PROPERTIES AND APPLICATION OF COLLAGEN DISPERSIONS FROM MEAT INDUSTRY SECONDARY RAW MATERIALS

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Background

Raw material of an animal origin is the basic and traditional source of proteins for production of food products. Reserves of the meat industry can be considerably increased at the organization of purposeful and rational use of the secondary collagen containing raw material which potential opportunities can be as much as possible opened at selective allocation and application of the purified collagen components on the basis of methods of biotechnology [1], including creation of multifunctional biologically active additives and combined meat products of the higer biological value, including prophylactic properties

The purpose of the work - production of physiologically active collagen products and components of various technological forms, studying of their properties and the estimation of applied aspects.

Objectives

Acetic and neutral collagen dispersions with mass fractions of dry substances 3 and 5 %, model films on their basis, modell forcemeats had the following composition: beef of the first grade – semifat pork in the ratio 1:1 with the addition of 5-30 % collagen dispersion served as objects of the research.

Methods

Dynamic viscosity of products was determined on the rotational viscosimeter RHEOTEST 2.1. at 20 ^{0}C. Microstructure of the model collagen films and thermally treated forcemeats was studied to reveal and identify the structure of collagen components with visual estimation of the preparations at the 120 times increase (microscope Biolam PIV 4) and spesific colouring by hematoxilin – eozin, functional-technological properties – according to standard methods [2].

Results and discussion

The department of meat and meat products technology of the Voronezh State Technological Academy has developed and patented [3] the original technology of production of purified collagen products of various functionality with application of non-used collagen containing resources accumulated at meat processing enterprises (wastes of gut and hide canning productions trimming of meat) with the use for purification complex ferment preparations of proteases, lipases from microbial sources or their compositions produced by home microbiological industry.

The technological scheme of production of collagen semi-finished products is realized at stages: collection, sorting, accumulation, raw material washing, grinding on a cutter with the diameter of holes of the orifice plate 2 - 3 mm, treatment by special preparations of ferments, division of solid and liquid fractions of the hydrolysate, removal by washing of water-soluble products of the hydrolysate and ferments homogenization of the mass, cooling, packing, marking, storage.

The purified collagen products are multi-functional and can be used: for replacement of split of cattle hides at the production of edible sausage casings, can be the basis for the production of food collagen dispersions used as bioadditives, food films or collagen films, the positive influence of which upon the products quality, reduction of losses, prolangation of storage life are well known. There has been shown the effect of their use for dosed enrichment of products by connective tissue analogues of food fibres with giving them the therapeutic-prophylactic properties including radiprotector ones [4].

In the course of work on production of physiologically active polyfunctional collagen products of different technological forms there has been motivated the technological scheme of obtaining BAA (biologically active additives) in the form of collagen dispersions, which has in a basis the known technological scheme of obtaining the collagen masses from secondary raw materials of the meat industry and supplemented with stages: dispersion of collagen in a solution of acetic acid with molar concentration 0,5 mole/dm^3 or treatment with ferment preparation of collagenaze from hepatopancrease of Camchatca crabs, producer joint –stock Company «Bioprogress» Schelkovo, Moscow region (Fig. 1).

The study of reological properties of the collagen dispersions, the ability to the formation of films, and also the influence upon the structure and functional – technological properties of forcemeats systems showed rather wide aspects of application. If has been established (Fig. 2) that collagen dispersions have properties of pseudo-plastic medium, which viscosity changes depending on speed of shift that is connected with partial or full destruction of the structure.

Quantitatively reological properties are characterized by sizes of the greatest viscosity at the non-destroyed structure; the least viscosity at completely destroyed structure [5].

The character of the current of the dispersions received on the basis of biotechnological and chemical methods, is described by the equation of Ostwalde - de - Willa:

$$\gamma_r = \frac{1}{\eta} \cdot \tau^N ,$$

where γ_R – the speed of the shift, c^{-1}; h-viscosity, Па·с; N - an index of structurization; τ - the tension of the shift, Па. The index of structurization is the quantitative criterion describing a structural branch of reological curve.

The character of currents curves of dispersions different on the way of production studied in a range of a gradient of the shift speed 0,3 – 30, the dispersions from mass share of dry substances 3 % had lower values of viscosity both non-destroyed, and the destroyed structure, which value for dispersions from mass share of dry substances (DS) 3 % and 5 % made accordingly 694 and 2977 Pa·c.

On value of an index of structurization collagen dispersions can be arranged in a decreasing line: acetic with mass share of DS 3 % (N = 2,2); neutral with mass share DS 3 % (N = 2,05); acetic and neutral (N = 2,0) with mass share of DS 5 % (N = 1,9).

It is shown, that reological properties of collagen dispersions depend on a way of their production. The dispersions obtained with application of a preparation of collagenaze, had higher value of viscosity of the nondestroyed structure, than dispersed in an acetic acid (accordingly 24122 and 14071 Pa·c for dispersions with mass shares of dry substances 5 %, however for viscosity of the destroyed structure inverse relationship (595 Pa·c and 694 Pa·c) is established.

In other words, disperse systems of different ways of production have various character of change of effective viscosity depending on a gradient of the shift speed. Thus limiting value of the effective viscosity corresponding to practically full destruction of the structure, corresponds to smaller values of a gradient of the speed on a cut for the neutral dispersions obtained with application of a preparation collagenaze.

Apparently, it is connected to distinctions in relative molecular mass of structural components of the disperse phase caused by selective destruction of peptide bonds at a level of intramolecular structure. As collagen dispersions represent a specific complex colloidal system consisting of 95-97 % from water and 3-5 % from fibrillar proteinas capable to self-organizing, comparative estimation y their structure formins abilities is of interest by studying a microstructure of model films, whence it is visible, that fermental processing at a stage of reception of collagenic dispersions allows to receive a film with more ordered structure of collagen fibrils.

Apparently, it is connected to the directed influence of collagenaze on structural elements of fibrils, resulting in their more uniform homogeneous distribution on volume of a dispersion. In turn, the homogeneity of dispersions visually estimated on the uniformity of a microstructure of modell films on their basis, renders positive influence on the stability of the determining technological parameters at formation by a method of extrusion (speed of plasticization of a material, reduction of pulsations of pressure in a zone of batching).

The estimation of digestability of collagen products in vitro by digestive enzymes contirms the effect of influence of a fermental preparation of collagenaze on the structure of collagen. So, if digestability of collagen masses is 8 %, that for the collagen dispersions obtained with the application of collagenaze grows up 52-58 %. It is interesting to note, that the level of digestability of collagen dispersions practically does not change in the result of heat treatment.

Preparations of the purified collagen proteins in the form of collagen dispersions positively influence upon both functional - technological properties of forcemeat systems, and on microstructural parameters of modell forcemeats after heat treatment. Control samples of forcemeats have more homogeneous and fine-dispersed structure, save a high hydrophilic ability after thermal denaturation and aggregations of albuminous molecules of the muscular fabric included in a disperse phase of forcemeat.

Conclusions

The total combination of estimation of reological, structureforming, functional - technological properties, and also physiological functionality of neutral collagen dispersions in the conditions imitating gastro-intestinal tract allows to characterize them as the polyfunctional biologically active food additive perspective for application at the production oj forcemeats and whole made meat products of traditional and original assortment. Ability of a disperse phase of neutral collagen dispersions to the formation of stable submolecular structures speaks about the prospective of obtaining of collagen biomaterials with the given paramenters of functional characteristics and consumer properties.

Pertinent literature

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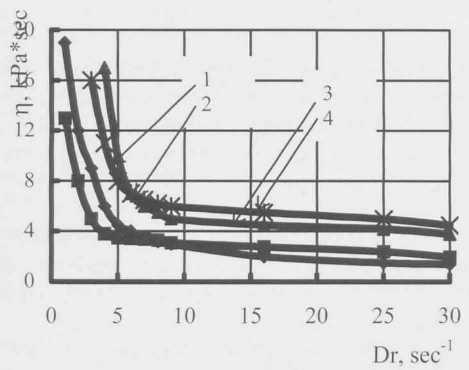

Fig. 1. Curves of the collagen dispersion current: η - effective viscosity; D_r – gradient of velocity upon the cutting surface. Dispersions: 1- acetic acid, 3 % dry sustance (DS); 2 - neutral, 3 % DS; 3 - neutral, 5 % DS; 4 - acetic acid, 5 % DS

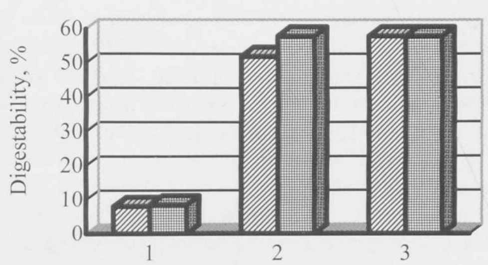

Fig. 2. Digestability of collagen products by the system of digestive ferments pepsin – tripsin in vitro: ▨ - collagen products on the basis of split of cattle hides (traditional technology); ▦ - the same on the basis of beef trimmings wastes (biotechnology methods); 1 – collagen mass; 2 – collagen dispersions before thermal treatment; 3 – the same after thermal treatment

Table. Functional - technological properties of modell forcemeats

Parameters	Values of parameters					
A mass share of bioadditive (collagen dispersions), %	5	10	15	20	25	30
Emusifying capacity, %	95,45	96,87	98,12	99,12	97,74	96,08
WBC, %	52,24	53,47	55,84	60,74	57,47	54,32
WHC, %	96,67	97,85	98,67	99,34	98,14	96,62
FHC, %	86,52	87,24	88,28	92,27	90,15	86,84