Poultry by-products as a basis of combined meat and vegetable feed for domestic animals

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Abstract. The use of poultry by-products remains one of the urgent strategies of the economic efficiency increase for a variety of reasons. The most effective is the by-products processing into the meat and bone meal with a high content of amino acids, fatty acids, vitamins and minerals and consequently with high nutritional value. This meal may be used individually and as a basis of the combined feed for domestic animals. The possibility of using poultry by-products as a basis for feed of domestic cats and dogs was studied. The quantitative and qualitative assessment of carcass after the duck Anas platyrhynchos domesticus manual deboning was carried out, and the moisture, proteins and fats content was determined by conventional methods. It was shown that the duck carcass had high nutritional value and can be used as a basis for domestic animals feed. Drawing up a recipe of the combined feed including duck carcass meal, additional protein sources and natural vegetables was carried out. The developed calculation and optimization computer program "Optipet" for the combined feeds recipes optimization was used, which allowed to determine the minimum cost value of the combined feed as required by current law documentation.

1. Introduction

The use of secondary raw material of the poultry processing remains one of the urgent strategy of the economic efficiency improving for a variety of reasons. First of all these by-products are formed annually in huge quantities. Thus, in 2009 more than 55.5 billion broilers with an average weight of 1.8 kg were slaughtered worldwide, while the total production of chicken by-products amounted to 17 million tons per year [1].

Second, by-products not properly treated may cause reproduction of insects, vermin, bacteria and viruses, which may result in water pollution (leaching of pathogenic microorganisms, organic substances and inorganic ions) and air pollution (harmful and foul-smelling gaseous substances) [2].

Third, by-products cannot be disposed of in landfills [3].

Finally, they are a valuable secondary raw material for the heat production by burning in biothermal holes, a source of alternative energy by solid-phase methane digestion or the effective organic fertilizers due to the high content of nutrients N, P, K [4].

However, the most effective is the processing of these by-products into meat and bone meal with a high content of essential amino acids, fatty acids, vitamins and minerals, depending on the composition of feed [1, 5, 6].

Chicken meal has one of the best amino acid profiles among the slaughtering secondary products [7]. Digestibility of raw meal protein is 20-30 % lower than in soybean meal and rapeseed flour [8-11], but higher than in meat and bone meal, keratinous flour, blood flour and corn gluten [12-14].
The sustainability and digestibility of chicken meal protein can be enhanced in various ways, for example, by lactic acid fermentation with molasses or brewer's grain, that reduces pH and stops bacterial and viral development [15]. The same effect is achieved by acid and alkaline treatment [17]. A common method is heat treatment under pressure of acute steam (wet rendering) or heating by dry steam (dry rendering) [2], leading to by-products sterilization and drying up to 8% of moisture. If the fat content is higher than 16% and the rancidity problems may occur during storage, additional extraction with solvents up to 10-12 % fat carried out [18]. Freeze drying also makes it possible to obtain a product without pathogens, but with a high fat content and a lower content of crude protein [19].

Such processing methods make the poultry meal a valuable source of protein for animals. Thus, meal increases the duodenal flow of amino acids in ruminants while ensuring microbial synthesis with sufficient nitrogen amount [20, 21].

Poultry by-product meal can be used as a protein supplement for dairy cows, for calves of Holstein breed and bulls; in the prenatal diet of cows it provides both normal reproductive function and milk production. Daily amounts of 0.5 to 0.7 kg have been recommended [2, 8, 12, 13], it is particularly effective when included in a mixed diet [21].

Poultry by-product meal is a useful and cheap substitute for soybean meal in the diets of lambs, especially after co-extrusion of poultry and soybean meal [2] or with wheat or corn grain [2, 22]. It was used for adult pigs in an amount of up to 10% [2, 23] and up to 100% – for young animals [24].

In the diet of adult poultry by-product meal is used in an amount of up to 7-10%, in the diets of broilers from 4% to 10% and laying hens - from 5 to 7.5 % [25, 26].

In the feeding of angora rabbits chicken meal in the amount of up to 8-10% completely replaced fish meal [27]. With its content of 18%, the growth of rabbits slowed down, but the specific cost of produced meat is minimal [28].

Finally, chicken meal in the amount of 5-25% was effective as an additional feeding for the various fish species aquaculture [29-35].

European legislation is tightening on the use of by-products of slaughter, and since 2002 the EU has introduced a ban on the use of secondary products of poultry processing for animal feeding [36].

The lack of adequate food protein is a problem of feeding pets. The Russian market of pet feed is developing dynamically today – its annual growth averages 12-25% [37]. Most of the market falls on importers – Germany, France, UK, USA and China.

Due to the current political and economic situation in the world, many importers have reduced the volume of supplies. On the other hand, the increase of the Russian population and domestic animals number causes a natural increase in the domestic animals feeding consumption. Thus, now there is a favorable situation for the development and promotion of new feed products [38-42].

The aim of this work was to study the possibility of using duck carcasses for the production of combined meat and vegetable feed for domestic animals.

In order to achieve this goal, we have decided to concentrate on the following tasks:
1. Determination of the fractional and component composition of the duck carcass;
2. Preparation of the combined feed recipe with the duck carcass meal;
3. Optimization of the feed recipe according to biological value and cost indicators utilizing a newly developed computer program;
4. The study of the obtained combined feed component composition.

2. Materials and methods
Duck carcasses after manual deboning were obtained from a local duck processing plant. Pre-differentiation of duck carcass into the three fractions– skin, fleshy part and meat and bone residue - was made. The soft fraction was chopped by cutter and meat and bone residue was pre-treated in a steam heater and also was milled to a homogeneous state. The by-products of poultry processing as well as the combined meat and vegetable feed on its basis were studied with help of accepted analytical methods in accordance with the regulatory documentation [43, 44]. Protein, fats, salt, fibers and moisture content of these three fractions were determined by InfraLum FT-12 Infrared Analyzer.
3. Results and discussion

The mass ratio of individual fractions of the duck carcass frame (Fig. 1) and their component composition (Fig. 2) were determined.

![Image of Fractional composition of the duck carcass after manual deboning.](image1)

**Figure 1.** Fractional composition of the duck carcass after manual deboning.

![Image of Component composition of the analyzed fractions.](image2)

**Figure 2.** Component composition of the analyzed fractions.

All fractions were characterized by sufficient protein content, especially meat-bone residue - more than 20%. The fat content is the highest in the fleshy part – 32.2%, and the lowest in the meat and bone residue – less than 6.0%. The results showed a high nutritional value of duck carcass and the possibility of its using for pet food.

The recipe of combined meat and vegetable feed for pets based on the duck carcass meal, additional sources of protein were fish meal, non-edible lamb trimmings, nonfat dry milk, additional vegetable ingredients – pumpkin, dried carrots and parsley.

The complexity of the problem of feed composition optimizing is associated with the huge number of options [45-47], so the computing program "Optipet" was developed to calculate and optimize the biological value and feed composition. The optimization criterion was the cost of the feed:

\[ \text{Cost} \rightarrow \text{min} \]  

Variables were the main components mass fractions, and the boundary conditions determined by the requirements of regulatory and technical documentation and quality assessment considerations. As a result, the optimized formulation and component composition of combined meat and vegetable feed were determined (Tables 1, 2).

| Components              | The composition of components, % | The mass fraction in the feed (%) |
|-------------------------|---------------------------------|----------------------------------|
| Duck carcass meal       | 23,10 5,60 0,90 77,20 0,40     | 47,50                             |

**Table 1.** Optimized recipe of combined meat and vegetable feed.
Fish meal  59,40  18,00  0,90  18,00  3,00  4,00
Non-edible lamb trimming  18,75  9,90  0,30  77,00  1,20  10,00
Non-fat dry milk  42,20  0,95  2,40  12,00  0,00  3,00
Pumpkin  2,90  0,10  1,50  89,00  9,00  8,50
Dried parsley  17,00  5,10  1,70  16,00  25,10  3,00
Dried carrots  13,20  3,60  0,80  18,00  22,00  6,00
Broth  24,00  2,60  1,20  98,60  0,00  18,00
The content in the feed  22,36  5,24  0,79  72,32  3,27  100,00

Table 2. Component composition of combined meat and vegetable feed.

| Parameter                                      | Calculated value | Actual value   |
|------------------------------------------------|------------------|----------------|
| Mass fraction of moisture, %                   | 72,3             | 74,0±3,3       |
| Mass fraction of proteins, %                   | 22,4             | 22,3 ±0,9      |
| Mass fraction of fats, %                       | 5,2              | 5,6±0,4        |
| The content of sodium chloride, %             | 0,8              | 1,15±0,03      |

4. Conclusions

Thus, the most effective way to use poultry by-products is to obtain meat and bone meal and production of combined meat and vegetable feed for domestic animals on its basis.

The developed and optimized formulation of this combined meat and vegetable feed meets the physiological needs of the animal organism and meets the established regulatory requirements.

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