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Drying Parameters of Hydrolysates of Keratin-Containing Raw Materials.

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ABSTRACT

For the purpose of obtaining a more complete view of chemical composition of the feather raw materials was conducted a research on studying the composition of the peptide fractions of the feather raw materials by electrophoresis in polyacrylamide in Laemmli`s gel. The obtained results suggest the presence in the investigated keratin-containing raw materials of a wide variety of protein fractions with different molecular weights. A half of all proteins are in the fraction with a molecular weight of 60,0-56,0 kDa. It is established that a sufficient quantity of feather raw material contains low molecular weight peptides. It is proved that this fraction corresponds to α-keratins. An important indicator of animal feed is their amino acid composition, therefore, it was studied the quantitative content of essential and nonessential amino acids in the composition of the feather down raw materials. The results of the study of amino acid composition of the feather raw materials indicate that the waste evisceration of birds is rich in sulfur-containing amino acids such as cysteine and methionine. It is proved that the data of a physico-chemical composition of a feather raw material, obtained from hens of three different breeds, allow us to recommend the waste evisceration of birds as a promising object to retrieve the high-protein balanced macroelement and microelement composition of feed for farm animals.

Keywords: the feather raw materials, mass fraction of protein, fiber, ash, waste evisceration birds, amino acids.

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INTRODUCTION

The most interest of all waste evisceration of birds is associated with the feather down raw materials, as it is 30% by weight of all waste. For its processing it is necessary to have a detailed study of the structure and origin of the raw materials and the search for alternative source of degradation [1, 2, 3]. In the article by O. F. Chernova, the employee of Institute of problems of ecology and evolution named after Severtsov of Russian Academy of Sciences, outlined a broad and useful overview of hypotheses of the origin of keratin-containing raw materials, such as feathers and hair, was given the list of the similarities and differences in their structure, were carried out some convergent traits [4, 5]. In this paper, of a particular interest are the physical and chemical properties of feathers for the selection of optimal conditions of total hydrolysis. Feathers and hair grow from the follicle with the participation of the ectoderm and the mesoderm. They are composed of layered keratin structures, and are able for regeneration. Regeneration is provided by stem cells that are located inside of the follicles [6, 7]. It turned out that the development of feathers and hair is regulated by a similar set of proteins operating in a uniform signaling cascades. SNN protein is a signaling center, Noggin – is responsible for cell division of hair and feather, WNTβ - 11 catenin – determines the differentiation of stem cells in germs. The appearance of skin structures is determined by the gradients of signaling proteins. It is experimentally shown that all skin appendages arise as a result of the interaction between ectoderm and mesoderm; the degree of participation of ectoderm and mesoderm may vary, i.e. the development and the differentiation of skin appendages are of a "common variations" [8]. The similarity of functions and a hypothetical common origin of feathers and hair provide many common features in their structure. The common origin refers to the participation of the same tissue structures in the production of feathers and hair follicles; this means some general histological properties and a similar biochemical regulation. Feathers and hair evolved separately. This is the evidence, in particular, for a different composition of keratin of feathers and hair. The feathers and scales of modern reptiles are composed of two types of keratin: α - and β-keratins, including a specific form of β-keratin - ϕ-keratin (analyzing relevant tissues of the alligator). The modern species of mammal hair are composed of only α-keratin [8]. Keratins (from the Greek. keras, keratos – a rig) – are the structural fibrillar proteins consisting of parallel polypeptide chains having a conformation α-helix or β-structure (the structure of the folded sheet). α - Keratins (often called keratins) are the main proteins that form the outside protective integument of vertebrates. Keratin is a typical representative of a class of fibrous proteins. It is found in the tissues of epidermal origin, including wool, hair, and horns, claws, quills, hooves, baleen, etc. [9]. All the above mentioned tissues represent a complex of multi-component biological entity composed of individual cells that form their histological structure of different elements [10]. The similarity of the tasks in case of separate evolution inevitably leads to the convergent similarity of constructive features. To illustrate the convergent signs of feathers and hair, O. F. Chernova considered the slim design of their layers. Guard hairs and needles (modified hairs) of mammals, as the barbs of the vane of the feathers of birds, are the three-layer keratin cylinders. The first layer is the cuticle, the second layer is the cortex, and the third is a core. All these layers are well visible on the slices of feathers and hair [10]. The purpose of this work is a research and a development of technologies for processing of keratin-containing feather down raw materials into a feed for farm animals.

OBJECTS AND METHODS

As the object of a research was used the feather raw material obtained from hens of different breeds: French breed "F-15 Iza" OJSC "Plemptitsesovkhoz "Kolmogorovskiy" (Kemerovo region, Askinsky area, the village of Kolmogorovo);

- Breed "Lohmann brown" CJSC "the Kuzbass integrated poultry farm" (the Kemerovo region, Novokuznetsk area, settlement Stepnoy);
- "Lomann LSL-classic" OJSC "Integrated poultry farm Inskaya" (Kemerovo region, settlement Yinskoy).

As the producers of enzymes with keratinase activity were used fifteen strains of microorganisms, provided by the All-Russian collection of industrial microorganisms Federal State Unitary Enterprise "Gosniigenetika" (http://www.genetika.ru/vkpm).

At different stages of work the following materials and reagents were used for the study:

- Distilled water (State standard 6709-72);

- Sodium chloride (State standard 4233-77, and 99.8%, chemically pure);
- Peptone enzymatic dry (State standard 13805-76, 80,0%);
- Agar-agar (State standard 16280-2002, 95,0%);
- Starch soluble (State standard 10163-76, 98,0%, pure for analysis);
- Acrylamide ("Sigma", USA);
- N,N'-methylene-bisacrylamide ("Sigma", USA);
- Ethidiumbromide (Sigma, USA);

At different stages of work the following equipment was used for the study:

- Spectrophotometer UV 1800 (Shimadzu, Japan).
- A direct microscope AxioScope A1 (Carl Zeiss AG, Germany).
- The AxioVert A1inverted microscope (Carl Zeiss AG, Germany).
- Ultracentrifuge Beckman J2-HS (Beckman, USA).
- The nitrogen analyzer Rapid N Cube (Elementar, Germany).
- Liquid chromatograph LC-20 (Shimadzu, Japan).
- ARACUS amino acid analyzer (Analytical Systems Gmb, Germany).
- Camera for vertical electrophoresis and power supply PowerPack HC, (Bio-Rad, USA).
- UV transilluminator TCP-20M (Vilber Lourmat, USA).
- System of gel documentation Gel Doc XR Plus (Bio-Rad, USA).
- Fermenter the Biostat A plus MO, 5 L, Sartorius (Sartorius, Germany).
- Refractometer HI 96801 (HANNA, Romania).
- Centrifuge CV-50 (ELMI, Latvia).
- Analytical balance AND HR-202 i (A&D, Japan).
- A pH meter - Sevew Compact (Mettler Toledo, USA).
- Laboratory microbiological incubator ILM-170-01 "Laminar-C" (CJSC "Laminar systems", Russia).
- Sublimation installation "Iney-6M" (Russia).

Theoretical and experimental investigations were carried out according to the modern methodology of study of complex phenomena using conventional, standard and original methods of biochemical, physico-chemical, structural and mechanical analysis.

RESULTS AND DISCUSSION

The results of determining the mass fraction of crude protein, crude fiber, ash, calcium, phosphorus, sodium in the samples of the feather down raw materials are shown in table 1. Table 1 shows that the waste evisceration of birds, obtained from hens of all the studied breeds are characterized by a high content of crude protein (79,53 - 90.11%) and low content of crude fiber (not more than 0.87%) and ash (not more than 0,20%).

The most valuable feather down raw materials in a relation to the protein content of keratin-containing wastes are obtained from hens of "Lohmann brown" breed (mass fraction of crude protein is 90.11%).

Table 1 – Chemical composition of feather raw material, obtained from hens of different breeds

Index	The indicator value for the raw material from hens of different breeds		
	«F-15 Iza»	"Lomann Brown"	"Lomann LSL-classic"
Mass fraction crude protein, %	79,53±5,33	90,11±5,56	89,08±5,51
Mass fraction of crude cellulose, %	0,87±0,04	0,49±0,02	0,69±0,03
Mass fraction of ash insoluble in hydrochloric acid, %	0,20±0,02	0,31±0,02	0,30±0,02
Mass fraction of calcium, %	0,90±0,1	0,97±0,1	0,89±0,1
Mass fraction of phosphorus, %	0,66±0,05	0,71±0,05	0,57±0,04
Mass fraction of sodium, %	0,16±0,02	0,31±0,02	0,20±0,03

The results of the determination of microelement composition of the feather raw materials indicate that the content of calcium (0,90-0,97%), phosphorus (0,7-0,71%) and sodium (0,16-0,31) of the investigated samples meet the requirements of normative documents presented to the feed for poultry.

The obtained data on the composition of feather down raw materials indicate that the waste evisceration of birds can be used as a promising raw material for producing high-protein feed for farm animals.

For the purpose of obtaining a more complete view of the chemical composition of the feather raw materials was conducted a research on studying the composition of the peptide fractions by electrophoresis on Laemmli`s polyacrylamide gel. The results are presented in table 2.

Table 2 – Molecular weight distribution of proteins of feather down raw material

The range of molecular mass, %	The relative content of fractions, %		
	«F-15 Iza»	"Lomann Brown"	"Lomann LSL-classic"
70,0-65,0	4,2	4,2	3,8
65,0-60,0	3,7	3,8	4,2
60,0-55,0	48,7	50,2	49,2
55,0-45,0	16,2	15,7	13,8
45,0-35,0	5,6	4,6	4,8
35,0-30,0	15,8	13,8	14,2
30,0-15,0	9,8	6,9	9,3
Less then 15	3,5	2,1	3,1

The results presented in table 2 indicate that the investigated keratin-containing raw materials have a wide variety of protein fractions with different molecular weights. The half of all proteins accounts for the fraction with a molecular weight of 60,0-56,0 kDa.

Low-molecular peptides with a molecular weight less than 10 kDa are containing in the feather down raw material in a sufficient quantities. According to the literature, this fraction corresponds to α-keratins. In addition, the èlektroforegramm revealed protein fractions with molecular weight of 43,0-33,0 kDa, probably, the representatives of the β-keratins.

An important indicator of animal feed is their amino acid composition. That is why we studied the quantitative content of essential and nonessential amino acids in the composition of the feather down raw materials.

The results of the study of amino acid composition of the feather raw materials indicate that the waste evisceration of birds is rich with the sulfur-containing amino acids such as cysteine and methionine.

Thus, the content of cysteine is in average of 9.15 mg/100 g of a sample, the content of methionine - 12,49 mg/100 g of a sample. As for the other amino acids, the high content observed for aspartic acid (6,89 mg/100g of a sample), serine (to 5.38 mg/100g of a sample), glycine (of 6.52 mg/100g of a sample), alanine (5.37 mg/100g of a sample), leucine (6,25 mg/100g of a sample), tyrosine (5,15 mg/100g of a sample), lysine (5,09 mg/100g of a sample), arginine (5,99 mg/100g of a sample).

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CONCLUSIONS

Thus, the data on physico-chemical composition of keratin-containing raw materials obtained from hens of three different breeds, allow us to recommend a waste evisceration of birds as a promising object to retrieve the high-protein balanced macroelement and microelement composition of feed for farm animals.

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