc}>F_{table}$ is valid for all mathematical models. This makes it possible to state that the models obtained (2–6) are adequate.

Approbation of results

After performing the experiments, using the principles of qualimetry, to determine the quality of the innovative shrimp meat-containing products, utility model patents have been developed and applications for them made to the State Enterprise "Ukrainian Institute of Intellectual Property" (UKRPATENT), namely: "Dumplings *Chornomorski* (application No. 202002229 of 06.04.2020), "Fish Fingers *Krevetkovi*" (application No. a20200227 of 06.04.2020).

The new-developed technologies of innovative products with the addition of *Palaemon adspersus* can be recommended to producers for the rational use of small shrimp in the Azov–Black Sea area for the manufacture of fish products.

Conclusion

During the formation of model compositions of dumplings with 15–30% of *Palaemon adspersus* meat added, the calorific value of the samples was increased by 2.6%, as compared with the reference. This is due to an increase in the protein content by an average of 8.4%. For the samples of fish fingers with the addition of 10–25% of *Palaemon adspersus* meat, the calorific value, compared with the reference samples, increased by 3.7–6.4%, due to a 5.7–8.3% increase in the protein content.

According to the results of qualimetric analysis of the sensory parameters of the model compositions under study, comprehensive sensory indicators have been established (0.84–0.94 for dumplings, 0.62–0.80 for fish fingers). Sample 1 had the highest value for dumplings (0.94), and sample 4 for fish fingers (0.80).

By the method of multiple linear regression with pre-established criterial factors, we have determined which samples of model compositions of the studied products have the best ratio of the recipe components. It has been proved that the determining factors for dumplings and fish fingers are: the content of *Palaemon adspersus* meat (x_1) and the content of the Azov-Black Sea goby meat (x_2).

The results of mathematical calculations make it clear that for dumplings, sample 1 had the highest calculated value (0.93). Consequently, the ratio of the recipe components (*Palaemon adspersus* meat, Azov–Black Sea goby meat, and unleavened dough) 1:2.7:3 is the most practical. For fish fingers, the highest calculated value of the parameter was that of sample 4, where the ratio of the recipe components (*Palaemon adspersus* meat, Azov–Black Sea goby meat, and egg powder) was 2.5:6.5:1.

Thus, the calculations confirm the results of qualimetric analysis of the sensory characteristics of the samples under study, and make it clear that sample 1 of dumplings and sample 4 of fish fingers have the most advantageous ratios of the recipe components.

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КВАЛІМЕТРІЯ ІННОВАЦІЙНИХ ПРОДУКТІВ З ДОДАВАННЯМ КРЕВЕТКИ *PALAEMON ADSPERSUS*

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Анотація. Ракоподібні азово-чорноморського басейну, зокрема, креветки *Palaemon adspersus*, є видом сировини, доступним за вартісними характеристиками та ресурсним забезпеченням на вітчизняному ринку завдяки промисловим обсягам видобутку. Тому, нами запропоновані інноваційні продукти з додаванням м'яса креветки *Palaemon adspersus*: пельмені та рибні палички. Основними рецептурними складовими пельменів обрано: м'ясо креветки *Palaemon adspersus*, м'ясо бичка азово-чорноморсько, прісне тісто, для рибних паличок: м'ясо креветки *Palaemon adspersus,* м'ясо бичка азово-чорноморського, яєчний порошок. Для підвищення смако-ароматичних властивостей було додано сванську сіль до суміші фаршу модельних композицій розроблюваних продуктів. Для обгрунтування раціонального вмісту рецептурних складових у модельних композиціях продуктів з додаванням м'яса креветки *Palaemon adspersus,* застосували метод кваліметричного аналізу органолептичних показників. Встановлено, що для пельменів раціональна концентрація м'яса креветки *Palaemon adspersus*, м'яса бичка азово-чорноморського, прісного тіста у співвідношенні, як 1:2,7:3, для рибних паличок - м'яса креветки *Palaemon adspersus*, м'яса бичка азово-чорноморського, яєчного порошку у співвідношенні, як 2,5:6,5:1. Отримані результати кваліметричного аналізу модельних композицій підтверджені математичними розрахунками методом множинної лінійної регресії з початковим визначенням критеріальних факторів впливу. Відповідно до проведених математичних розрахунків отримали найвище значення показника (y_1=0,93) для модельної композиції пельменів з додаванням м'яса креветки *Palaemon adspersus* зі співвідношенням рецептурних складових, як 1:2,7:3. Для рибних паличок найвище значення показник (y_4=0,8) визначили для модельної композиції зі співвідношенням рецептурних складових, як 2,5:6,5:1. Такі розрахунки підтверджують об'єктивність, оперативність та доцільність обраного методу кваліметричного аналізу досліджуваних модельних композицій.

Ключові слова: креветка *Palaemon adspersus,* кваліметричний аналіз, органолептичні показники, пельмені, рибні палички.

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