Poultry by-products, reserve for growth of export potential of the industry

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Abstract. The article discusses the scope of application of by-products from down-feather filling. It shows new tendencies and technologies of complex utilization of down-feather filling and other low-cost wastes of poultry processing industry in world and domestic practice. It analyzes the potential of Russian enterprises to use by-products as export potential. It was found out that despite the negative dynamics on the import of the respective products its value remains rather high that testifies to the possibilities of growth of the export component of the down-feather filling’ processing products.

1. Introduction

While processing of our products, we obtain our main, related and by-products. The majority of the enterprises are not ready to process by-products today, but sell them as a rule in the form of down feather filling, and in the worst case in the traditional way, i.e. burning them in the Lapla boilers or exporting them to the territory, which creates a serious environmental problem, which focuses on financial losses. At the same time, as the world experience shows, down feather filling are a significant source of added value in the industry.

The development of this area is limited by a number of economic, political, environmental and social factors. This situation is particularly significant and relevant given the positive dynamics of the poultry industry.

Poultry farming is one of the most intensive and dynamic branches of agricultural production in Russia. According to the Russian Poultry Union, turkey, duck, goose, guinea fowl and chicken production is a promising area of growth in poultry production for slaughter and the expansion of poultry product range. In 2018, the structure of poultry slaughter production in farms of all categories was as follows: broilers - 90.2%, technological rejection of egg crosses - 4%, turkeys - 4%, ducks - 1.3% and geese - 0.5%.

Nowadays poultry import in Russia is reduced within the framework of the State Program of Agricultural Complex Development till 2024 in order to motivate domestic producers to manufacture quality products. Domestic poultry production per capita was 32.5 kg in 2016 and 34.1 kg in 2018. According to Rosstat, poultry production (live weight slaughter) in Russia in all categories of farms in 2018 amounted to 6.7 million tons, which is 1.2% more than in 2017, when the volume of poultry production (live weight slaughter) was 6.7 million tons (Figure 1).
The increase in poultry meat production leads to an increase in waste volumes. The level of poultry production in Russia corresponds to the output of about 502 thousand tonnes of feather per year. Taking into account the fact that about 7.5% of the live weight of the poultry are down feather waste, the problem is extremely urgent. In this regard, the aim of the study is to study the state of down-feather filling processing, to identify the reasons that constrain the progressive development of this direction and systematize proposals that contribute to the improvement of the efficiency of preparation and processing of down-feather filling.

2. Materials and methods
The monographic, statistical, economic, comparative, and narrative-logic methods of analysis were used in the process of studying the issue of collection, storage, preparation and processing of down-feather filling.

3. Results of the research
The analysis of the state of functioning of poultry farms and related economic entities engaged in processing and preparation of down-feather filling has shown that at the moment this sector is not occupied in Russia. Therefore, it has potential not only in the domestic market, but also as an essential source of export potential. Systematization of the main directions of application of these wastes allowed to present them visually in the figure 2.

As can be seen from the figure, the field is very wide, due to the fact that this raw material contains up to 85% of biologically valuable protein (keratin, protein), as well as contains a large number of such essential amino acids (cysteine, methionine, lysine, proline and serine). According to the data, the demand for feed protein in Russia is growing and currently amounts to 500 thousand tons per year. For example, a slaughter line of 6,000 broilers can produce 1,000 to 2,000 tons of feather per year.

Currently, the main technologies of feather processing are hydrothermal processing by means of extruding, for obtaining feather meal and enzymatic hydrolysis for obtaining protein hydrolysate.

Today, the key approaches to the recycling of keratin-containing waste are alkaline, hydrothermal, enzymatic hydrolysis (Table 1).

Based on the above data, it can be stated that the industry needs to develop new technologies for down-feather filling waste. Addressing these issues, both for the development of the industry and for environmental protection are promising sectors.

It shows new tendencies and technologies of complex utilization of down-feather filling and other low-cost wastes of poultry processing industry in world and domestic practice. Global experience in the production of keratin peptides allows us to give preference to biotechnical methods of processing keratin with the use of proteolytic enzyme preparations. It is this approach that made it possible to create the first Russian industrial technologies for production of protein hydrolysers from down-feather filling. They found applications in cosmetology, skin care creams and nail strengthening products, as well as shampoos to
restore damaged hair. Scientists at Malaysian Pahang University argue that keratin protein solution can be used not only in cosmetology, but also for medical purposes, such as bone replacement and bone grafting.

![Diagram of down-feather applications](image)

**Figure 2.** Main fields of application of down-feather filling.

| Name of method          | Advantages                                                                 | Disadvantages                                                                 |
|-------------------------|-----------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Acid hydrolysis         | High degree of hydrolysis, prevention of degradation of arginine amino acid, elimination of desamination of serine, threonine, cysteine, cysteine and methionine | Destruction of the amino acid tryptophan and tyrosine. A sufficiently long hydrolysis process |
| Alkaline hydrolysis     |                                                                             | Destruction of amino acids of cysteine and methionine. Salt formation. Duration of the process |
| Hydrothermal method     | Short duration of the process. Exception in the use of chemicals             |                                                                              |
| Fermentative hydrolysis | Close to natural processes.                                                 | Process period - average                                                     |
| Biocatalytic method     | Close to natural processes                                                  | Difficulty of working with mesophilic microorganisms                         |

Some companies in the United States and Europe use the processing of bird feathers into protein to produce pet food [1, p.550, 3]. In Russia, feather meal is used with the addition of low-value slaughter products of poultry, by-products, poultry meat and plant products. These canned foods have a high nutritional value and are recommended for feeding adult animals and young animals, both in pure form and as an additive. In addition, the poultry feather can be fully used as a source of protein in the formulation of feed for poultry and cattle, under the condition of hydrolysis [1, 4]. It has been proven that feather meal contains twice as much protein as soybean meal.
It is extremely interesting to process the poultry feather to obtain free amino acids, such as methionine, which is widely known as a stimulating additive in fattening birds. Domestic scientists have proposed a new technology for obtaining methionine concentrates from the preliminary hydrolyzed poultry feather on the basis of freezing liquid products and heating at a certain temperature, adequate heat of crystalline methionine dissolution. Liquid and dry methionine preparations with the content not less than 60% to dry substances are received. The preparations are tested as part of mixed fodder for broilers when they are fattened. It was established in vivo experiments not only to increase the mass, but also to increase the biological value of meat and by-products.

However, the process is expensive because the feathers are hydrolyzed in high-temperature installations that require a lot of water and energy. According to scientists from the Philippines, modern methods of disposal of chicken feather waste are quite expensive and environmentally harmful. Therefore, they proposed a new way of using down-feather filling, namely in construction, as one of the components for the creation of cement-bonded particle boards. The results of the study showed that the physical and mechanical properties (strength, rigidity, dimensional stability) of the feather containing 5-10% fibers or feathers are advantageously different from the fibre cement board, for example, Hardiflex® with excellent properties, such as resistance to termites [2]. It is advisable to use this technology in the construction of houses in the southern regions of the country for a certain contingent of people with low incomes.

Textile industry is a significant direction of down-feather filling processing. This raw material is used as a filler in blankets, pillows and duvets. The most expensive filler is considered to be down - 99-100%, it is called the down of exclusive quality. When you add a feather, the category decreases. From the highest category 70% of down and 30% of feathers are sewed by men's, women's and children's down coats and overalls. Such clothes are considered light and well protecting from frost. The main competitor of down is synthetics. If before synthetics was the province of the rich, and natural materials were worn by ordinary people, in the last decade the trends have changed. Down is more likely to be associated with elite products, and synthetic is more likely to be associated with widespread consumption. Despite the fact that the technologies of synthetic production in sportswear have advanced far ahead.

The most valuable is the down of waterfowl, in addition to the climatic conditions in Russia allow to raise a bird with high-quality down. Table 2 presents the main indices of down in comparison with synthetic scales and cotton fabrics used in the manufacture of bedding.

| Indices          | Cotton wool, % | Chemical fiber, % | Down, % |
|------------------|----------------|-------------------|---------|
| Relaxation       | 67             | 75                | 90      |
| Capacity         | 100            | 130               | 150     |
| Heat insulation  | 100            | 110               | 130     |
| Hygroscopicity   | 24             | 0,9-1,0           | 40      |

A review of the processing of down-feather filling showed that there is room for improvement in efficiency for each of them as part of the technological solutions. At the same time, enterprises engaged in this type of activity are characterized by a number of more detailed reasons for their progressive development, which are clearly presented in figure 3.
Figure 3. Factors limiting the growth of production of products from down-feather filling.

All this leads to a reduction in the number of such enterprises, which is a negative thing for the economy of the industry. For example, Kariguz ceased to operate and was reorganized into Kariguz Oil Company LLC, which became financially unstable in 2017. A down processing plant in the village of Dovolnaya, Novosibirsk Region (Sibirsky Pooh, LLC, capacity - 10 tons of down per year) said in December that it was on the verge of bankruptcy, but corrected the economic situation and came out in the plus. For today in Russia there are 80 operating factories on manufacturing of down blankets. Total operating organizations with OKVED 10.12.5 Production of feather and down about 43 large and medium. The down products market in Russia is not constant. There are only a few large companies in Novosibirsk, Rostov-on-Don and Moscow, and a few dozen other small industries. There is practically no competition. The exception is the cushion and blanket manufacturing enterprises, most of which use raw materials that have not been fully processed.

Thus, the current situation with the increase in the segment of feather and down-feather filling testifies to the need for the use of mechanisms to facilitate the filling of the niche products of processing of these raw materials both in the domestic and foreign markets. Analysis of export potential by these items is shown in Figure 4.

Figure 4. Export by HS code: 67, in US dollars. Source: Federal Customs Service of Russia.
As can be seen from the above schedule, there is a downward trend in the purchase of foreign products in 2018. These products are mainly purchased in the following regions of Russia for further processing or sale: The Moscow Region - 30.5%, Moscow - 27.5%, Primorsky Krai - 20.1%, St. Petersburg - 5%, Novosibirsk Region- 3.2%. At the moment, the value of down in the world markets varies from 30-60 U.S. dollars.

Exports from Russia of goods from the group of "treated feathers, down, artificial flowers, products from human hair" for the period 2016 - 2018 amounted to $4.3 million, weighing a total of 480 tons. Of these, 26% belong to the subgroup "processed feathers, down". These products are mainly exported to Belarus in the amount of 45% in the amount of USD 2 million, to Ukraine in the amount of 18.2%, Kazakhstan in the amount of 10.5% and the USA in the amount of 7%. Mainly such regions of Russia as Moscow - 26%, Kostroma region - 17.2%, Rostov region - 16.1%, Smolensk region - 14.2% export.

As for the import of goods from the group of "processed feathers, down, artificial flowers, products from human hair" to Russia for the period 2016 - 2018 amounted to $ 89.4 million, weighing 37.4 thousand tons. Only 3% of the total is "processed feathers and down". The main importers are China, which accounts for 88%, followed by the Czech Republic - 3%, followed by Vietnam and Belarus.

**Figure 5.** Export in Russia by HS code: 67, in US dollars. Source: Federal Customs Service of Russia.

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4. **Conclusion**

It was found out that despite the negative dynamics on the import of the respective products its value remains rather high that testifies to the possibilities of growth of the export component of the down-feather filling’ processing products. Study of the issue of preparation and processing of downfeather filling allowed to state that practically till 2000 this raw material was considered as secondary waste and was mainly disposed of in Lapas boilers and in the nearby territories. At the same time, in recent years, interest in this type of raw materials has increased as from the side of scientists, practitioners and business. This is due to the incredible possibilities of its use in various spheres of national economy. The existing arsenal of applied technologies of its processing is characterized by its advantages and disadvantages [5]. Their systematization made it possible to orientate oneself with the main proposals to increase the competitiveness of this product, which will allow to increase its export potential. These reserves and the mechanisms of their implementation lie in the understanding that tomorrow a significant share in the structure of exports will be occupied by the products of processing of by-products, including down-perchandise raw materials, as the intensity of competition in this sector is not so great compared to the main products.

For realization of the given prospect the state support, the enterprises which are engaged in processing of feather and down-feather filling is necessary. Introduction of innovations in their resource potential (technical and technological, personnel) against the background of using modern marketing and logistics approaches will ensure maximum coverage of this sector. Such a vision of the problem under study and its solution will contribute to the development of the industry and the growth of its export potential.

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