RESEARCH OF THE INFLUENCE OF CHITIN-CONTAINING FOOD ADDITIVES ON THE RHEOLOGICAL PROPERTIES AND BIOLOGICAL VALUE OF MINCED FISH

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Abstract

The problem of the deficiency of dietary fibre and mineral substances in the diet of modern man is well known. This problem is proposed to be solved by making a food product - fishballs - based on a combination of minced fish meat from pollock and salmon belly, containing the biologically active chitin mineral food supplement "Hizitel". Dietary supplementation is derived from the waste of processing shrimp shells. The influence of chitin-mineral nutritional supplement on the rheological properties of minced fish and the biological value of products based on it has been studied. The optimum modes of mixing minced fish compositions were identified and the nutritional and biological value of the functional foods developed were defined.

Key words: *"Hizitel", functional-technological properties, rheological properties, dietary supplement, nutritional and biological value, chitin-mineral substance*

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1. Introduction

The dietary habits of modern man and the excessive consumption of food products leads to a deficiency in the nutrition of coarse and mineral substances, which can cause the development of a number of diseases, such as osteoporosis, diabetes mellitus, violation of peristalsis of the gastrointestinal tract, obesity, and atherosclerosis, among others.

According to the requirements of the Ministry of Health, the daily need for calcium, magnesium and phosphorus is as follows 1250 mg, 400 mg, 800 mg, respectively, and that of dietary fibre is 20–40 gr.

These quantities are difficult to obtain from traditional foods due to the need to consume large amounts of food. Previously, this problem has been solved by using dietary supplements and medicines.

The development of functional foods enriched with calcium and dietary fibres can help to solve this problem.

It is known that chitin-containing materials, such as chitin and chitosan isolated from crustacean shells, contain dietary fibres, but there are no mineral components in them, as these are removed during the demineralisation of the shell [1, 2, 3] .

We proposed using the chitin mineral complex obtained from shrimp shells by deproteinisation and additional degreasing, which retains all of the mineral components of the raw materials [4].

2. Materials and Methods

In order to achieve a high degree of protein removal, it was carried out by the double-processing of shrimp shell using catholyte obtained by the electrolysis of water in a direct current field in the presence of a 1–2% solution of sodium sulphate, as well as directly in the cathode chamber of the electrolysis cell. Lipids were removed by the action of surface-active substances [4]. The received "Hizitel" had the following properties: weight fraction of ash – 27%; moisture content – 5%; protein in dry substance – 0.25%; total phosphorous – 13.53 mg·g-1; mineral substance content – 55%; mass fraction of calcium – 282.35 $mg \cdot g^{-1}$; mass fraction of magnesium– 27.65 $mg \cdot g^{-1}$; and weight fraction of insoluble dietary fibre – 37%.

Given that chitin-containing materials have a coarse-fibrous structure and are not water-soluble, when developing functional food, it was necessary to take into account their influence on the rheological properties of minced fish [5]. The content of total nitrogen, protein and fat was determined by the Kjeldahl reference method on Kjeltek systems, using the extraction method on the Soxhler device.

The aim of this work was to study the influence of chitin mineral food additives on the rheological properties of minced fish and the biological value of products based on it.

3. Results and discussion

For this research, the following materials were selected: minced fish from salmon and pollock in a ratio of 1:1. By mixing the meat of various types of fish, we can regulate the nutritional value of minced fish during its production process. Minced fish from pollock meat has a low fat content, which reduces its nutritional and organoleptic value and does not allow the assimilation of macroelements. In addition, it has a coarse consistency and a fibrous structure. In turn, salmon fish belly is fat, provides good formability of the mixture and has a delicate texture. Therefore, to eliminate the aforementioned shortcomings of minced fish from pollock, it was suggested to mix it with minced fish of salmon belly [6].

As a chitin-mineral substance, the “Hizitel” dietary food supplement obtained from shrimp recycling waste was selected. The high content of macroelements and sorption properties, in contrast to other chitin-containing materials, is ensured by the preservation of the mineral constituent of raw materials in it.

To substantiate the optimum mode for mixing minced systems with food fibres, their structural and mechanical properties, such as shear stress, dynamic viscosity, as well as functional properties, like moisture retaining power (MRP) and fat retaining power (FRP), were studied. They determined not only the consistency of the product, i.e. its density and succulence, but also the yield of the finished products and the degree of separation of water and fat [7].

We had a task to obtain flow curves for a stuffing mixture without the "Hizitel" dietary supplement and for a mix with the "Hizitel" dietary supplement.

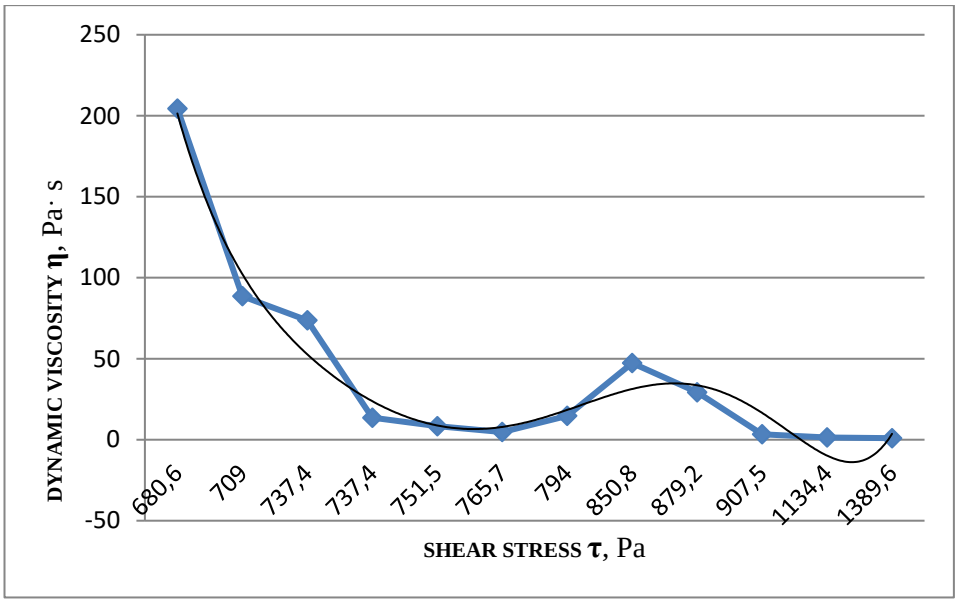

Figure 1. Dependence of dynamic viscosity of minced fish (salmon belly and pollock) on shear stress.

Fig.1 shows that the maximum Newtonian viscosity of minced fish was 248 Pa·s. The system behaves as a non-Newtonian fluid. When the shear load increases, a decrease in viscosity is observed, which can be caused by a break in the physicochemical bonds (765 Pa). After that, the formation of additional bonds proceeds, and the viscosity increases to 47 Pa·s. When the tangential stress reaches 850 Pa, the formed bonds break again, and the viscosity drops, which is expressed in the destruction of the integrity of the minced meat structure and its stratification with the release of the water and fat phase.

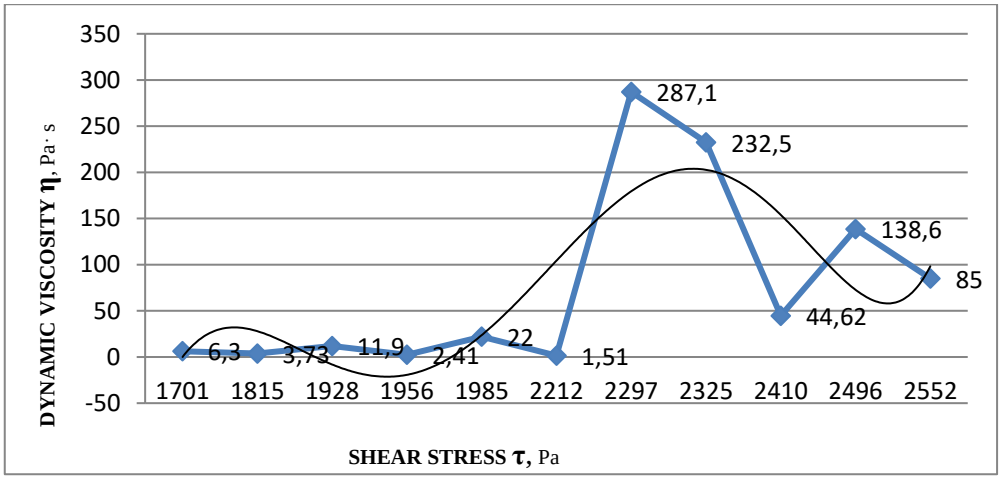

Figure 2. Dependence of dynamic viscosity of minced fish (Salmon belly and Pollock + dietary supplement "Hizitel") on shear stress.

The flow curve of the same stuffing system with the addition of 10% “Hizitel” additive is presented in Figure 6. This amount was calculated on the basis of 50% of the daily need for calcium, magnesium, phosphorus and 30% dietary fibres. An appreciable change in the shape of the flow curve was observed, namely an increase in the shear stress from 1400Pa to 2500Pa.

To reduce the cost of the product, as well as to reduce the energy usage of the mixing equipment, it was proposed to introduce water into the composition. Its quantity was determined by decreasing the shear stress to the values of the initial stuffing mixture.

To ensure the required viscosity and the necessary organoleptic properties of the product, a certain quantity of water was chosen: 30%. This recipe was chosen as the basic formulation.

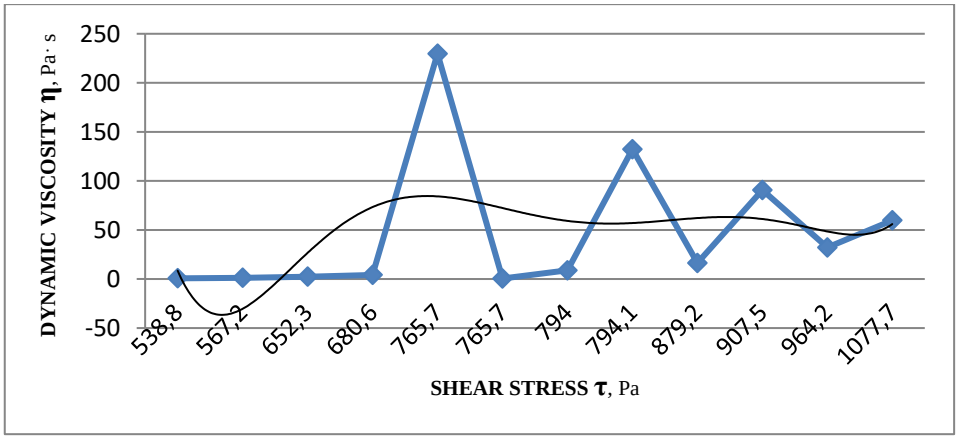

Figure 3. Dependence of dynamic viscosity of minced fish (salmon belly and pollock and dietary supplement "Hizitel" and 30% water) on shear stress

Also, on the basis of rheological studies, stirring regimes for this mixture were recommended. It was established that mixing should be carried out at tangential stresses not exceeding 1360 Pa, since an increase in these values leads to a sharp increase in the dynamic viscosity and destruction of the system in phases. The optimal mixing conditions were: a shear rate of no more than 85 s^{-1}, and a rotor speed of no more than 240 rpm.

Table 1. Functional and technological properties of minced fish salmon belly and Pollock

Object of research	MRP	FRP	pH
Minced fish (Salmon belly and Pollock)	44.8	61.3	6.8
Minced fish (salmon belly and pollock + dietary supplement "Hizitel")	63.2	84.2	7.6
Minced fish (salmon belly and pollock + dietary supplement "Hizitel" + 30% water)	54.7	75.4	-

Table 1 shows that when the dietary supplement "Hizitel" is introduced to minced fish, the parameters of MRP and FRP increase. It is possible to add water in an amount of 30%, while maintaining satisfactory values for these parameters.

Ready-made fishballs: from minced fish of salmon and pollock without "Hizitel"; with "Hizitel", water and salt; and with "Hizitel", water, salt and tomato paste. It was suggested to add tomato paste to preserve the colour of the salmon.

Table 2 presents the physicochemical properties of the fishballs.

Table 2. Physical and chemical properties of fishballs

Indicator	Content in the product	Calculated estimated error
Mass fraction of crude protein, %	12.4	± 0.5
Fat mass fraction, %	13.6	± 0.5
Mass fraction of dry substances	27.3	±0.5
Mineral residue after calcinations, %	4.0	±0.05
Mass fraction of NaCl, %	2.1	± 0.05

4. Conclusions

Thus, the developed functional food product based on a mixture of minced fish from pollock and salmon belly and the chitin-mineral supplement "Hizitel" in an amount of 10% satisfies 50% of the recommended daily need for the macroelements potassium, magnesium and phosphorus, and 30% of the norm in dietary fibres.

The optimal mixing parameters and product formulation were chosen by using rheological studies.

The introduction of “Hizitel” allowed the biological value of the product to be increased, and its price to be reduced by approximately 25% due to the inclusion of 30% water into the formulation without deterioration of the organoleptic characteristics.

5. References

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