The Technology of Dehydrated Soup Base from Poultry Meat and Bone Residue

S V Polyanskikh¹, M M Danyliv¹, U R Dubrovina¹, O N Ozherelyeva¹, O A Vasilenko²

¹Voronezh state university of engineering technologies, 19, Revolyutsii Avenue, 394036, Voronezh, Russia
²Voronezh state agrarian university named after emperor Peter the Great, 1 Michurina Street, 394087, Voronezh, Russia

E-mail: max-dan@yandex.ru

Abstract. This research paper describes the technology for obtaining dehydrated soup base from the meat and bone residue obtained during the primary processing of poultry. The authors proposed a rational cutting of poultry and assessed the chemical composition of the meat and bone residue; during experimental studies it was found that a significant amount of fat predominates in the bone residue, where skin from the neck was used and makes up 21.3%, the protein remained at the level of 22.7 % Water-soluble proteins predominate in the meat and bone residue and make up 52.3 and 63.1% for the residue from the carcass and the residue from the carcass and skin, respectively, the mass fraction of alkali-soluble proteins is 23.5 and 17.6%, respectively. The total mass fraction of essential amino acids is lower than in minced meat, the limiting amino acids are lysine (71%), leucine (69%), and threonine (68%). To organize the convection drying, we used a dryer with a liquid vibro-boiling bed.

1. Introduction

Currently, significant volumes of poultry and poultry products are recorded in the Russian Federation, the USA, India, the EU countries, and many others, which undoubtedly leads to the achieving the food security in our and other countries. Such large Russian manufacturers as Prioskolye CJSC, BEZRK-Belgrankorm and many others continue to successfully develop in the market. At the same time, production growth leads to the formation of a significant amount of poultry slaughter products and other non-food waste from the poultry processing industry and other food industries, which can lead to certain environmental problems and pollution [1, 2, 3].

Assessing the research potential of the leading Russian scientists, we can state the fact that there are many technologies for processing waste obtained from poultry slaughtering, most of which are aimed at the manufacturing of B2B products, while the technologies that implement waste processing for food purposes are very insignificant.

According to experts of businessstat, in 2016-2020, the dynamics of sales of soups and broths in liquid form in the country will be multidirectional. Thus, in 2020, sales are expected to decrease by 14%, after which the market growth will begin. In 2020, the market capacity for soups and broths in liquid form in Russia will be 4.1 thousand tons, which is 21% higher than the similar indicator in 2019. The concept of the poultry farming development in the Russian Federation for the period of 2013-2020 (hereinafter
referred to as the Concept) defines the main directions of the poultry farming development for the long term. Its implementation is aimed at satisfying the population’s needs for poultry products to the level of the recommended consumption standards by increasing the production of poultry meat up to 4.5 million tons, and over 50 billion of eggs as well.

To improve the efficiency of production at the poultry processing companies, it is advisable to deeply process and introduce new progressive methods for cutting and deboning carcasses based on the rational use of poultry meat. The use of such technology helps to eliminate the negative effects of the defects in poultry farming, slaughter, and transportation. The most valuable parts of the carcass are sent to the semi-finished products and finished products manufacturing; the remaining parts with high bone share, less valuable in nutritional terms (bone carcasses, backs, necks, legs, wings) - for mechanical boning [4, 5, 6].

2. Materials and methods
As the objects of study, the meat and bone residue obtained during the cutting of poultry and the production of mechanically deboned poultry meat obtained in the conditions of the Russian poultry production was selected. When developing the technology for the production of dehydrated soup base, experimental studies were carried out under the conditions of the research laboratory of the Department of Animal Products Technology at VSUET. The cutting scheme was carried out according to GOST 31962-2013 “Chicken meat (carcasses of hens, chickens, broiler chickens, and their parts) and TU 9214-212-23476484-2010 “Natural semi-finished products from broiler chicken meat” during the production of semi-finished products. The determination of the total chemical composition of meat products was carried out according to generally accepted procedures: determination of the mass fraction of protein - by the Kjeldahl method according to GOST 25011-2017; determination of the mass fraction of fat - by the Soxhlet method according to GOST 23042-2015; determination of the mass fraction of moisture - according to GOST 33319-2015; determination of the mass fraction of total ash - according to GOST 31727-2012 (ISO 936: 1998); mass fraction of moisture - according to GOST 9793-2016. Amino acid composition was defined according to GOST 34132-2017, using the automatic amino acid analyzer AAA 400 according to the attached instructions by the method of classical ion exchange chromatography. Organoleptic assessment was performed according to GOST 9959-2015. The biological value of proteins was determined by the calculation method according to the recommendations of academician N.N. Lipatov using Biocen software.

3. Results
Currently, the modern poultry processing industry is characterized by considerable degree of overproduction, due to the high production development within the country. Improving the technology of poultry farming and processing involves the maximum use of all production capacities. Simultaneously with the increase in production of a wide range of poultry products including the key raw materials (natural semi-finished products, breasts, wings, fillets, hips, drumsticks, etc.), there is the need for processing the secondary slaughter products remaining after the cutting, i.e. organic waste.

Currently, innovative solutions for waste processing are met by the lack of comprehensive technological solutions and projects for their disposal, which has led to the accumulation of organic waste from the poultry processing industry in large companies. The waste accumulation near the companies will lead to serious environmental problems in the nearest future. To solve these problems, many operators apply rational poultry processing schemes, which provide for deep processing and maximum use of all parts of the poultry carcass. The technology of obtaining meat of mechanical deboning of poultry, carried out by processing substandard carcasses and skeletons on presses of mechanical deboning, was widely used in Russia. As a result of this technological process, the so-called mechanically deboned meat and meat and bone residue are obtained, the latter is subsequently disposed of or processed into semi-finished technical feed.

The problem of recycling the organic waste has been the subject of many scientific papers in all regions of the Russian Federation.
Professor Antipova L.V., associate professors Polyansky S.V. and Orekhov O.G., the scientists of Voronezh State University of Engineering Technology, noted that as a result of mechanical separation, secondary raw materials are accumulated - bone residue in the amount of 27–40% of the mass of raw materials, which is mainly used for the production of feed and, less commonly, food products. The authors of one of the developed technologies [Antipova L.V., Orekhov O.G., 2013] for processing the meat and bone residue indicate that accumulation of considerable volumes of such raw materials in the production conditions require comprehensive study of the composition and features of the meat and bone residue and the design of additional and more rational ways for its use including those applying the biotechnology methods.

To choose a poultry cutting scheme, GOST 31962-2013 “Chicken meat (carcasses of hens, chickens, broiler chickens and their parts). Specifications” used in the production of poultry carcasses was analyzed as well as TU 9214-212-23476484-2010 "Natural semi-finished products from broiler chicken meat” used for the production of semi-finished products.

According to the cutting scheme presented in the regulatory documentation, we have studied the ratio of carcass parts, as this is important for calculating the production cost and the calculation of technological output. The obtained experimental data for cutting the poultry are presented in table 1.

| Table 1. Proportion of the poultry body parts in cutting according to GOST 31962-2013. |
| Semi-finished product | Average output values, % |
|-----------------------|--------------------------|
| Fillet                | 27.3                     |
| Wing                  | 9.8                      |
| Hip                   | 15.9                     |
| Drumstick             | 11.3                     |
| Offcuts               | 23.1                     |
| Skin from neck and breast | 9.6                   |
| Process waste (cords from fillet, lungs, kidneys) | 2.1 |
| Process loss          | 0.9                      |
| Total                 | 100.0                    |

For the production of the dehydrated soup base, on the basis of studying the proportion of the poultry carcass parts, it is advisable to use the offcuts set, which is a skeleton with small cuts of meat left during boning of the carcass and the division of the semi-finished products. The meat of mechanical boning is produced on a separator for mechanical boning of poultry meat LIMA RM 350 S (France). The resulting meat and bone residue is pieces of bone from 1 to 3.5 cm in size and approximately 4% of muscle tissue cuts. The chemical composition of the meat and bone residue was evaluated for the mass obtained from the skeleton and skin and without skin, because chemical composition depends on the type of raw materials used and the technological regime of the separator. The experimental data are presented in table 2.

| Table 2. Assessment of the chemistry of the meat and bone residue. |
| Semi-finished product | Mass fraction of, % |
|-----------------------|---------------------|
|                       | protein  | fat    | ash   | moisture |
| Skeleton meat and bone residue | 22.7    | 17.6   | 9.3   | 50.4     |
| Skeleton and skin meat and bone residue | 20.3    | 21.3   | 8.3   | 50.1     |
| Ground meat of mechanical boning from skeleton | 14.7    | 16.2   | 0.8   | 68.3     |
| Ground meat of mechanical boning from skeleton and skin | 11.8    | 24.2   | 0.9   | 63.1     |

During experimental studies, it was found that a significant amount of fat predominates in the bone...
residue, where, in addition to the skeleton, the skin from the neck was used, and amounts to 21.3%, which may indicate a possible oxidative damage to fat during storage of the finished product. Therefore, for the further research, it is preferable to use only carcass skeleton as the raw materials. Also, the meat and bone residue obtained from the skeleton contains higher share of protein at the level of 22.7%. The study of the fractional composition which we have performed is of no small importance for the further use of the meat and bone residue as a raw material for the production of dehydrated soup base. The experimental data of the study of fractional composition are presented in table 3.

| Raw material                        | Mass fraction of proteins, % |
|-------------------------------------|------------------------------|
|                                     | water-soluble | salt-soluble | alkali-soluble |
| Skeleton meat and bone residue      | 52.3          | 24.2         | 23.5           |
| Skeleton and skin meat and bone residue | 63.1          | 19.3         | 17.6           |

As follows from the data presented in table 3, water-soluble proteins predominate in the meat and bone residue and make up 52.3 and 63.1% for the residue from skeleton and the residue from skeleton and skin, respectively, the mass fraction of alkali-soluble proteins is 23.5 and 17.6% respectively. For food production, the amino acid composition is of utmost importance, so, for the further organization of the production of dehydrated soup base, we analyzed the amino acid composition of raw materials in order to study the planned nutritional and biological value of resulting soups and broths (Figure 1).

The total mass fraction of essential amino acids is lower in the meat and bone residue than in the ground meat, the limiting amino acids are lysine (71%), leucine (69%) and threonine (68%).

Based on the literature review and patent search, to solve the production problem of producing the dehydrated soup base, we have compiled the main technological basic production operations: drying of bone residue, grinding, packaging and storage. The technological process for the production of the dehydrated soup base is presented in Figure 2.
To organize convective drying, we plan to use a liquid-bed dryer with the liquid bed, which is capable of drying many types of bulk materials, semi-finished products, and products in many industries, including food processing [8, 9]. The vibr-boiling dryer is the most energy-intensive and efficient solution for product drying. To achieve better drying results, the equipment uses vibration, which ensures high process efficiency, especially in products with high humidity, as is the case with the meat and bone residue under the study. To establish the optimal drying time, studies were carried out and the drying curve of the meat and bone residue was constructed (Figure 3). As it follows from the data presented in Figure 3, the skeleton meat and bone residue reaches the required residual moisture within 90 minutes. Later no decrease in humidity was observed, so, the process is advisable to be stopped. The skeleton and skin meat and bone residue reaches the specified values within 100 minutes, which is due to the higher mass fraction of fat. Subsequently, the drying of the meat and bone residue obtained from poultry cutting was carried out in a liquid boiling bed at the \( t_{\text{air}} = 45 ^\circ \text{C} \), duration 90 minutes, air velocity 5 m/s, product layer height 120 ± 20 mm; drying is carried out till the residual moisture content of 10-11% remained unchanged for 10 minutes. Based on the drying parameters and residual moisture in the product, the technological yield of the dehydrated base is 45-50%. During the experimental studies, it was found that the dehydrated base contains a significant amount of protein which is 54.7 and 54.9% for the
dehydrated base from the skeleton meat and bone residue and the skeleton and skin meat and bone residue, respectively. The total composition of the essential amino acids has not changed, while due to the increase in the mass fraction of protein and the decrease in moisture, the total content of amino acids has increased. The calculation of the indicators of biological value showed that the biological value of the developed dehydrated bases is at the level of 74%, KRAS 25%. The preparation of broths was carried out by brewing a package weighing 5 g for 10 minutes. To assess the organoleptic characteristics of the broth, it is poured into glass glasses, at least 50 cm² each, and determine the following features: appearance and color, smell (aroma), taste and richness (saturation with nitrogenous extractive substances). The assessment was carried out using the scale of organoleptic assessment. The organoleptic evaluation showed that the obtained broths from the dehydrated base are transparent with slight turbidity, the color is light yellow, lipid drops are absent; the consistency is liquid, the smell typical for chicken broth is moderate, the taste is typical for chicken broth as well as the smell is moderate. Overall rating is 4.8-4.9.

4. Conclusion
The developed technology provides for the rational use of the meat and bone residue obtained during poultry processing in order to obtain the dehydrated soup base, aimed at developing non-waste methods of poultry processing with maximum use of basic nutrients. The technology allows of expanding the range of poultry products, reducing the complexity of the process, increasing the shelf life of the product and economic efficiency of production.

References
[1] Martin-Rios, Carlos & Demen-Meier, Christine & Gössling, Stefan. 2018. Food waste management innovations in the foodservice industry. Waste Management. 79. 196. 10.1016/j.wasman.2018.07.033.
[2] Jayathilakan K, Sultana K, Radhakrishna K, Bawa AS. 2012 Utilization of byproducts and waste materials from meat, poultry and fish processing industries: a review. J Food Sci Technol. 49(3):278-293.
[3] Martynova, E.I. & Rusanova, G.Ye. 2019 Food wastes and meat and poultry processing wastes treatment. Poultry and Chicken Products. 21. 42-44.
[4] Orekhov O.G. 2013 Dry broth-based concentrates from bone residue Poultry and poultry products. No3, 2013. - Pp. 60-63.
[5] Antipova L.V., Polyansky S.V., Orekhov O.G., Sulina Ju.A. 2013 Substantiation of the applied issues of the rational use of poultry bone residue Bulletin of VSUET. No1 (55). pp. 110-115
[6] Song DH, Choi JH, Choi YS, et al. Effects of Mechanically Deboned Chicken Meat (MDCM) and Collagen on the Quality Characteristics of Semi-dried Chicken Jerky. Korean J Food Sci Anim Resour. 2014;34(6):727-735.
[7] Pavlova N.E., Danyliv M.M., Dvoryaninova O.P. 2013 Development of the food and forage product technology using convection drying Modern knowledge intensive technologies, No 8-2, 2013, pp. 214.
[8] Danyliv M.M., Dvoryaninova O.P., Astanina M.V. 2013 Low waste food technology Proc.conf. "Innovative technologies in the food industry: science, education, and production", Voronezh, VSUET, 2013. Pp. 563-564.