PRODUTION OF EDIBLE CASINGS, FUNCTIONAL INGREDIENTS BIOMATERIALS ON THE BASIS OF CONTROLLED BIOMODIFICATION OF COLLAGEN PROTEINS OF ANIMAL TISSUES

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One of the most important demands of the food products manufacture is the application of polymer packing materials with the given technological characteristics meeting demands of harmlessness, ecological purity, and safety. Collagen as natural highmolecular biopolymer of strengthened structure is one of the preferable materials for the production of edible casings, food films and coverings. Animal tissues are the rich source of collagen. Hence, the large scientific and practical interest to the non-food by-products, used very seldom, are secondary by-products of agricultural animals processing, which have a considerable mass share of collagen. In view of heterogeneity of a total protein fraction and presence of non-protein substances, technological approaches in the production of purified collagen substances involve purification film ballast components in the structure of fibers. Characterizing ratio of different chemical components in the composition of secondary collagen-containing by-products, one should note a high share of collagen fraction with the developed fibrillar structure, rather low content of non-collagen proteins and fat. These kinds of raw materials present interest for isolation of collagen and making collagen substances of different functionality for the production of food coverings, films, moulding materials /1, 2/.

The aim of the work is the production of purified biopolymer materials, physiologically valuable food products with given properties on the basis of controlled exogenous biocatalysts and physico-chemical effects, which guarantee realization of barrier technologies of storage, appearance of products and also maximum use of secondary protein resources of meat industry (not used at present tame or used with some limits) with the perspective of realization of wasteless production on the basis of deep processing of the raw material.

Objects and methods.

The objects of study were secondary collagen containing raw material of meat industry (veins, tendons, fasciae) collagen dispersions and model films.

Collagen half-finished products for the subsequent dispersing and moulding of collagen films were obtained by means of preliminary treatment of initial raw material with multi-enzymatic compositions of fermentative preparations, produced by home industry: megatherin Г-20Х and liporisine, protosubtiline Г-20Х and liporisine in accordance with the method /1/. Fermentative preparations megatherine and protosubtiline are characterized by a high level of total proteolytic activity with minimum collagenaze effect and have the identical physico-chemical characteristics – temperature optimum of action 37-40°, pH-optimum 6,8-7,2 for protosubtiline Г20Х and 7,0-7,2 for megaterine Г20Х. Characteristics of fermentative preparations (low interval of a medium pH values, low specific expenditure of fermentative preparations and connected with them non-high expenses for auxiliary materials at the introduction of technologies on their basis) meet the demands of meat industry. For the control we used collagen products on the basis of cattle hides, obtained at the plant producing artificial casing "Belkosine" (Luga, Leningrad region).

Methods.

Proteolytic activity of fermentative preparations was determined by the modified method of Ason /3/; collagenase - /4/; lipolitic – by modified method of Ota-Yamada /5/; mass share of moisture in collagenase products – in accordance with recommendations /6/; dynamic viscosity of collagen dispersions – on rational viscosimeter Rheotest 2.1 at 20°C; temperature of collagen cooking - /7/; mass of 1 m^2 of film and pH of aqueous extract of model films - /8/; valuation of structural changes of collagen – by X-ray-phase analysis (on the installation DRON-4-07).

Results and discussion.

Survey of the existing approaches and methods showed that all known technological methods of obtaining of collagen products are based on the application of either chemical or successive chemical and fermentative hydrolysis. Some methods take much time, including methods leading to the destruction of native structure of collagen proteins and need many unnecessary operations. At the same time, qualitative and functional characteristics of collagen dispersions and film coverings are not sufficiently high and do not fully meet the demands of meet industry, veterinary medicine, medicine.

When solving the set tasks, we proceeded from the possibility of isolation of collagen substances in maximum purified from ballast substances with the application of biotechnological methods /1/ at the first stage, and food organic acids (acetic acid – 0,5 mole/dm^3, grape acid 0,5 mole/dm^3, succinic acid 0,2 and 0,5 mole/dm^3, lactic acid 0,5 mole/dm^3) for dispersing collagen proteins at the second stage. Model films made of collagen dispersions were moulded by the of spreading on polyethylene and dried at 37°C during 24 h. Comparative valuation of organoleptic and main physico-chemical properties of the model films showed that according to the desirable use for moldings of food films, organic acids may be placed in the following way: acetic>succinic>grape>lactic.

Viscosity of collagen dispersion in lactic, succinic and grape acids is higher than in acetic acid. That is why, it is necessary to make the additional fermentative treatment with proteolytic fermentative preparation, which has pronounced collagenolytic activity.

Purity and wholeness structure of collagen are the main demands, which determine the application of a preparation and the product.

Valuation of activity degree of fermentative preparations on the collagen structure is a rather difficult experimental task. Theoretical and practical interest represents the use of X-ray-phase analysis at the investigation of structure peculiarities of biomolecules characterized by a high degree of regularity and the existence of crystalline phase, to which collagen belongs.

On all difractogrammes, both experimental and control ones, we may see amorphous area. Pointing to the presence of some share of amorphous phase in the samples investigated.

Joint analysis of stroke-diagrammes points to similar placement of the main diffraction lines at the definite angles 20 and confirms the presence of the main phase-purified collagen.

It has been noted, that model films made of collagen half-finished products, purified by different methods from ballast substances (chemical and biochemical), have different degree of crystallinity. It has been established that the degree of protein crystallinity in samples treated with megaterine is higher and share of amorphous phase is less than that of control samples, treated with chemical reagents according to the traditional technology applied in industry.

The character of the organic acid used for the production of collagen dispersion has some influence upon the preservation of native crystalline structure of collagen. Comparative analysis of difractogramm shows that from two samples of model films obtained on the basis of collagen dispersion in organic acids (succinic, acetic), the film made of acetic acid dispersion has more pronounced crystalline structure.

As it is known, one of the main operations in the technology of film materials production is structure formation of collagen substances widely used in industry with the application of tanning agents, such as glutaraldehyde, formaldehyde, glyoxal having toxic properties.

At the same time, we have some information about of the possibility of application of ecologically safe physical effect on bioobjects with the aim of changing structure properties of proteins.

We studied the influence of impulse magnetic field (IMF) upon the change of structure of collagen films to valuate the possibility of regulation of structure formation of strong materials.

The effect of IMF upon collagen proteins was carried by series of triangle impulses with independently varied amplitude, impulse frequency, number of impulses in one series and duration of the impulse back front. It has been esfableshed that brief effect of IMF induce durable (dozens of hours) changes of structure of collagen proteins, characterized by changes of the level of crystallinity.

The revealed effect has a threshold of excitement according to the amplitude of the magnetic field strength with the following interval of saturation on this parameter. It linearly increases with the number of impulses in a series (at their small number) and has different character for collagen substances, obtained as the result of chemical and biochemical treatment of animal tissues.

According to conditions of IMF influence the effect of additional structural formation in collagen films can be characterized by relaxation to its initial level or by its irreversible increase, that is characteristic of films, obtained with the application of proteolytic fermentative preparations. The revealed effect can be connected with the changes of conformational condition of the protein macromolecules due to IMF – induced intercombinational electron transitions in bonds determining mutual disposition of molecules frągments and it has practical importance for the production of artificial collagen materials, food films and coverings with given functionality and with the controlled characteristics of strenth without using additional chemical structural formation with the application ot tanning agents.

Thus, methods of biotechnology, which can be put at the base of the development of thin, ecologically pure, technologies of new and modified food products, useful ingredients for enriching of food products physiologically useful substances, physiologically active and safe ecologically moulding and film materials. Have the perspective in the production of purified collagen biomaterials.

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