Denaturation of collagen structures and their transformation under the physical and chemical effects

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Abstract. The process of denaturation of collagen structures under the influence of physical and chemical factors play an important role in the manufacture of food technology and the production of drugs for medicine and cosmetology. The paper discussed the problem of the combined effects of heat treatment, mechanical dispersion and ultrasonic action on the structural changes of the animal collagen in the presence of weak protonated organic acids. Algorithm combined effects of physical and chemical factors as a result of the formation of the technological properties of products containing collagen has been shown.

1. Introduction

The purpose of work - implementation of physical and chemical degradation of hard collagen structures in the presence of weak organic acids. As an object was the defatted collagen protein suspension characterized by the following complete amino acid composition (in g / 100g protein): Asp – 7.02; Thr – 2.12; Ser – 2.79; Glu – 13.31; Pro – 7.57; Gly – 10.53; Ala – 6.96; Cys – 0.04; Val – 4.13; Met – 1.76; Iley – 2.18; Ley – 5.00; Tyr – 4.56; Phe – 5.12; His – 8.13; Lys – 2.96; Arg – 8.27. Fractional composition of the soluble part of the protein according to electrophoresis on 18% polyacrylamide gel was (fraction kDa): 10 kD – 5%, 10 ... 17 – 8%, 17 ... 26 – 9%, 26 ... 43 – 14%, 43 ... 72 – 15%, 130 ... 72 – 16%, 130 ... 170 – 15%, more than 170 kDa – 18%. Co-content of free amino acids in the protein of 0.005%.

The concept of "food protein" animal includes the sum of a plurality of fractions of protein molecules with a molecular weight of several thousand to hundreds of thousands of different sequences with co-constitute amino acids, which are subject to degradation to smaller fragments to form intermediate poly- and oligopeptides and further fragmentation to free ami-
no acids. Protein content of the animal tissue is typically approx. 20% and contains from 0.001% to 2% of free amino acids. Depending on the state raw protein content of free amino acids may exceed this level several times. In certain kinds of protein products mediprophylactic action but which are protein hydrolysates, free amino acid content may be 50 – 100%.

Preliminary studies have shown that the way conventionally used the so-called hard collagen acid hydrolysis in the presence of strong mineral acids leads to total protein irreversible disintegration into constituent amino acids. The macromolecular structure ceases to exist. In some cases, it requires the implementation of a controlled degradation of collagen in the preparation of functional foods. This problem can be solved at the expense of the dosed physical and mechanical [1] and the heat [2] effects, as well as through the use of a weak organic acid, [3] as a suitable lactic acid.

2. Results

Hydro unit significantly affects the result, in terms of the effectiveness of the dispersing device to obtain a final protein precursor in the form of a gel with enhanced moisture-retaining properties, which is important for further production (Table 1).

| The value of the hydro unit (mass ratio of the raw material: liquid) | Viscosity gel, min | Moisture content of product, % wt. |
|---------------------------------------------------------------------|--------------------|----------------------------------|
| 1 : 1                                                                | No flow            | < 85                             |
| 1 : 10                                                               | 30                 | 90                               |
| 1 : 20                                                               | 5                  | 97                               |

An important factor affecting the speed and the result is an irreversible degradation of collagen is the effect of lactic acid concentration.

Table 2: Effect of the lactic acid concentration on the properties of the protein (1 hr, 20°C)

| Lactic acid content in the mixture to be treated, % wt. | pH of gel | The proportion of free amino acids with respect to their total protein content,% |
|--------------------------------------------------------|-----------|--------------------------------------------------------------------------------|
| 0.0028 (8% to the raw material)                         | 2.8       | 0.02                                                                            |
| 0.0014 (4% to the raw material)                         | 3.5       | 0.01                                                                            |
| 0.0007 (2% to the raw material)                         | 4.0       | 0.005                                                                           |
| 0.0003 (1% to the raw material)                         | 4.0       | 0.005                                                                           |
The system used by the hydrolytic treatment, as substances that contribute to mild hydrolysis of the components used in a weak organic acid - lactic acid, which is without any restrictions can be used in the preparation of technology products, since she is a natural component.

Data on the possible effects of lactic acid on the product properties are shown in Table 2.

It is seen from the data obtained that the lactic acid concentration in a certain range of 1...2% by weight. It has little effect on the value of the effectiveness of the hydrolysis treatment, as the content of free amino acids in the system is practically not increased. The same concentration is sufficient for effective pulverization feed structure and subsequent transfer to a homogeneous gel. Large concentrations of lactic acid to reduce the pH level of the system, which is already beginning to affect the pH of the finished product, in the case, for example adding to the product formulation of the composition at a level 10% of normal. Based on these considerations, the optimal amount of lactic acid added can be considered a level of 2% to the raw material.

Significant impact on the rate of protein degradation has a temperature. Table 3 summarized the major influence on the properties of the parameters derived from collagen degradation products. Also it contains the dispersion of the system to 200 microns, which is the threshold value of the food system, determining the absence of negative taste sensations.

Table 3: Effect of physical and chemical processing parameters on the properties of the protein products

| Processing conditions | Protein fractions in the product, % | Free amino acids, % | The proportion of particles < 200 mkm, % |
|----------------------|-----------------------------------|---------------------|----------------------------------------|
|                      | < 10 kD | 10 – 70 kD | 70 – 170 kD | > 170 kD |                      |
| 3 hours, hydro module 1:20, 20°C, 2% lactic acid | 5 | 43 | 32 | 20 | 4.5 | 66 |
| 3 hours, hydro module 1:20, 60°C, 2% lactic acid | 15 | 55 | 17 | 13 | 6.5 | 89 |
| 3 hours, hydro module 1:20, 20°C, 2% lactic acid, dispersing 5000 rpm | 39 | 41 | 12 | 8 | 8.3 | > 99 |
| 3 hours hydro module 1:10, 20°C, 2% lactic acid, 5000 rpm, ultrasound 200 W/1 | 63 | 20 | 12 | 5 | 13.6 | > 99 |
3. Conclusions

3.1. Varying the technical parameters of physico-chemical treatment of proteins with a rigid structure of collagen produces degraded protein structures.

3.2. The products with such characteristics can be used to produce formulations with the required functional components (bioavailability digestibility, moisture content, particle size distribution) properties.

Acknowledgments

The study was funded by a grant of the Russian Scientific Fund (project №15-16-00008).

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