ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Obtaining A Biologically Active Food Additive Based On Formed Elements Blood Of Farm Animals.

Ruslan Saferbegovich Omarov[1]*, Sergei Nikolayevich Shlykov[1], and Anton Alekseyevich Nesterenko[2].

[1]Stavropol State Agrarian University, Zootekhnicheskiy lane, 12, Stavropol 355017, Russia.
[2]Kuban State Agrarian University named after I.T. Trubilin, Kalinina str., 13, Krasnodar 350044, Russia.

ABSTRACT

This article discusses the results of experimental studies of the methods of hemolysis of the formed elements of the blood of slaughter animals in order to obtain a functional component suitable for creating antianemic products based on various food products. As the most optimal, an acid method of hemolysis was selected using ascorbic acid. Various parameters for the introduction of volumes and concentrations of ascorbic acid were studied from the standpoint of obtaining a product with the most favorable composition and properties. It was established that the introduction of ascorbic acid with a molar concentration of 0.75 mol / dm^3 provides the desired physicochemical, organoleptic and functional-technological properties of the final product with a degree of hemoglobin oxidation of about 50%. The finished functional component of hemolyzed blood cells is characterized by a good balance of amino acid composition, high content of organic iron, as well as the ability to stabilize various food disperse systems. This allows us to recommend its use in the development of preventive meat products, and in the production of imitation confectionery.

Keywords: blood of slaughter animals, iron deficiency, hydrolysis, antianemic products, preventive nutrition.

Corresponding author

ISSN: 0975-8585

INTRODUCTION

Recently, the belief is growing that food should be both a source of nutrients for the body, and have qualities that promote the health of the body, which is attracting more and more attention to the category of functional foods.

According to the World Health Organization, 0.5 billion people in the world suffer from iron deficiency anemia and more than 1.5 billion people suffer from iron deficiency in their diet. The lack of iron in the human body causes a violation of vital functions and leads to various diseases, increasing the risk of mortality. In children, iron deficiency anemia can lead to developmental delay and behavioral abnormalities - decreased motor activity, ability to social interaction and concentration of attention, pregnant women increase the risk of premature birth and low birth weight babies, in adults often manifested by decreased performance. In the treatment of iron deficiency anemia, first of all, salts of this metal are used, which, however, can cause a number of side effects that impair the functioning of body systems [3, 7]. An alternative to drug prevention and treatment of iron deficiency anemia can offer prophylactic foods with an increased content of organic iron [1, 6].

The blood of slaughter animals and blood products are a unique source of essential and biological active substances, due to the high content of organic iron and high-grade proteins, qualitatively and quantitatively adequate to human body proteins [4].

The problem of maximum and rational use of the blood of industrial animals is highlighted by many leading scientists and specialists. The expediency of its use in the composition of medical, preventive and feed products is shown, original ideas on effective processing technology are being developed and implemented [5, 8].

The nutritional status of hemoglobin is ensured not only by its high protein content and good amino-acid balance, but also by the high amount of iron, the organic form of which is the best, in terms of digestibility, for humans. Assessing the prospects for expanding the use of blood to obtain preventive nutrition products, an urgent task is the development of conditions for the pretreatment of raw materials, primarily from the effective hemolysis of uniform elements for the release of the iron-containing complex [7].

It is known that meat products are rich in iron, possessing some antianemic effect, but, at present, there are no meat products on the Russian market with a balanced composition and a given content of organic iron, which proves the expediency of expanding the range of meat products.

An important feature of blood is its ability to take brown color [1] due to the oxidation of hemoglobin iron, which can be realized in the development of imitation confectionery products, whose share in the structure of food products is quite large.

MATERIALS AND METHODS

Experimental studies were carried out in the research laboratories of the department of production technology and processing of agricultural products of the Stavropol State Agrarian University.

The objects of the study were cattle blood (pH 7.4, viscosity - 5.5 N / s / m^2), the stabilizer is sodium pyrophosphate. Blood cells were obtained under laboratory conditions by centrifuging in a laboratory centrifuge at 8000 rpm.

Hemolysis was carried out according to the following scheme: 1 cm3 (or a different volume when studying the effect of hemolyzing reagent volumes on the process rate) of a chemical reagent solution was added to 1 cm^3 of uniform elements. The dynamics of hemolysis were recorded by determining the optical density of a mixture of 0.25 cm^3 hemolysate and saline (diluted 84 times) at a wavelength of 670 nm.

The determination of the methemoglobin content, the study of the physicochemical, organoleptic and functional-technological properties of hemolysates were carried out according to standard methods [2].

ISSN: 0975-8585

RESULTS AND DISCUSSION

Serious limiting factors for the use of blood in food production include specific red color, odor and poor digestibility, since the stroma of blood cells is poorly exposed to the action of digestive enzymes [1].

For the industrial use of blood and its components in food products it is necessary to cause the destruction of the cell membranes - hemolysis. The result of hemolysis is the transition of hemoglobin from the bound state to the free state, i.e. into a solution with uniformly distributed content of formed elements, accessible to the action of digestive enzymes and subsequent assimilation by the body.

Currently, there are several ways to destroy blood cells: aqueous hemolysis (dilution with water 1: 2), hemolysis using solutions of acids, alcohol or ether, as well as the enzymatic method [1, 2].

To select the optimal method of hemolysis, a number of studies were carried out using various hemolyzing substances: hydrochloric acid with a concentration of 0.25 mol / dm^3 (1: 1 ratio), water (1: 2 ratio), collagenase enzyme in the form of a 5% solution (final drug concentration in the system is 0.025 g / dm^3). Comparative characteristics of the obtained hemolysates are presented in table 1.

Table 1: Characteristics of hemolysates of blood corpuscles of slaughter animals

Гемолизат	Moisture content, %	Mass fraction of protein,%	Moisture content, %	Mass fraction of ash,%	Appearance	Smell
Water	86,7	9,4	86,7	1,8	Brownish red liquid	There is a weak blood odor
Hydrochloric acid	79,4	17,2	79,4	2,5	Brown liquid	Neutral, odorless blood
Enzymatic	63,8	33,6	63,8	2,3	Bright red mass	Neutral, odorless blood

Water hemolysis is a traditional and widely used method of destruction of the stromal membranes in laboratory practice. The rate of its flow is quite high, causing destruction of about 70% of the cells in a minute and 80% in 2 minutes, however, a much longer amount of time is required to destroy 100% of the cells. In food technologies, it is impractical to use aqueous hemolysates due to a decrease in the concentration of dry substances, slight oxidation of iron and low organoleptic characteristics.

Acid hydrolysis provides a product with a high protein content, neutral odor and desired color, however, the addition of hydrochloric acid significantly increases the acidity of the medium (the pH of the system is 2-3 units), which requires the addition of neutralizing alkali, causing undesirable dilution of the hemolysate and a salty taste. thereby limiting its use.

The advantages of enzymatic hydrolysis include a high concentration of dry substances, the disintegration of the shells of blood cells to water-soluble products, the accumulation of peptide fractions of the protein and the presence of up to 30% heme iron in the free state.

However, the duration of the process and the bright red color of the resulting hemolysate limits its use due to the risk of developing pathogenic microflora and the low oxidation state of hemoglobin.

Laboratory studies of alcohol hemolysis showed an extremely low flow rate in the absence of significant advantages over the acidic method.

Considering the advantages of acid hemolysis, it is proposed to replace hydrochloric acid with ascorbic acid, which is widely used in the food industry, the introduction of which does not require neutralization after hemolysis.

In the search for the optimal molar concentration of ascorbic acid, factors such as hemolysis rate, its fullness, the active acidity of the final hemolysate and the degree of hemoglobin oxidation were taken into account.

The introduction of a solution of ascorbic acid with a concentration of 0.25 mol / dm^3 increases the time course of hemolysis and causes insufficient oxidation of hemoglobin. The molar concentration of 1.5 mol / dm^3, on the contrary, causes almost instantaneous destruction of the cells, however, this pH shifts to the acidic side, causing strong oxidation of hemoglobin and the appearance of an acidic, astringent taste and too dark color in the final product. Thus, it is advisable to use ascorbic acid with a concentration of 0.75-1.0 mol / dm^3. Evaluation of the influence of the ratio of the volumes of a solution of ascorbic acid (0.75 mol / dm^3) and formed elements on the duration of hemolysis was carried out in 3 variants: 1: 0.5; 1: 1; 1: 1.5 (Figure 1).

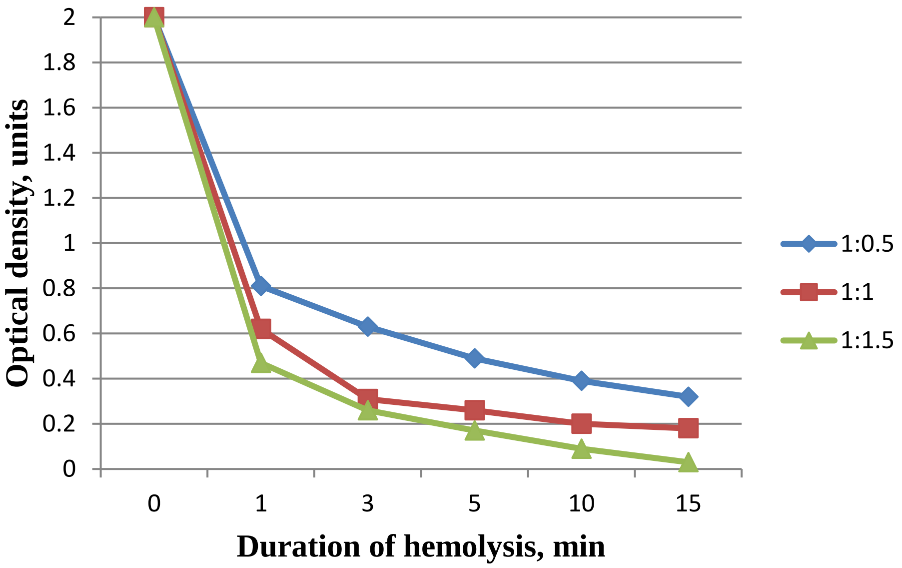

Figure 1: Study of the dynamics of hemolysis of blood corpuscles with ascorbic acid concentration of 0.75 mol / dm^3

Analysis of the experimental data showed that when the ratio of the formed elements and the acid is 1: 0.5, the hemolysis time significantly increases. Using a 1: 1.5 ratio will require the introduction of large amounts of acid, which will lead to system dilution and additional costs.

Thus, the maximum hemolysis of erythrocytes is rationally achieved when the ratio of the volume of formed elements and acid in a ratio of 1: 1, while ensuring minimal dilution of the system.

In addition to hemolysis, the introduction of ascorbic acid stimulates the active oxidation of hemoglobin to methemoglobin, thereby changing the color of hemolysate from red to brown.

It was established that the degree of hemoglobin oxidation depends both on the concentration of ascorbic acid and on the ratio of the volumes of its introduction with the uniform elements. At the same time, an increase in the degree of dilution of the system increases the concentration of methemoglobin (Figure 2).

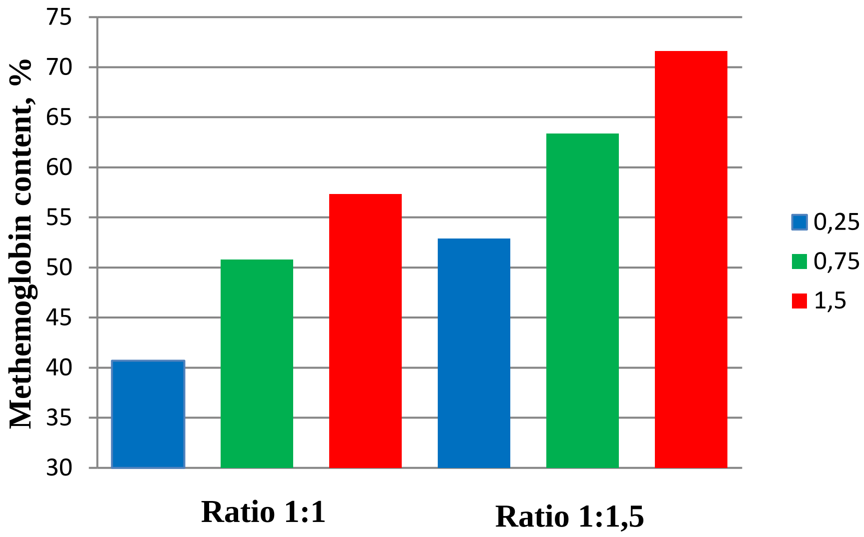

Figure 2: Effect of concentration (mol / dm^3) and the ratio of solutions of ascorbic acid and formed elements on the content of methemoglobin

An assessment of the color of various variants of the test samples revealed that the optimal brown color of hemolysate, which is close to the color of chocolate, is formed during the oxidation of about 50% of hemoglobin to methemoglobin. This is achieved by adding ascorbic acid with a concentration of 0.75 mol / dm^3 in relation to the uniform elements of 1: 1. Further development of hemoglobin iron oxidation forms an excessively dark color in hemolysate, which is unacceptable for food products.

Dissociation of hemoglobin also leads to the release of heme rings, which are characterized by increased digestibility.

The high biological value of the hemolysates obtained is also formed due to the transition to the dissolved state of about a third of the porphyrin complexes. Thus, the proposed method of hemolysis allows to obtain a product with acceptable organoleptic characteristics and potential anti-anemic efficiency.

A further goal was to study the quality indicators of the obtained product in dried form. Drying of the product was carried out in a laboratory setup with an air inlet temperature of 125-160 °C, at the exit of 60-70 °C. Characteristics of the dry product are presented in tables 2 and 3.

Table 2: Qualitative indicators of ascorbic hemolysate

Indicators	Value
Dry matter content,%	80,3
Moisture contents, %	8,4
Protein content,%	74,6
Fat content,%	2,9
Iron content,%	0,9
Ash content,%	4,4
The degree of solubility,%	95,8
Structure	Powdered, lumps easily destroyed
Colour	Light brown, uniform throughout the product
Smell	Without smell

Table 3: Results of the study of the quality of the amino acid composition of dry hemolysate

Amino Acids	Indicators		
	Amino acid content in dry hemolysate protein, g / 100 g protein	Amino acid score, %	Reference protein (essential amino acids), g / 100 g protein
Phenylalanine + Tyrosine	6,88	114,7	6,0
Valin	5,74	114,8	5,0
Threonine	2,47	61,7	4,0
Leucine + Isoleucine	11,57	105,2	11,0
Methionine + Cystine	1,58	45,1	3,5
Lysine	4,96	90,2	5,5

High quantitative and qualitative indicators of the protein component of hemolysate and the high content of dry organic iron in it make it possible to characterize it as a valuable raw material when developing products of preventive action. It is important to note that 100 g of dry hemolysate contains about 6000% of the average daily iron intake.

The study of the functional and technological properties of hemolysate was carried out for both the dried product and the reduced one (mass fraction of dry substances was 22%). The results are presented in table 4.

Table 4: Functional and technological properties of hemolysates

Indicators	Dry hemolysate	Recovered hemolysate
Moisture binding ability	58,9	61,2
Fat binding capacity	22,1	24,0
Emulsifying ability	62,5	63,8
Emulsion stability	63,9	64,6
Gel-forming ability	+	+

Experimental data showed that hemolysates have good water and fat binding properties, form stable emulsions and have a gel-forming ability, which makes their use in a wide range of food products technologically justified.

CONCLUSION

Thus, ascorbic acid hemolysis of the blood cells of slaughter animals allows to obtain highly valuable functional raw materials for the development of anti-anemic products. High functional and technological properties and acceptable organoleptic characteristics allow the use of ascorbic acid hemolysate of blood cells in the development of both meat products and imitation confectionery products.

ACKNOWLEDGEMENT

This research was made possible by a grant of the President Russian Federation #МК 2274.2017.11.

ISSN: 0975-8585

REFERENCES

[1] Antipova, L.V. Creation of antianemic products based on secondary products of meat processing industry / L.V. Antipova, A.S. Peshkov, A.E. Toporkova, E.I. Kuznetsova // Fundamental research. - 2008. - № 6. - p. 123.

[2] Antipova, L.V. Methods of research of meat and meat products / L.V. Antipova, I.A. Glotova, I.A. Rogov. - M .: Kolos, 2004. - 571 p.

[3] Uspenskaya, M.E. Antianemic food using blood of slaughtered animals // ME. Uspenskaya, L.V. Antipova, Z.R. Ibragimova, R. Yu. Gazdanova // Bulletin of the Voronezh State University of Engineering Technologies. 2013. - № 4 (58). - p. 151-153.

[4] Izgaryshev, A.V. Selection of parameters of acid hydrolysis of red blood cell mass of cattle and pig // A.V. Izgaryshev, O.V. Krieger, A.P. Lapin // Modern problems of science and education. - 2013. - № 1. - p. 419.

[5] Sizenko, E.I. Scientific support for the processing of livestock raw materials and the production of high quality food // Achievements of science and technology of agriculture. - 2007. - № 10. - p. 33-37.

[6] Faivishevsky, M.L. Nonconventional technologies of processing and use of food blood of slaughter animals // Everything about meat. - 2006. - № 1. - p. 14-17.

[7] Nowak, B., von Mueffling T. Porcine blood cell concentrates for food products: hygiene, composition, and preservation / B. Nowak, T. von Mueffling // Journal of Food Protection. – 2006. – vol. 69. – p. 2183-2192.

[8] Gonzalez-Rosendo, G. Bioavailability of a heme-iron concentrate product added to chocolate biscuit filling in adolescent girls living in a rural area of Mexico / G. Gonzalez-Rosendo // Journal of Food Science. – 2010. – vol. – 75. – p. H73-H78.