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CHEMICAL CHARACTERISTICS OF POULTRY SLAUGHTERHOUSE BY-PRODUCTS**

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Abstract. In this study, nutritional components that are obtained during poultry slaughtering having significance with respect to processing into animal feeds were investigated. By-products obtained during poultry slaughtering are considered very valuable raw materials for production of highly valuable animal feeds and energetic feeds.

Recognition of chemical and physical characteristics of the raw materials represents essential prerequisite for conduction of any technological process, for proper raw materials handling as well as for the equipment and machines design that are necessary for acceptance and processing of the inedible slaughterhouse by-products.

Authors have found that the nitrogen complex of the examined raw materials contains predominantly proteins. Digestible nitrogen for all investigated raw materials equals approximately with total nitrogen content, indicating that all proteins from these raw materials are accessible for utilization in animal organism, with exception of feathers that need special technological processing.

Basic chemical composition, nitrogen fractions and amino acid composition of the inedible by-products from poultry slaughterhouses indicate that the processing of these raw materials could be directed into production of swine and pet feeds production, as well in production of bio fuels and biogas. Blood and feathers anyhow represent significant protein source, and soft wastes, heads and legs, as well as the mixed raw material, besides as protein source, can be regarded as raw fat source.

Key words: poultry, slaughter by-products, chemical composition

Introduction

In industrial conditions of poultry slaughtering besides to meat, edible and inedible products are obtained. Many of these following products are considered as the raw material sources for production of animal feeds and technical fats. Because of that, this production attracted the attention of many investigators.

For the more complete utilization of raw materials of animal origin, better performing of the technological process and production of the high-quality products, good knowledge of basic raw materials characteristics is unavoidable (*Okanović et al., 2008). Ristić et al. (2005*), studying the structure and parameters concerning recognition of potential animal wastes quantities, stated that the by-products from the slaughtered poultry represent in the processed form abundant source of components convenient for nourishment of animals.

Ostapec (1979) pointed out that feather's basic protein (keratin) is a full-value protein that includes all irreplaceable amino acids. *Álvarez-Astorga et al.* (2001) claimed that the by-products from poultry slaughtering could be microbiologically contaminated, what causes the necessity of permanent professional supervision (HACCP) for prevention of serious risks with respects of animal- and human health.

In order of identification of the application value of by-products generated at poultry slaughtering, in this study chemical, nutritional and basic physical characteristics of such materials were determined. Besides to that, goal of this study was to point out the nutritive substances contents that could enable better understanding of quality of the available animal raw materials for production of the high-quality protein- and energetic feed, being the main task of these investigations.

Materials and methods

For the investigations, inedible by-products obtained at slaughtering and processing of fattened chickens (broilers) with body weight of about 1750 grams was used.

Estimations of chemical characteristics of inedible by-products were performed in laboratories of the Scientific Institute for foot technologies in Novi Sad, using 30 broilers.

Immediately after slaughter of the fattened chicks, their blood, wet feathers and digestive tract with crop and gizzard and mixed inedible products (trachea with crop and esophagus, small intestine with spleen and gizzard, cloacae and cuticle, heads and legs. Five slaughtered birds, according to the structure of the

by-products, were used as one sample for further investigations. Samples, composed in such a way, were put in plastic bags, labeled and taken into refrigerator at about 4°C. Four hours after the slaughter, samples were transferred into chemical laboratory.

All samples prior to examination were ground with homogenizer and after that used for chemical composition determinations. Basic chemical parameters (water, protein, fat and ash contents), nitrogen fractions and digestible nitrogen were determined according the AOAC methods (1984). For amino acids composition, amino-analyzer Biotronic LC 5001 was used. Protein hydrolysis was performed with 6 mol/L HCl for 23 h at 110°C. Cystine and methionine were ore-oxidized with performic acid (15 h at 2°C (*Moor, 1963*).

Bulk weight was determined by measuring of weight of unit of volume at free filling of measuring vessel.

With respect of right interpretation of the determined data, they were statistically evaluated with calculations of arithmetic mean ($\bar{x}$) and standard deviation (Sd) values (*Hadživuković, 1991*).

Results and discussion

Results for basic composition of the examined fattened poultry slaughtering chicks are shown in the Table 1.

Table 1. Basic chemical composition of inedible fattened chicken slaughtering by-products

By-product	Moisture (%)		Protein (%)		Fat (%)		Ash (%)		N-free extract (%)
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$
Blood (coagulated)	80,75	0,62	15,93	0,50	0,26	0,02	0,93	0,06	2,13
Feather (wet)	72,43	0,86	24,61	0,69	0,85	0,04	0,36	0,01	1,75
Soft offals (guts)	66,75	1,09	12,86	0,66	15,78	0,23	1,44	0,09	3,17
Heads and feet	66,45	0,42	16,09	0,76	7,16	0,4	5,26	0,43	5,04
Various offals	62,78	0,76	13,75	0,33	16,94	0,08	3,86	0,23	2,67

Basic composition of the inedible by-products from the slaughtering line of fattened chickens shows that this raw material, besides to water, contains mostly

crude proteins, and then crude fats and ash, and that nitrogen-free extractive substances content is practically negligible. From the point of view of nutritive value, the most favorable is blood composition. Higher protein content was found to be present in feathers, but it is well known that crude proteins of feathers are largely not digestible, because they contain mainly keratin.

Nitrogen-free extractive substances make more than one-third part of dry substances of this the very by-product. In other wastes, their shares in dry substances are significantly lower.

Mineral substances (ash) are in higher quantities presenting heads and legs, as well as in the mixed wastes (*Ristić et al., 1993*). Basic composition of the inedible poultry slaughterhouse by-products indicates that they can be directed into production of various feeds. Blood and feathers, undoubtedly, can be considered as significant protein sources, and soft wastes, heads and legs, as well as the mixed raw material, besides to proteins, are significant source of crude fats.

The obtained results are coherent with investigations of *Ristić et al.* (1999), which stated that wet feathers contain 77.21% of water, 21.35% of proteins, 0.64% of fats and 0.16% of ash, as well as of *Ristić et al.* (1993) who have found that the mixed wastes (intestines, heads and legs) contain 62.50% water, 13.64% proteins, 18.36% fats and 3.20% ash. High shares of proteins (in the dry substance) obtained also *Jalil et al.* (2001), while *Abaldova et al*. (1980) quote that dry feathers of broilers contain 82.5% proteins, 1.8% fats and 2.2% ash.

Nitrogen fractions and digestible nitrogen contents of inedible by-products obtained ad poultry slaughtering are outlined in Table 2.

Table 2. Nitrogen fractions and digestible nitrogen contents

	Protein N (%)		Nonprotein N (%)		Ammonia N (mg %)		Ammonia N (mg %)		Digestible N (%)	
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Blood (coagulated)	2,16	0,04	0,37	0,05	187	6,32	93	6,52	2,34	0,12
Feather (wet)	2,06	0,10	1,36	0,10	-	-	-	-	0,77	0,09
Soft offals (guts)	1,40	0,05	0,52	0,07	120	7,42	60	6,40	1,89	0,05
Mixed offals	1,94	0,07	0,18	0,04	49	4,95	27	6,56	1,91	0,06

Nitrogen fractions composition of poultry slaughterhouse wastes confirms that the largest part of nitrogen is in form of proteins. Protein-free share of nitrogen by the highest share originates from changes occurring during

processing of these raw materials before their processing, and in this case before their analyzing. Therefore, these data at the same time indicate to stabilities of individual wastes, which could be significant with respect to their processing. Of the investigated wastes, the highest stability of nitrogen substances complex is at feathers, because these substances are bound in the complex macromolecules. Soft wastes have lower stability than mixed wastes, and blood's stability is the lowest one.

Deamination processes, which occurred prior to sampling for the analysis and during the analyzing, are present, to the lower degree in blood, soft and mixed wastes. The same is the case for the hydrolytic processes, which are to the highest level observable for the blood. Totally taken changes of nitrogen complex were not expressed in any more significant level. Digestible nitrogen quantity, with respect to total nitrogen content, for all examined samples except for feathers, indicates that the largest part of proteins is available for utilization in the animal organism. Non-digestibility of feather proteins is well known, and their transformation in the more digestible form is accomplished with the hydrolytic manner of processing.

Amino acid composition of proteins (Table 3) of inedible byproducts from poultry slaughterhouses shows that they are valuable raw materials for processing into protein feeds. Essential amino acids represent more than 48% of the total amino acids in the blood proteins, and in other analyzed wastes, their shares vary from about 36% up to over 38%. Of the essential amino acids, significant are high contents of lysine (with exception of feathers), threonine, valine, isoleucine, leucine and phenylalanine, i.e. of allmost all essential amino acids.

Feeds that can be obtained from by-products of animal waster processing, can be combined from all wastes, or can be manufactured from each individual waste. At that time, nature of their protein fractions should be kept in mind, while for their utilization in animal organism some special technological conditions have to be fulfilled. Blood fraction is very sensitive already on water elimination, so that it creates great dangers with respect to decomposition of inactivation of individual amino acids. Using combined processing, some of mentioned difficulties can be eliminated, but the processing method depends on composition and quality of the obtained products.

Nonessential amino acids represent the greatest part of amino acids in feathers, soft and mixed products (48 – 53%), and their share in the blood amounts to 42%. It is important to mention that the largest part of lysine is in active form and that in not a single sample (with exception of feathers its activity was not below 98% based on its total availability in the raw materials. This was normal to expect, while alpha amino nitrogen content showed that the examined samples contained not a remarkable quantities of free amino acids.

With respect of right handling of raw materials, and calculation of volume of equipment and machines used for receiving and processing of inedible slaughter by-products into proteinaceous feeds and technical grease, it is important to be familiar with physical characteristics of raw materials.

Table 3. Amino acid composition of proteins of by-products obtained by slaughtering of poultry

	Blood		Feather		Soft offals		Mixed offals	
	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd	$\bar{x}$	Sd
Lysine	8,16	0,21	2,05	0,10	7,27	0,29	6,29	0,47
Histadine	5,04	0,62	0,58	0,06	1,95	0,11	1,65	0,14
Arginine	6,32	0,17	5,93	0,12	6,29	0,24	7,05	0,48
Aspartic acid	9,15	0,75	6,25	0,20	9,20	0,56	8,67	0,71
Threonine	4,48	0,60	4,58	0,55	4,46	0,63	4,13	0,29
Serine	4,82	0,58	10,39	2.81	4,66	0,54	5,16	0,79
Glutamic acid	10,58	2.59	9,91	2,20	13,14	2,50	13,60	3,44
Proline	4,98	0,76	10,36	2,26	5,17	1.17	6,44	1.39
Glycine	4,25	0,53	6,77	1,17	7,08	1,18	10,87	2,26
Alanine	7,81	1,38	4,06	0,37	5,97	0,84	6,47	0,76
Valine	0,58	0,20	7,04	1,53	0,99	0,21	1,15	0,25
Methionine	6,76	1,02	9,52	1,95	5,64	1,37	4,90	0,67
Cistine	2,17	0,06	1,02	0,19	1,73	0,38	1,86	0,26
lsoleucine	4,35	0,57	5,03	0,51	4,75	0,75	4,24	0,78
Leucine	10,31	1,72	7,21	1,75	8,15	1,83	7,22	1,69
Tyrosine	2,76	0,76	2,88	0,68	4,02	0,99	3,69	0,61
Phenilalanine	5,83	0,95	5,03	0,51	4,54	0,93	4,14	0,58
Tryptophane	1,32	0,21	-	-	1,20	0,15	1,33	0,19

At planning storage capacities and capacities of transporting and conveying equipment, it is important to keep in mind that this raw material is susceptible to the attack of microorganisms (*Alvarez et al., 2001*) and to chemical degradations of proteins evolution of gasses in them, i.e. to leading to the increasing of their volume (*Ristić et al., 1996*). These changes of raw materials depend on storage and transport conditions and times.

The outlined results show that the inedible by-products obtained on slaughtering lines of fattened chicks represent essential sources of proteins and fats. With processing of these by-products, it is possible to obtain feeds of animal origin and technical grease (*Ristić et al., 1996*). According to origin and chemical composition of basic raw material, applying the corresponding technology, it is possible to make blood flour (*Tasić et al., 2008, Okanović et al., 2008*), meat flour and flour from the hydrolyzed feathers. With convenient combinations of the mentioned raw materials and using the corresponding technologies, it is possible to increase assortment of feeds (*Ristić et al., 2003*).

Jalil et al. (2001) using biotechnological processes (starter cultures) processed waste materials from poultry slaughtering and obtained feeds that gave good results when applied for fattening.

Table 4. Bulk weights of inedible poultry slaughterhouse according to their weights and structures.

By product	Bulk density	
	$\bar{x}$	Sd
Guts	0,79	0,08
Fats	0,78	0,07
Blood	1,03	0,01
Raw feather (wet)	0,68	0,06
Poultrv feet	0,54	0,06
Poultry heads	0,79	0,09
Poultry soft offals	0,87	0,09

In the World, there are different technological methods for animal waste processing . Each of them has its own specifications that reflect themselves on the quality and yields of products. During processing, protein structures are changed and particular amino acids react with other substance present in raw material (*Ristić et al., 2005*). Yields of the obtained products, i.e. quantities of the obtained proteinaceous feeds and fats based on unity of raw materials, besides of the relation of particular components, directly depend on method of fats separation and on processing losses of individual substances, i.e. on the applied technological process (*Ristić et al., 2001*).

Conclusion

Based on investigations of basic characteristics of inedible by-products obtained on lines for slaughtering of poultry, it is possible to conclude the following:

1. Inedible by-products obtained on slaughtering lines of poultry, belonging to the third category by-products, are significant sources of proteins and fats that represent convenient raw materials for processing into proteinaceous feeds for swine and pets.
2. Nitrogenous complex of the examinated raw materials is predominantly composed of proteins, present in different quantities, depending on the structure and kind of the raw material.

3. For all samples, digestible nitrogen is approximately equal with total nitrogen, indicating that all proteins of these raw materials is accessible for utilization in animal organism, with exception of feathers. Nondigestibility of feather proteins is well known, and their processing in digestive form is performed by hydrolysis.
4. Amino acid composition of the analyzed raw materials indicates that these materials are potentially convenient for proteinaceous feeds production. It should be kept in mind, that the amino acid compositions of individual analyzed raw materials are different.

HEMIJSKE KARAKTERISTIKE SPOREDNIH PROIZVODA KLANJA ŽIVINE

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Rezime

U radu su ispitivane hranijive komponente animalnih sirovina koje se dobijaju pri klanju živine značajne za preradu u stočna hraniva. Sporedni proizvodi klanja živine su vrlo vredne sirovine za proizvodnju visoko proteinskih i energetskih hraniva.

Poznavanje hemijskih i fizičkih karakteristika sirovina neophodan je preduslov za vođenje tehnološkog procesa, za pravilnu manipulaciju sa sirovinom kao i za projektovanje aparata i mašina koje se koriste za prijem i preradu nejestivih sporednih proizvoda klanja.

Autori su utvrdili da je azotni kompleks ispitivanih sirovina sastavljen pretežno od proteina. Svarljijivi azot kod svih ispitivanih uzoraka približan je ukupnom azotu što pokazuje da su svi proteini iz ovih sirovina pristupačni za iskorišćenje u organizmu životinja, osim kod perja, koje zahteva posebnu tehnološku obradu.

Osnovni sastav, azotne frakcije i aminokiselinski sastav nejestivih sporednih proizvoda iz živinskih klanica pokazuje da se prerada ovih sirovina može usmeriti u proizvodnju hraniva za ishranu svinja i kućnih ljubimaca, biogoriva i biogasa. Krv i perje svakako predstavljaju značajan izvor proteina, a meki otpaci, glave i noge, kao i mešana sirovina, pored proteina, značajan su izvor i sirove masti.

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