Amino acid content in extruded feed mixtures

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Abstract

Introduction. To determine amino acid profile of extruded feed mixes containing flax feed extract based on water, amino acid profile amino acid profile and biological value of extruded feed mixes of different formulating composition has been studied.

Materials and methods. We investigated extruded feed mixes made of wheat, maize, wheat mill-run and flax feed extract based on water (FFEBW) having different percentage. Ratio (wheat:corn:FFEBW) for mixture 1 is 40:40:20, for mixture 2 is 45:45:10. Ratio (wheat mill-run:corn:FFEBW) for mixture 3 is 40:40:20. The mixture was mixed and extruded at 110–120 °C temperature, 2–4 MPa pressure decontaminating it. The concentration of free amino acids was determined by the method of ion-exchange chromatography.

Results and discussions. Undertaken researches of amino acid composition of the extruded feed mixtures allowed to identify and numerically define 9 essential amino acids (valine, leucine, isoleucine, lysin, methionine, phenylalanine, threonine, arginine, histidin) and 8 nonessential amino acids (aspartic, cystein, serine, tyrosine, glutaminic acid, glycine, pyrrolidine carboxulic acid, and alanine), calculations of amino acids score of extruded feed mixtures are also described that allows to get data on every amino acid, to define the first limited amino acid, calculate the coefficient of divergence amino acid score (CDAAS) and index of protein biological value (BV) of the investigated standards of extrudate.

The most essential amino acids contains mixtures № 1 – 42,82% on 100 g of protein and № 2 – 41,27% on 100 g of protein.

Content of leucine, lysin and threonine in protein of mixtures presents 8,34–9,8% 100 g, 3,44–3,84% 100 g, and 2,67–3,75% 100 g, accordingly, that confirms high protein value of extruded feed mixtures.

With the help of calculations, it is determined that the greatest biological value has protein of mixture № 1 – 70,25%. This mixture appeared the most balanced among amino acid composition comparatively with other mixtures. The least index of biological value is set in mixture № 3 – 65,25%, that is explained by more considerable divergence amino acid score than other amino acids.

Conclusion. It is recommended to add flax feed extracts in the complement of grain mixtures as an effective method of biological value increase of extruded feed mixtures, as hit allows to increase the content of protein and amino acids.

Introduction

Feeding has dramatic impact on growth, development, health and productivity of agricultural animals and poultry. It isknown, the food value of feed cannot be expressed by one index, it must be complex. In the system of complex estimation of food value of feed the special role belongs to protein. Providing of feed of animals' protein is one of major questions in organization of feeding [1].

Disintegration and synthesis of proteins pass constantly in the organism. In the digestive route proteins are disintegrated to the amino acids and soak through into blood. From amino acids cells synthesize own proteins. It is impossible to replace proteins by other nutritives, as their synthesis in the organism it is possible only from amino acids, but protein can be replaced by fats and carbohydrates, id est used for the synthesis of these species[2]. There are 20 amino acids in vegetable and animal feed. Not all amino acids that contain proteins are equivalent for the organism. Some amino acids cannot be synthesized in the organism and must be involved in feed. These amino acids are named vitally necessary or essential [7].

Essential and nonessential amino acids participate in the processes of metabolism, construction of organism's tissues, adjusting of antibodies' synthesis and others like that. The exchange of vitamins and mineral substances is closely connected with amino acids. Some amino acids directly provide energy muscular tissue, serve as neurotransmitters or their predecessors [1, 2].

Large value has free proteogenic amino acids in feed, id est those, that are not in the complement of proteins, but are in the free state[4]. Free amino acids directly from feed are soacked through into blood and join in the processes of metabolism, passing the stage of hydrolysis in gastrointestinal tract, that is very important for young cattle that grow, or patients [3]. From 20 proteogenic amino acids, agricultural cattle are not able to synthesize 10, in particular arginine, histidin, lysin, methionine, phenylalanine, threonine, tryptophane, valine, isoleucine and leucine[7]. Thus, these 10 amino acids must be in feed for agricultural cattle and is essential. If growing stock will not get these essential amino acids with feed, then they stopped to grow[8].

Absence or lack of these amino acids in feed results to metabolic disturbance – negative nitric balance, grow stopping, regeneration of proteins, origin of pathological changes in the nervous system, visceral organs of incretion, composition of blood. The appropriate decline of the enzymic systems' activity comes, the functions of liver, kidneys are violated and others[6].

For example, at the lack of protein in the rations of pigs that are on fattening, they spend 10–12 feed per 1 kg of increase, and at balance ration is 4–4,5 feed.

Feed proteins, that contain all vital amino acids in the composition, are named valuable. Animal protein (milk, eggs, meat) belong to them[11]. Those protein, that does not have or contain insufficient amount of amino acids, necessary for synthesis proteins of animals' body, are named inferior (vegetable protein). For comparative description of aprotein food value of different feed it is necessary to know their amino acid composition. The more essetial and especially critical (lysin, methionine, tryptophane) amino acids will have feed, the more it will be valuable, comparatively with other feed, where will be less amount of these amino acids[13].

Materials and methods

Materials

Materials for researches were the standards of of extruded feed mixtures tests with addition of flax feed extract for agricultural animals. The samples of feed were grated in advance in porcelain mortars to the powdery state.

Methods of determination of amino acids in feed mixtures of fodder mixtures

Extraction of amino acids was conducted in mixture by chloroform-water in correlation 1:1, at the permanent shaking off during 3 hours. Then centrifuging during 15minutes at 8000 revolution per minute. Water phase was selected and made subsidence of proteins by sulfosalicylic acid during 30 minutes at 4 °C, with further centrifuging (15 minutes at 800 revolution per minute). The got supernatants were conducted of 0,6 M lithium-citrate buffer solution (pH 2,1).

The concentration of free amino acids was determined by the method of ion-exchange chromatography on the amino acid analyzer of «BIOTRONIK LC 6001» (Germany). The essence of the method is based on photometric determination (570 nm) of the painted complex of ninhydrin with amino acids and further transformation of coefficient of transmissivity into the coefficient of asorptance, proportional concentration of permeate by means of logarithmic strengthener, that allows to carry out this transformation, facilitating further calculations [4]. As the standard of amino acids was used «Amino Acid Calibration Standard» (Benson Company, USA). This method is one of the best highly sensitive quantitative methods in protein chemistry. It gives absolute and exact (to 10 nmol) values to content of amino acids in any physiology liquids, extracts of tissues, food mixtures and others.

It is istinguished biologically valuable and less valuable (inferior protein). The first ones contain all essential amino acids. The composition of less valuable proteins is scarce for one or a few essential to amino acids. An important value had both essential and nonessential amino acids, also it is important to have balance of essential amino acids in the product. For determination of biological value of proteins different methods (chemical, biological, calculated) are used.

Methods of determining the biological value of feed mixtures

The biological value of feed mixtures is stipulated by composition and content of essential amino acids, that is determined by comparison of amino acid composition of investigated protein on the certificate scale of amino acids of hypothetical «ideal» protein. This methodical approach got the name of amino acid score. Amino acid score is the index of biological value protein that presents by part percentage ratio of the certain essential amino acid of general content of amino acids in the investigated protein to the standard (recommended) value [5, 6].

There are some methods of amino acid score calculation, and the simplest is the relation of every essential amino acid in the tested protein to the amount of the same amino acid in hypothetical «ideal» protein, fully balanced after amino acid content. FAO/WHO offered the standard amino acid scale that compare composition of investigated protein. Calculation of amino acid score of every essential amino acid it was expected

$$C_j = \frac{AK_i}{AK_{rs}} \times 100, \tag{1}$$

where C_j is amino acid score i- of essential amino acid of protein,%; AK_i is content of essential amino acid of protein of extruded feed mixture, g/100 g protein; AK_{rs} is the contents of essential amino acid in the standard protein, g/100 g of standard protein. It is considered that the limited biological value of amino acid is score that has the least value [9].

The coefficient of divergence of amino acid score (CDAAS) shows the average surplus of amino acid score of essential amino acids in comparison with the least score level of anyessential amino acid (surplus amount of essential amino acids that is not used on plastic necessities). CDAAS is calculated by the formula (2):

$$CDAAS = \frac{\sum_{j=1}^{N} \Delta RAC}{n}, \tag{2}$$

where ΔRAC is divergence amino acid score of amino acid that is calculated by the formula (3):

$$\Delta RAC = C_i - C_{min}, \tag{3}$$

where C_i is score surplus of i- essential amino acid%; C_{min} is the minimum of scores of essential amino acid of investigated sprotein in relation to the standard%; n is the amount of essential amino acids.

The size of biological value is determined by the formula (4):

$$BV = 100 - CDAAS, \tag{4}$$

If the size of CDAAS less, the highest quality of protein is [8, 10].

Results and discussions

Undertaken researches of amino acid composition of the extruded feed mixtures allowed to identify and numerically define 9 essential amino acids (valine, leucine, isoleucine, lysin, methionine, phenylalanine, threonine, arginine, histidin) and 8 nonessential amino acids (aspartic, cystein, serine, tyrosine, glutaminic acid, glycine, pyrrolidine carboxulic acid, and alanine), calculations of amino acids score of extruded feed mixtures are also described that allows to get data on every amino acid, to define the first limited amino acid, calculate the coefficient of divergence amino acid score (CDAAS) and index of protein biological value (BV) of the investigated standards of extrudate. The sum of sulfur-containing amino acids was also taken into account, such as methionine, that in the organism changes into cystein, the sum of aromatic amino acids, because phenylalanine transforms into tyrosine. The got results are given in the table.

Amino acid composition of extruded grain mixtures in% to protein mass

Amino acid	Rank FAO/ WHO	Equivalence ratio (wheat:corn:FFEBW)				Equivalence ratio (wheat mill-run:corn: FFEBW)			
		mixture № 1 40:40:20		mixture № 2 45:45:10		mixture № 3 40:40:20		mixture №4 45:45:10	
		Contents	Score	Contents	Score	Contents	Score	Contents	Score
Valine	5,0	3,06	61	2,79	56	2,91	58	2,6	52
Lysin	5,5	3,84	70	3,65	66	3,5	64	3,44	63
Leucine	7,0	9,8	140	9,4	134	8,52	122	8,34	120
Isoleusine	4,0	2,38	60	2,44	61	1,57	40	1,54	40
Threonine	4,0	3,66	92	3,75	94	2,84	71	2,67	67
Methionin+ cysteine	3,5	3,31	95	3,25	93	3,19	91	3,07	88
Phenylalanine+ tyrosine	6,0	8,04	134	7,65	128	6,71	112	6,39	107
Histidin	-	2,61	-	2,31	-	2,14		2,01	
Arginine	-	6,42	-	6,03	-	6,07		5,94	
Sum of essential amino acid		42,82		41,27		37,45		36,0	
Σ ΔRAC			232		220		278		257
CDAAS			29,75		27,5		34,75		32,13
BV			70,25		72,5		65,25		67,87

The value of the content of nonessential amino acids of extruded feed mixtures is given in the table.

It is known [10,12], that the full value of proteins is determined not only by quantitative content of amino acids but also by certain their correlation, balanced, easy changing and by good comprehensibility.

At determination of amino acid composition of protein of extruded grain mixtures (table 1) it is set that the great number of essential amino acids is contained in mixtures № 1 – 42,82% on 100 g of protein and № 2 – 41,27% on 100 g of protein. The least content of essential amino acids mixture is differ in №4 – 36% on 100 g of protein, however, looking at the table, this mixture leads on the contest of nonessential amino acids 64% on 100 g of protein.

Analysing amino acid composition of protein of extruded feed mixtures, it follows to mark, that among essential amino acids with high content is distinguished leucine, lysin and threonine. Their content in protein of mixtures presents 8,34.9,8% 100 g, 3,44.3,84% 100 g, and 2,67.3,75% 100 g, accordingly, that confirms high protein value of extruded forage mixtures.

It is known [11, 13, 15], that leucine is needed for construction and development of muscular tissue. This amino acid assists synthesis of protein in muscles and liver, restoration

processes in tissues and prevents destruction of muscles' protein. Considerable content of leucine from 9,8 g/100 g in mixture №1 a to 8,34 g/100 g in mixture № 4 talks that extruded feed mixtures can be attributed to the rich natural sources of this amino acid next to the eggwhite, casein, by protein of hazel-nut and others.

Lysin is acyclic amino acid and belongs to the group of diamino-carohylic acids. In nature it meets only in L- form. In the process of metabolism during amino acid exchange lysin occupies the special place as it participates in the reactions of transamination. After removal of missile group of proceeding of lysin iterating from other sources of nitrogen it does not take place.

It is determined [14,16-21], that lysin influences on mineral exchange (assists consumption of calcium and phosphorus and iron inhausting; in bowels it is able to execute the functions of cations of potassium at the deficit in the ration of this element), influences on hematopoietic function of marrow, transformation of carotin in vitamin A, the state of the nervous system, activity of enzymes.

In most cases lysin is the first most scarce amino acid in the rations of pigs, bird and even ruminant animals. It is needed for continuation of height, dairy productivity and forming of the skeleton. At its defect they are marked muscular degeneration, height oppression, decline of dairy productivity [17].

All investigated standards of extruded feed mixtures had approximately identical amount of lysin – from 3,44% 100 g of protein mixture № 4 to 3,84% 100 g of protein mixture № 1, that fully provide day's requirement of animals in lysin, that presents 1,5 – 4 g [16].

Threonine has two asymmetric atoms of carbon in α- and β-positions. For the actions of aldolase, threonine fissions on athanal and glycine that also is important amino acid for growing stock of cattle. Threonine is included in hypoplastic amino acids, acetylformic acid is appeared that is an initial substance for biosynthesis of glucose and hepatin. It stimulates immunity, assisting making of antibodies, together with methionine participates in the exchange of fats and positively influences on liver work. Necessary threonine and for proteins synthesis of skeletal muscles, collogen and elastin, glycerin, digestive enzymes, supporting activity of gastrointestinal tract, it is important for normal development of cattel organism [19, 20, 22].

It is set that extruded feed mixtures have also enhanceable contents of threonine, that assists supporting of normal protein balance in the animals' organism. The great amount of its quality was educed in mixture № 1 – 3,75 g/100 g protein.

Sulfur-containing amino acids serve as the source of sulphur in the organism of animals, that participates in providing of many biochemical processes. The major functions of these amino acids are structural and catalytic contents of redox and transport of electrons. The lack of cystein in the ration, methionine becomes the basic donor of sulphur. At these terms cystein appears from methionine, as the result of the requirement of animals' organism which is provided in this amino acid. However, this process is undesirable, because methionine is the most essential amino acid and the its lack is resulted to brake of proteins synthesis and reduction of productivity. At the same time methionine is the most toxic substance, that in surplus predetermines decomposition of cholesterol, and also liming of vessels and formation of malignant desease. Day's necessity of agricultural animals of all age-related groups presents 1,5 – 3 g [15].

Researches showed that extruded feed mixtures have the content of methionine and cystein that is presented 3,07.3,31 g/100 g of protein, that fully provide cattle's supply in food.

Calculated amino acid score is shown that protein of extruded feed mixtures is valuable source of phenylalanine and leucine. After these amino acids score is equal to «standard» protein.

On content of methionine and threonine of protein of extruded feed mixtures goes to «standard» – 3,5 and 4 g/100 g.

The least indexes of amino acid score were marked in the investigated mixtures of isoleucine and valine. It should be noted that score of these amino acids was in the limits of 40.61%.

Calculated amino acid score can not fully represent biological value of protein, because it does not take into account its balanced of all essential amino acids [22]. Thus, for determination of biological value of protein of extruded feed mixtures the coefficient of divergence of amino acid acore of protein of investigated standards was calculated.

The given calculations testifie, that the greatest biological value is owned by protein of mixture № 1 – 70,25%. This mixture is the most balanced after amino acid composition comparatively with other mixtures. The least index of biological value is set in mixture № 3 – 65,25%, that is explained by more considerable divergence of amino acid score of some amino acids.

Conclusions

1. Undertaken researches in relation to extruded feed mixtures with the use of flax extract on the basis of water were identified 9 essential and 8 nonessential amino acids. Among essential amino acids phenylalanine and leucine had enhanceable content, among nonessential is glutaminic acid, glycine and aspartic acid. After amino acid composition of protein of extruded feed mixtures is valuable, as all essential amino acids including major of them are methionine and lysin are included in its composition.
2. Biological value of protein of extruded feed mixtures after amino acid score, that is in the limits of 65,25–70,25%. It is estimated that methionine and threonine of protein of extruded feed mixtures goes to «standard» – 3,5 and 4 g/100 g.

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