



## ANALYSIS OF THE POSSIBILITY OF FISH AND MEAT RAW MATERIALS COMBINATION IN PRODUCTS

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### ABSTRACT

Aspects for the use of regional raw materials in ground food technology require further study of functional and technological properties to be able to predict them depending on the chemical composition of raw materials and processing methods. The aim of our research was to comparatively study the chemical composition, functional-technological, rheological properties of fish raw materials, and duck meat in terms of their possible compatibility in meat-containing products. The subject of our research was representatives of the regional aquaculture *Carassius gibelio* and *Hypophthalmichthys molitrix*, as well as the meat of Muscovy duck (*Cairina moschata*). It has been established that the nutritional value of freshwater aquaculture objects *Carassius gibelio* and *Hypophthalmichthys molitrix* is virtually identical in protein and fat content, making them interchangeable in terms of nutritional balance when developing the combined product. The ratio of protein and fat to water for duck meat is higher 3.54 – 4.88 times that of aquaculture, which can be used in the selection of components of the formulation of emulsified products, taking into account the nutrient balance. It has been confirmed that the addition of salt enhances water holding capacity, water binding capacity, and fat holding capacity. Water holding and water-binding capacities of minced fish are higher due to higher water levels, which, combined with the low-watering duck meat, can be predicted to create a forcemeat system with high functional-technological properties. The ability to emulsification and retain fat in the state of emulsion in minced duck meat has proved to be better, which when combined with fish minced meat can compensate for the ability to retain fat in the system of combined products. A combination of regional aquaculture with waterfowl meat will not only improve the functional and technological parameters of combined minced systems but also balance them by correcting the composition of proteins and fats.

**Keywords:** fish; meat; combination; analysis

### INTRODUCTION

The problem of healthy nutrition is one of the most important issues facing society. Human health depends on the satisfaction of physiological needs for energy and nutrients (Gibney et al., 2009; Waterlander et al., 2018). According to the WHO Regional Office for Europe, about 80% of all diseases are in one way or another related to nutrition, and for 41% of them, nutrition is a leading risk factor (WHO, 2004). Violation of dietary recommendations leads to the development of pathological conditions of the body, especially with prolonged deviation from a balanced diet (Hennig et al., 2018; Kimokoti and Millen, 2016).

One of the reasons for the unfavorable conditions for human health is the lack of protein in the diet, which today is up to 30% for Ukrainians, especially for the protein of animal origin (Prokopenko, 2018). The main sources of animal protein are raw meat from slaughtering cattle and

pigs. The volume of their production no longer meets the needs of the world population in protein and, therefore, in essential amino acids. Moreover, the methods used in agriculture for meat production have almost exhausted their potential (FAO, 2018).

Aquaculture is of practical interest in filling nutrient deficiencies as promising components for creating new foods. The use of fish in conjunction with raw meat will significantly expand and diversify the range of high-quality protein products of high quality and create the possibility of designing products with a balanced nutritional composition. Furthermore, combining animal protein of different origins, in addition to the rational use of raw materials, will allow expanding the volume of biologically complete protein products, to ensure the economic efficiency of its production, by reducing the cost.

On the one hand, the range of meat products has been significantly expanded in recent years, in the formulation of which different ingredients of non-meat origin are used. On the other hand, aquaculture production has become an important source of food protein in many countries over the last decades (Pauly and Zeller, 2017). This industry is developing rapidly, and its competitiveness is driven by the availability of raw materials to processing facilities, its rapid renewal, and low cost.

The nutritional and biological value of fish raw materials is the main indicator of its inclusion in the formulation of dietary foods. In the proteins of the muscle tissue of the hydrobionts, the high content of the compounds necessary for the human body, such as essential amino acids, polyunsaturated fatty acids, including the unique ones - docosahexaenoic and eicosapentaenoic (Mohanty et al., 2016). Fish ranks first among animal protein products by methionine content (Vidotti et al., 2003).

In addition to resource availability, an important criterion for the selection of aquaculture in food technology is its nutritional value, organoleptic, taste, and functional and technological characteristics. A sufficient number of works are devoted to the study of the chemical composition of freshwater aquaculture (Abramova, 2005; Lebsjka and Gholembovsjska, 2014; Bozhko et al., 2018; Boghdanov, 2005).

In addition to the traditional indicators of the biological and nutritional value of fishery raw materials, Tereschenko (2004) suggested to supplement their characteristics with some critical coefficients and, first of all, with the coefficient of nutritional saturation ( $C_{ns}$ ). According to the classification of Tereschenko (2004) fishery raw materials, depending on  $C_{ns}$  is divided into low saturated ( $C_{ns} \leq 0.3$ ), medium saturated ( $C_{ns} = 0.3 - 0.6$ ), and highly saturated ( $C_{ns} > 0.6 - 1.5$ ).

As a result of studies of the biological efficiency, nutritional and biological value of fish muscle tissue, fish proteins have been found to have a high digestibility rate of 1.89 – 1.90, while for beef this figure is only 1.64 units (Sidorenko, 2009).

However, there is a problem with aquaculture implementation, which is related to the peculiarities of the anatomical structure of the fish body. The presence of a large number of soft muscular bones, as well as the specific taste, necessitate the processing of fish for minced meat and combine it with other raw materials. At the same time, due to the wide variation of the components of the stuffing, it is possible to manufacture a wide range of products, including those with high biological value and certain physiological orientation (Bozhko et al., 2018). Combining raw materials with different functional and technological properties (FTV) makes it possible to obtain products with a wide range of functional properties.

One of the pressing issues in the technology of combined food is the use of raw materials, which under the influence of technological processes forms a homogeneous system with directional-set properties. The production of high-quality products with a combined composition of raw materials requires information about the kinetics of the structure formation process, hydrodynamic properties of raw materials, which determine the degree of bound moisture, and, therefore, technological and consumer performance of products. Simultaneously selected

components of the formulation should have sufficient technological properties, their maximum compatibility, or mutual compensation to ensure stable food emulsions.

At the same time, at each stage of the technological process, they take into account the characteristic functional properties of each ingredient and the influence of each of them on the formation of a stable emulsion and the qualitative characteristics of the finished products (Kosoy et al., 2005). Thus, the prospects for the use of regional aquaculture in ground-based food technology require further study of functional and technological properties to be able to predict them, depending on the chemical composition of the raw material and the processing methods used.

### Scientific hypothesis

We are expecting the confirmation of the high technological qualities of fish raw materials and the possibility of combining it with meat raw materials as part of the combined products. Therefore, the purpose of the research was to comparatively study the chemical composition, functional-technological, rheological properties of fish, and meat raw materials in terms of their possible compatibility in meat-containing products.

We are expecting that the chemical composition, high functional and rheological indicators, critical coefficients of *Carassius gibelio*, and Muscovy duck meat will improve the technological properties of combined meat systems, balance them by correcting the composition of proteins and fats.

### MATERIAL AND METHODOLOGY

The subject of our research was representatives of the regional aquaculture *Carassius gibelio* and *Hypophthalmichthys molitrix*, as well as the meat of Muscovy duck.

*Carassius gibelio* weighing 250 – 350 g and a white carp (*Hypophthalmichthys molitrix*) weighing 1800 – 2000 g were purchased from the local supermarket in Sumy, Ukraine. The fish was stripped of the scales, the interior was removed, the meat was separated from the bones and ground into a meat grinder with a grid diameter of 2 – 3 mm. Samples of minced meat were divided into two groups, one of which was added 1.5% salt to the minced meat.

Muscovy duck (*Hypophthalmichthys molitrix*) weighing 2000 – 2500 g was purchased from the Sumy region local market from a poultry farm. Ducks were deboned and ground. For processing, the duck meat was minced through a 2 mm plate and then through a 3 mm plate of a meat grinder. Two types of forcemeat were prepared: 1 – without salt, 2 – with an addition of 1.5 % salt. The salt was added during mixing the minced meat. Samples were evaluated for different parameters.

### Raw Protein Measurement

Protein measurements were performed using the Kjeldahl method (ISO 937, 2007). 5 g of homogeneous fillet with 20 mL of concentrated sulfuric acid and 8 g of catalysts were placed in a special container and then heated at 350 °C for 30 min. After mineralization, the sample was quantitatively transferred to a solution of

NaOH at a concentration of 33%, sealed, and distilled off with the steam. The resulting steam distillate was transferred to a container containing several drops of the Tashiro indicator. The titration was performed with a solution of 0.01 N sulfuric acid.

### Fat Measurement

Total fat was measured by the Soxhlet method (ISO 1443, 2008). 4 g of the dried sample in a paper cartridge was placed in an extraction flask of a Soxhlet apparatus. Petroleum ether with a boiling point of 45 °C was used for the extraction. After multiple extractions, the weight of the test cartridge to constant weight was determined. The difference between the initial and final weight shows the percentage of fat.

### pH measurement

The pH of the mincemeat was measured using a Partabell digital pH meter pcd650. Samples were prepared to measure pH based on the standard method (Pasichnyi, 2013), and 10 g of minced meat in 100 mL of water were mixed.

### Moisture analysis

Moisture was determined by the method of drying (ISO 1442, 2008). 5 g of the sample was placed in a container, dried for 1 hour at 150 °C.

### Cooking loss

Cooking losses were calculated by the difference of weight before and after cooking, and the moisture content was determined by drying the samples (4 g) at 150 °C.

### Methods of measuring functional indicators

WBC (water binding capacity) of minced meat was determined by the pressing method (Pasichnyi, 2013). WHC (water holding capacity) of minced meat was defined as the difference between the mass fraction of moisture in the minced meat and the amount of moisture released during the heat treatment. The following procedure was used to determine the emulsifying capacity (EC). The stability of the emulsion was determined by heating at 80 °C for 30 min. and cooling with water for 15 min followed by centrifugation and measuring the ratio of the emulsion layers (Pasichnyi, 2013).

### Determination of critical coefficients

Critical coefficients were determined by the method (Kosoy et al., 2005). Coefficient of protein watering (Cw) was calculated as a ratio between moisture content and total protein; protein-water factor (PWF) as the ratio between total protein and moisture content; lipid-protein coefficient (LPC) - as the ratio between fat content and protein content; food saturation factor (FSF) as total protein, total fat and moisture content.

The coefficient of chemical composition (CCC) was calculated according to the formula (1):

$$CCC = [F/M] \times P \quad (1)$$

Where: F – total fat, %; M – moisture content, %; P – total protein, %.

### Definition of rheological indicators

Rheological indices of minced systems were determined using a rotational viscometer. RV-8m viscometer was used with a corrugated rotor (2 mm corrugation step) with an inner cylinder (Rc) of 0.605 cm, and an outer rotor radius of Rn – 1.9 cm, the length of the rotor was equal to 8 cm. on a scale using a stopwatch. The processing of the obtained results was performed according to the method (Pasichnyi, 2013).

### Statistical analysis

The data statistical analysis was produced by Microsoft excel and Statistica 15. All experiments were carried out in triplicate and the results reported are the results of those replicate determinations with standard deviations. The Student t-test was used for the statistical analysis of the obtained results. Data are presented as mean ± standard error of the mean (SEM). The smallest acceptable difference for probes from the one sample was pointed at 5%. Probes with more differences were not considered.

## RESULTS AND DISCUSSION

Adherence to the theory of balanced nutrition has allowed substantiating a holistic system for determining the nutritional and biological value of products based on their chemical composition (Pasichnyi, 2002). In turn, based on chemical composition data of food introduced the concept of different value categories. The term "nutritional value of the product" is used to determine the percentage of chemical composition conformity of the product under study to the formula of balanced nutrition, that is, the term reflects the completeness of the useful qualities of the product (Bohrer, 2017; Sándor et al., 2011). On the other hand, the chemical composition of raw materials, namely the quantity and quality of proteins, the content of fat fraction and water, are responsible for the functional and technological properties of the food products created from it (Kinsella, 1982; Sikorski, 2001).

In the development of combined products, the key is the selection of recipe composition, which is carried out on the basis of the chemical composition of raw materials and taking into account the compatibility of components from a technological point of view. Therefore, the first step in developing a new product is to analyze the nutritional value and chemical composition of the raw ingredients.

The results of the study of the chemical composition of two fish species: silver carp (*Carassius gibelio*) and silver carp white (*Hypophthalmichthys molitrix*) and Muscovy duck (*Cairina moschata*), presented in table 1.

The analysis of the table shows that the freshwater fish studied belong to the low-fat protein raw material. The crude protein content of the muscle of the silver carp was 18.60 – 18.78% depending on the season of the catch. Protein concentration in silver carp meat was slightly lower and amounted to 17.60 – 17.70%. High levels of protein in muscle in both marine and freshwater aquaculture have been identified by several researchers (Tacon and Metian, 2013). Also, the results of studies (Pilon et al., 2011; Rudkowska et al., 2010) confirm the benefits of fish protein in human nutrition.

Protein and fat content in the muscle tissue of aquaculture and duck turned out to be almost identical.

Thus, the concentration of crude protein in duck muscle was  $17.36 \pm 0.09\%$ . Similar data were obtained by (Mazanowski, Kisiel and Gornowicz, 2003). The crude fat of fish and duck muscles was almost the same, at  $3.20 - 3.60\%$ , while the total fat of the silver carp was  $25.9\%$  higher on average. The moisture content of all three study object objects varied between  $75 - 79\%$ , which is described by authors (Ali, et al., 2007; Tilami and Sampels, 2018).

Moisture and protein content in muscle tissue determines the consistency, taste, and yield of the finished product. The moisture content also has a significant effect on the structure of the functional groups of the protein molecules, their stabilization and space configuration, and, thus, on the functional and technological properties of the meat system as a whole (Huff-Lonergan and Lonergan, 2005). A certain prediction of the functional and technological properties of the muscle tissue of aquaculture objects can be made by the indicators of structural-critical coefficients, as  $C_w$ , PWF, and LPC. They complement the overall picture of rheological properties, such as effective viscosity. The chemical composition coefficient and the food saturation factor allow us to determine the technological suitability of the resulting mince and to determine possible variants of its combination or rational enrichment.

Table 2 shows the results of the coefficient calculation based on the study of the chemical composition of freshwater fish and Muscovy duck.

$C_w$  of muscle tissue proteins of *Carassius gibelio* is  $7.3\%$  and  $2.3\%$  higher, depending on the season of catching than the silver carp. This indicates that in muscle tissue of *Carassius gibelio* one part of the protein accounts from  $4.31$  to  $4.36$  weight parts of moisture, most of which are insufficiently bound by hydrophilic protein components. Such muscle tissue is more elastic and gel-forming, as well as heat and mechanical resistance, which should be taken into account when selecting the processing method and modes. The moisture and protein ratio in the duck muscles is more balanced and is  $3.73$ .

LPC of the muscle tissue of both the silver carp and the white silver carp had no significant differences. At the same time, some dependence of the values of this indicator on the catching season is traced. Both aquaculture species had LPC above in the autumn catching period, which also indicates a more tender and dense consistency of muscle tissue. Also, the value of LPC can predict the food saturation of raw materials. For duck meat, this figure is more than  $3.54 - 4.88$  times, which can be used in the selection of components of the formulation of emulsified products, taking into account the balance of nutrients.

The protein-water factor of the muscle tissue of the silver and white silver carp is in the range of  $23.17$  to  $24.4$ , which indicates the ability to produce products with a gentle and juicy texture. On the other hand, the value of this figure for duck meat is  $26.79$ , which indicates a denser texture. Therefore, the investigated raw material by the size of the PWF is close to the raw material with high molding properties, for which the value of the specified coefficient is normalized in the range from  $26$  to  $30$  units.

The calculation of the coefficients of the chemical composition and food saturation showed that the raw material is medium saturated, for which the value of this parameter is determined within  $0.3 - 0.6$  (Tischenko, Bozhko and Pasichnyi, 2017).

Minced meat is a complex heterogeneous system. Its functional and technological properties depend on the ratio of tissues and their content of specific proteins, fats, moisture, and added components.

Sodium chloride content is one of the main components of the ground beef systems that affect the functional properties of proteins. Its contents and the way of incorporating it into the structure may have different effects on the water-binding capacity of the ground meat systems and, accordingly, on the organoleptic characteristics and yield of the finished products (Hermansson and Akesson, 1975).

The ability of the muscle tissue of fish to bind and hold moisture depends on many factors, including storage temperature, pH, degree of grinding, and more. The size of

**Table 1** The chemical composition of the muscle tissue of aquaculture and waterfowl.

Sample	Moisture, %	Protein, %	Fat, %	Ach, %
<i>Hypophthalmichthys molitrix</i>				
Autumn catch	$75.00 \pm 0.71$	$18.78 \pm 0.03$	$5.03 \pm 0.01$	$1.19 \pm 0.01$
Spring and summer catch	$76.10 \pm 0.46$	$18.60 \pm 0.04$	$4.21 \pm 0.03$	$1.09 \pm 0.01$
<i>Carassius gibelio</i>				
Autumn catch	$78.80 \pm 0.36$	$17.60 \pm 0.07$	$3.60 \pm 0.17$	$1.20 \pm 0.03$
Spring and summer catch	$77.20 \pm 0.70$	$17.70 \pm 0.01$	$3.20 \pm 0.00$	$1.90 \pm 0.01$
<i>Cairina moschata</i>				
-	$76.34 \pm 0.86$	$17.36 \pm 0.09$	$3.42 \pm 0.98$	$0.99 \pm 0.17$

**Table 2** Critical coefficients of muscle tissue of aquaculture and waterfowl.

Sample	Season of catching	$C_w$	PWF	LPC	CCC	FSF
<i>Carassius gibelio</i>	Autumn	4.36	23.17	0.207	0.96	0.28
	Spring and summer	4.31	23.10	0.285	0.77	0.27
<i>Hypophthalmichthys molitrix</i>	Autumn	3.99	22.40	0.267	1.25	0.32
	Spring and summer	4.09	22.30	0.226	1.09	0.30
<i>Cairina moschata</i>	-	3.73	26.79	1.01	4.66	0.53

the WHC muscle tissue is determined by the content of immobilized moisture in it.

Maintaining of WHC of fish meat in the process of processing at the level of fresh fish indicators is of great practical importance, as it allows increasing the yield and improving the quality of finished products.

With the increase of WHC, the stickiness and elasticity of the forcemeat increases, the shear stress decreases, and the

functional properties improve (Borresen and Alsted, 1983).

Salt gives the ground meat some flavor and improves rheological characteristics (Smith, 2001). Thus, the introduction of up to 3% NaCl mincemeat mass increases the solubility of myosin-type proteins (Bandman, 1999; Chen et al., 2017).

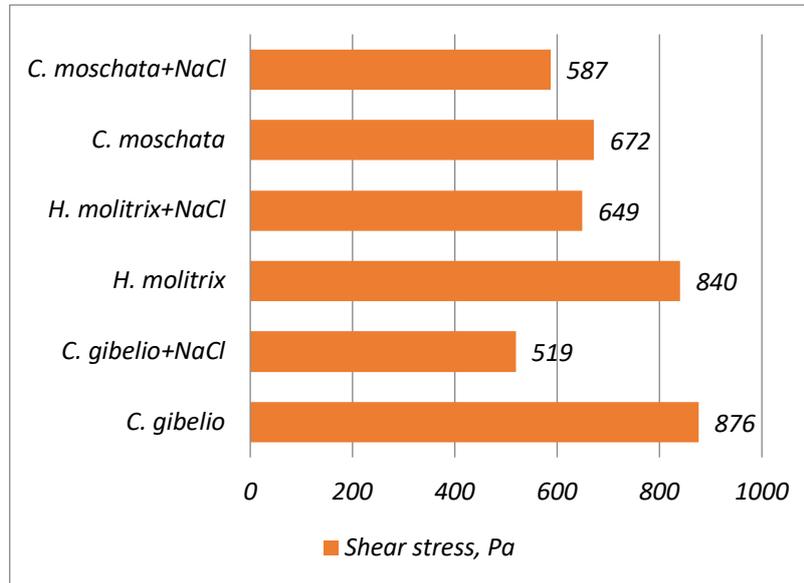


Figure 1 Shear stress of experimental samples forcemeat.

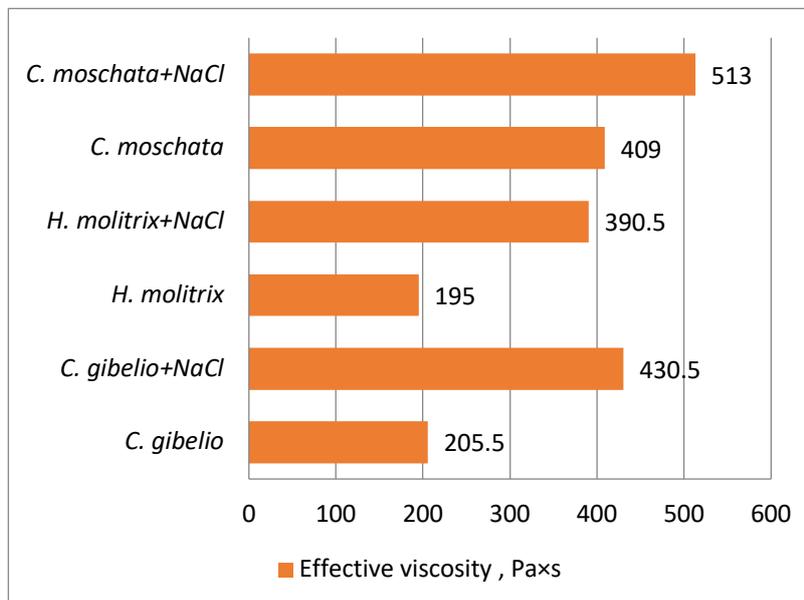


Figure 2 Effective viscosity of experimental forcemeat samples.

Table 3 Functional and technological properties of the muscle tissue of the studied aquaculture and waterfowl.

Parameter	<i>Carassius gibelio</i>		<i>Hypophthalmichthys molitrix</i>		<i>Cairina moschata</i>	
	forcemeat	forcemeat+NaCl	forcemeat	forcemeat+NaCl	forcemeat	forcemeat+NaCl
Moustore, %	76.70 ±0.56	76.20 ±0.37	77.40 ±0.30	77.80 ±0.60	65.02 ±1.03	64.70 ±0.67
WHC, %	63.40 ±0.71	79.30 ±0.50	60.70 ±0.27	73.60 ±0.81	61.54 ±0.33	64.81 ±0.67
WBC <sub>a</sub> , %	81.70 ±0.23	91.40 ±0.40	76.80 ±0.31	83.40 ±0.27	76.88 ±0.42	83.27 ±0.36
WBC <sub>m</sub> , %	80.40 ±0.36	85.10 ±0.23	79.40 ±0.12	79.70 ±0.51	45.56 ±0.36	49.87 ±0.93
FHC, %	28.70 ±0.70	31.40 ±0.04	29.60 ±0.09	30.10 ±0.16	47.71 ±0.66	55.38 ±0.91
pH	6.47 ±0.03	6.51 ±0.01	6.31 ±0.07	6.37 ±0.03	6.21 ±0.03	6.38 ±0.01
Plasticity, cm <sup>2</sup> .g <sup>-1</sup>	9.40 ±0.93	12.70 ±0.77	8.70 ±0.20	10.51 ±0.30	15.54 ±0.03	14.87 ±0.07

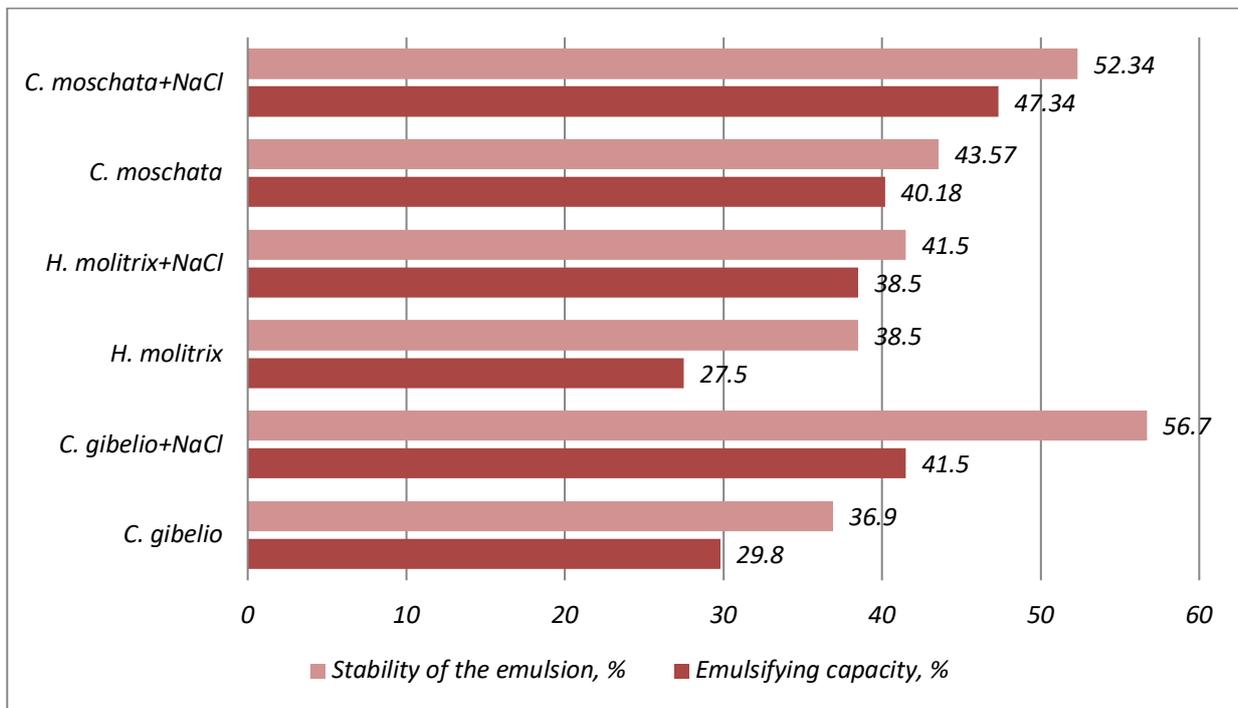


Figure 3 Emulsifying properties of experimental forcemeat samples.

At the same time, it is not recommended to introduce less than 1% NaCl into minced meat, since in this case, it acts as an oxidant (Tischenko, Bozhko and Pasichnyi, 2016; Mariutti and Bragagnolo, 2017).

Table 3 summarizes the results of the functional properties study of minced meat of freshwater aquaculture and waterfowl.

The analysis of the table shows that the introduction into the structure of minced meat of 1.5% of salt has influenced the indicators of WHC and WBC.

The slightly higher indices of moisture-binding and moisture-holding capacity of minced meat in the presence of NaCl can be explained by the increased hydration of muscle tissue. This occurs by a mechanism where functional groups of proteins with electrostatic properties attract water dipoles and thereby increase hydration and WHC. Ruusunen and Puolanne (2005) explained in the work that chlorine ions, joining positively charged groups of proteins, support them in a state of swelling.

Good molding properties have forcemeat systems with WHC above 53%. All experimental samples of minced meat had an index of WHC by 10.7 – 13.9% higher than the minimum value, which is consistent by Petrova and Bogdanov (2019).

Shear stress and effective viscosity of aquaculture and duck meat are shown in Figure 1 and Figure 2.

Plastic fluidity of forcemeat with the addition of salt begins at the size of the shear stress 519 Pa of muscle tissue of the crucian, which is 39.8% lower than in forcemeat without salt. It should be noted that there is a general tendency to improve the elastic-mechanical properties of minced meat with the addition of sodium chloride. The lowest viscosity of 195.0 and 205.5 Pa.s are minced without the addition of NaCl, indicating a profound disturbance of their structure and smear consistency.

When mixed with forcemeat 1.5% sodium chloride, there is a significant increase in their viscosity. Thus, the effective viscosity of *Carassius gibelio* muscle tissue increased by 42.8% and amounted to 430.5 Pa.s, and forcemeat of white carp – by 92.2% and became 390.5 Pa.s. The effective viscosity of duck meat was higher than fish and was 409 – 513 Pa.s, increasing with the addition of salt. So, it makes sense to combine fish forcemeat with waterfowl to increase effective viscosity, especially in the presence of NaCl. Analysis of rheological processes in minced meat will allow the use of the results obtained to evaluate and plan the technological processes in the production of combined food.

Results of the physical properties study of hydrobiota minced meat compared to waterfowl meat is shown in Figure 3.

The higher emulsifying capacity of the muscle tissue of *Carassius gibelio* is due to the values of the coefficients  $C_w$  and PWF, as well as the content of bound moisture. EC and SE of forcemeat are higher when NaCl is added. The values of these indicators are consistent with the indicators of WHC and WBC of minced fish and are caused by the increased content of water-soluble and salt-soluble fractions of proteins of the muscle tissue of hydrobionts (Rembeza and Rechina, 1990). For this reason, only mobile and flexible macromolecules of proteins can form adsorption layers at the interface of two phases and to form a helical structure of the gel in a continuous phase (Xiong and Brekke, 1989). According to (Yakubchak, 2006) the emulsifying capacity of minced poultry meat is 75%, and the emulsion stability is about 70%, which when combined with this raw material with multicomponent functional mixtures based on animal proteins (Strashynskiy et al., 2016; Yancheva, Dromenko and Grinchenko, 2017) will allow to effectively develop meat products with a combined composition raw materials.

## CONCLUSION

It has been established that the nutritional value of freshwater aquaculture objects, namely *Carassius gibelio* and Muscovy duck, is identical in protein and fat content, making them interchangeable in nutritional balance when developing the combined product.

The ratio of protein, fat, and water for duck meat is higher 3.54 – 4.88 times then for aquaculture, which can be used in the selection of components for the formulation of emulsified products, taking into account the nutrient balance. The protein-water factor of muscle tissue of *Carassius gibelio* and white carp is in the range from 23.17 to 24.4, which indicates the possibility to produce products with a gentle and juicy consistency. PWF for duck meat is 26.79, which indicates a denser consistency. All types of raw materials under study have high molding properties, which indicate the possibility of combining them.

A comparison of the functional and technological properties of fish and duck forcemeat confirms that the addition of salt enhances WHC, WBC, and FHC. At the same time, WBC and WHC of fish are higher due to higher water levels, which, combined with low-watering duck meat, can be predicted to create a high-fat forcemeat system. A comparative analysis of the rheological properties of samples allows suggests that the combination of high-viscosity fish will compensate for the low fluidity of Muscovy duck meat.

The ability to emulsify and holding fat in the state of emulsion in minced duck meat has proven to be better. A combination with fish minced meat can compensate for the ability to retain fat in the system of combined products. Thus, due to the basic functional properties of raw materials and chemical composition, regional aquaculture, combined with waterfowl meat, will not only improve the technological properties of combined meat systems but also balance them by correcting the composition of proteins and fats.

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