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Effect of Fine Grinding Process on Temperature Characteristics and Water-Binding Capacity of Chicken Bone Paste

Baktybala Kabdylzhar[1,2*], Aitbek Kakimov[1], Anuarbek Suychinov[2], Madina Rakimova[1], Syrym Yessengeldin[1] and Gulvira Bekeshova[1]

[1] Department of technological equipment and mechanical engineering, Faculty of Engineering and Technology, Shakarim University of Semey, Kazakhstan
[2]Kazakh Research Institute of Processing and Food Industry, Semey Branch, Kazakhstan.

***Corresponding Author:**
Email: baktybala.20@mail.ru

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ABSTRACT

The article describes the technology of obtaining chicken meat and bone paste by fine grinding of bone raw materials. Grinding of meat and bone raw materials is carried out in several stages using a power chopper and a microgrinder «Supermasscoloider». The processing scheme of meat and bone raw materials consisted in sequential grinding of meat and bone raw materials, preliminary freezing to a temperature of (-18) ºC - (- 20) ºC in freezers. During the grinding process, the influence of the amount of added water on the temperature and water-binding capacity of the meat and bone paste after grinding is investigated. From the results, it was revealed that the temperature of the meat and bone paste at the outlet of the microgrinder decreases from 16ºC to 9ºC, depending on the amount of added water. The addition of water leads to a decrease in the water-binding capacity of the meat and bone paste from 65.81 to 33.68%.

Keywords: Chicken bone paste, Temperature, Fine grinding, Water-binding capacity.

Introduction

In the process of processing raw materials of animal origin, in addition to obtaining the main raw materials (meat and meat products), secondary products rich in collagen remain: skins, cartilage and nervous tissues, blood, offal of categories I and II, as well as bone raw materials [1, 2].

The content of highly digestible proteins, phosphorus and calcium salts, fats, vitamins, macro- and microelements, amino acids in the bone have led to the widespread use of bone raw materials for the production of various products [3, 4].

Irrational use of secondary raw materials and waste from the meat processing industry can lead to environmental and economic problems [5, 6]. Wider introduction of complex processing of secondary raw materials will allow its rational use as the main components in the technology of meat products, which will affect the increase in the volume and range of products [7, 8].

Chicken processing generates a very large amount of waste, some of which contains a large amount of nutritional components. One such waste is chicken bone, which is largely unused or limited in the production of animal feed, pet food and fertilizer [9, 10]. Chicken bones are not used properly despite their high nutritional value and protein content. Chicken bone can be used in many ways besides the production of collagen products. The chemical composition of the chicken bone: 15.6% protein, 9.5% fat, 14.7% minerals and 57.5% water [11, 12].

The purpose of this work is to study the influence of the fine grinding process on the temperature characteristics and water-binding capacity of meat and bone paste.

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Materials and methods of research

The objects of the research were samples of frozen chicken meat and bone paste. Meat and bone raw materials were obtained from meat processing enterprises and large meat trading pavilions in Semey city (Eastern Kazakhstan region, Kazakhstan Republic). Before researching, raw materials were stored in freezers at a temperature of ((-18) ºC - (-20) ºC).

At the first stage of experimental studies, a scheme for processing meat and bone raw materials was developed (Figure 1).

Meat and bone raw materials were preliminarily frozen in freezers at a temperature of ((-18) ºC - (-20) ºC) for 60 min. After that, frozen raw materials were fed into a bin of a power chopper with a diameter of plate holes of 8 mm and crushed. After grinding on a power chopper, we get meat and bones minced meat.

All types of meat and bone minced meat were divided into 5 samples of equal weight with the additional addition of ice water in certain ratios: 0% (without adding water), with 25%, 50%, 75% and 100%. Water is added to prevent overheating of the product.

After mixing, the meat and bone minced meat was ground on a microgrinder «Supermasscolloider» with a gap between the grinding wheels of 0.1 mm. At the exit from the grinder, a meat and bone paste is obtained with smearing consistency without a feeling of rigidity on the tongue. The obtained meat and bone paste was stored at a temperature of 2-4 ºC [13].

Method for determining the water-binding capacity. The content of bound water was determined by the method of R. Grau and R. Hamm in the modification of VNIIMP. The method is based on determining the amount of water released from meat during light pressing, which is absorbed by filter paper, forming a wet spot [14].

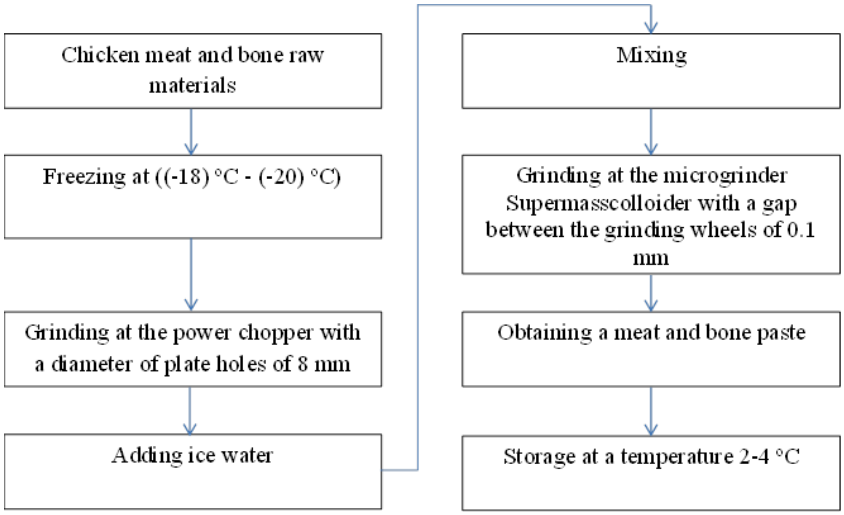


Figure 1. Scheme of grinding meat and bone raw materials

Research results

One of the main factors influencing the physical and chemical properties of the product is temperature. During the operation of the power grinder in the grinding chamber, the product is heated by various forces. An increase in the temperature of meat and bone minced meat is observed, which can lead to protein denaturation. During heat treatment, which causes denaturation of protein substances, the structure of the meat and bone paste is strengthened, and the water holding capacity decreases [15, 16].

In the process of grinding on the power chopper, there is a change in the temperature of the raw materials depending on the diameter of the plate. The smaller the diameter of the plate, the higher the temperature of the output raw material. It was revealed that the temperature of raw materials after grinding on a power chopper with a plate diameter of 8 mm increases slightly. The temperature increased to (+2)-(+3) ºC. An increase in temperature occurs due to the formation of heat due to the mechanical work of the destruction of bone tissue, the friction of bone raw materials on the working organs of the machine, the work of elastic and plastic deformation of bone raw materials.

In the process of grinding on the microgrinder «Supermasscoloider», a change in the temperature of the output raw material is observed depending on the amount of water added. So, with a gap 0.10 mm between grinding wheels, the highest temperature of 16 ºC is fixed in the meat-bone paste sample without adding water. With an increase in the proportion of water, a decrease in temperature to 11 ºC is observed at a ratio of meat and bone paste to water of 1:0.5; up to 9 ºC in meat and bone paste in the ratio with water 1:1.

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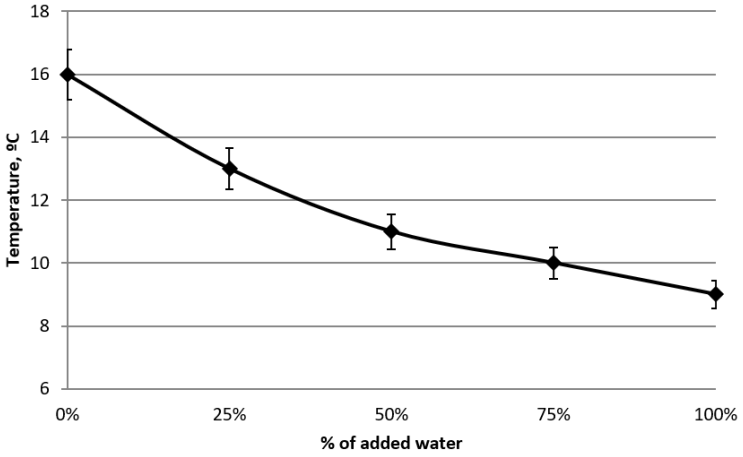


Figure 2. Temperature change of meat and bone paste

With fine grinding, a sharp change in structural and mechanical characteristics occurs, as a result of which not only the physical and mechanical destruction of the tissue occurs, but also chemical changes. Grinding of cells in the process of grinding contributes to an increase in the total surface of interaction with water, the release of proteins, an increase in bound water and a change in the forms of communication between water and minced meat.

At the next stage, the change in the water-binding capacity of meat and bone paste depending on the addition of water was investigated.

One of the important quality indicators of meat products is its water-binding capacity. The ability of meat products to retain or bind water depends on such properties as juiciness, losses during heat treatment, and technological advantages [17, 18].

The research results showed that the water binding capacity of the meat and bone paste is reduced due to the additional addition of water to the meat and bone paste. So, if the water binding capacity of the meat and bone paste without adding water was 65.81%, then with the addition of 50% water it decreased to 52.28%, and with the ratio of meat and paste and water 1:1 it was 33.68%.

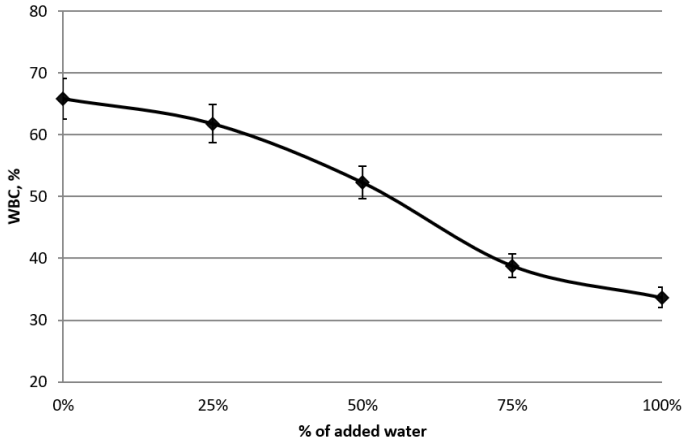


Figure 3. Change in the water-binding ability of meat and bone paste

Conclusion

Based on the research, it was found that the process of water binding of water and meat and bone paste significantly affects the quality of the final product. Thus, the addition of water to the meat and bone paste leads to a decrease in the temperature at the outlet of the microgrinder, improves its consistency and organoleptic properties. The water-binding capacity of meat and bone paste decreases with the addition of water. This research has been funded by the Ministry of Agriculture of the Republic of Kazakhstan (BR10764970).

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