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UNDEGRADABLE PROTEIN – IMPORTANT FACTOR IN BALANCING OF DIETS FOR FATTENING LAMBS

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Invited paper

Abstract: Although sheep breeding in our country mainly had extensive character, there is still room for implementation of the new concept of expression of nutritional value of proteins, primarily in fattening of lambs. For the purpose of maximum use of the genetic potential of high-yielding meat/fattening sheep breeds, share of undegradable protein in diet must be taken into consideration, since high protein requirements of such animals cannot be satisfied by microbial protein synthesis from usual protein and energy sources. Therefore, in contemporary, science based systems for assessment of protein value of feeds, degradability of proteins from food in rumen plays major role. In absence of data in domestic literature related to undegradability of proteins in certain feeds, results obtained in this study should be perceived as direction for future norming of diets in fattening of lambs in the intensive rearing system.

Key words: lambs, undegradable protein, gain, digestibility, meat quality

Introduction

Main goal of norming of proteins in diets for lambs is to provide adequate quantities of amino acids to satisfy their maintenance and production requirements. Amino acids available for absorption and production are provided from three sources *(Grubić et al., 1997)*:

- protein synthesized in rumen by micro-organisms (microbial protein)
- protein in food not degraded by micro-organisms (undegradable protein)
- protein of endogenous origin which is in normal production circumstances minor *(Orskov, 1982)*.

Micro-organisms in rumen of ruminants degrade dietary protein to peptides, amino acids and ammonia, and subsequently use these substances for synthesis of own proteins. During each of these degradation and synthesis process certain losses occur (usually around 20%), which means that due to the action of micro-

organisms reduced amount of amino acids reaches the place of digestion and absorption/intake of proteins.

In order to obtain optimal pool of amino acids for certain production, it is necessary to provide in diet for lambs protein fraction which avoids degradation in rumen (undegradable protein), which is achieved, among other things, through use of different protein sources.

Significance of rumen undegradable protein was indicated by *Zeremski et al. (1989)* and *Grubić et al. (1993)*. Namely, in order to utilize to maximum genetic potential of high yielding meat breeds, share of NP in diet must be considered. Microbial synthesis of proteins from usual protein and energy sources is not enough to satisfy high requirements of such animals in proteins *(Shahrbabak et al., 2009; Hussein et al., 1991; Grubić et al., 1992)*. Recently, with the considerable increase, i.e. improvement of production capacities of ruminants, a disproportion between conventionally expressed protein value of food and production achieved de facto was established *(Grubić et al., 1991b)*, which initiated new research resulting in new systems to valuate protein value of feeds.

In contemporary systems for assessment of protein value of feeds which are based on scientific findings, and expression of ruminant requirements in proteins *(INRA 1989; ARC 1992; NRC 1985; NRC 2001)* degradability of protein in rumen has important role. It refers to the degree to which proteins of certain feeds are degraded in rumen and reticulum, i.e. amount of amino acids provided by this feed at the level of duodenum. Feeds with easy degradable proteins are not preferred in ruminant nutrition *(Jovanović et al., 2001)*. As a rule, in order to achieve high production it is necessary to provide in diet more proteins which as undegraded reach the place of digestion and adoption.

According to *Grubić et al. (1991),* for each production level there has to be optimal ratio between proteins degraded in fore-stomachs under the action of micro-organisms (degradable protein – DP) and proteins which avoid degradation (undegradable protein – UP). The simplest procedure to influence the volume and rate of dietary protein degradation in rumen is in adequate choice of protein source *(Grubić et al., 1992)*. *Zeremski (1989)* states that the use of animal feeds which have low protein degradability in reticulum-rumen has important role in utilization of production potential and intensive fattening of lambs. Proteins deriving from mentioned feeds belong to the high valuable proteins because they contain essential amino acids necessary for growth and development of lambs. Excellent sources of high valuable proteins which degrade slowly in rumen are: fish meal, meat-bone meal, blood and soybean meal.

According to *Titgemeyr et al. (1988)*, value of protein source in ruminant nutrition is determined by its ability to provide:

1. limiting amino acids in small intestine and
2. nitrogen available to micro-organisms in rumen and reticulum.

The effect of undegradable protein on production parameters of fattening lambs

Feeds with proteins which pass through reticulum-rumen and reach duodenum undegraded, influence greater yield in lambs, provided that sufficient quantities of energy have been provided *(Zeremski, 1988)*.

It is known that in ruminants, micro population of rumen degrades protein to peptides, amino acids and ammonia, and subsequently these substances are used for synthesis of own proteins. During each of these degradation and synthesis processes certain losses occur (usually around 20%), which means that due to the action of micro-organisms reduced amount of amino acids reaches the place of digestion and absorption/intake of proteins. If the degradation volume is greater, proportionally the quantity of amino acids which is left directly for the animal is smaller *(Grubić et al., 1992)*. Specific role of absorbed amino acids from small intestine of lambs is protein synthesis which contributes to growth of body tissues. This is especially important in intensive fattening of weaned lambs which have high genetic potential for growth. So, feeds whose proteins have passed the reticulum-rumen and reached duodenum undegraded, such as fish meal, meat-bone meal, etc., enable higher yields in lambs.

This was confirmed in studies by *Ružić-Muslić (2006, 2007d)* where the level of undegradable protein (43:51:58%) influenced very significantly (P<0,01) the final fattening result expressed as average daily gain, i.e. final body mass of fattening lambs.

Table 1. Production results of fattening lambs

Traits	Levels of undegradable protein		
	43%	51%	58%
Initial body mass, kg	18.12	18.08	18.17
Initial age, days	60	60	60
Final body mass, kg	30.78[a]	33.52[b]	35.17[b]
Total gain,kg	12.70[a]	15.40[b]	17.00[b]
Average daily gain, kg	0.169[a]	0.205[b]	0.227[b]
Use of dry matter kg / kg gain	4.54	3.71	3.30
Use of total, proteins, g/ kg gain	732	596	549
Use of NEM, MJ/kg gain	33.77	29.37	26.25

Difference between a and b is statistically significant at the level of (P<0.01)

The highest daily gain (0.227kg) and the best conversion of dry matter (3.30kg) was realized by lambs on treatment with 58% of UP in mixture. Results

similar to ours, in regard to the effect of source of undegradable protein were obtained by *Orskov et al. (1971)*, *Miller (1978), Grubić et al. (1991), Walz et al. (1998), Peter et al. (2000), Memiši et al. (2002*). *Grubić et al. (1991),* in the analysis of the relationship between average daily gains and protein value of the diet expressed through total, digestible and undegradable proteins in diet, established the highest correlation coefficient (r=0.72) between daily gain and share of undegradable protein in diet, slightly lower between gain and crude protein (r=0.72) and the lowest between gain and digestible proteins (r=0.68).

With the increase of share of undegradable proteins in total proteins, use of energy decreased by 4.4 -7.5 MJ NEM for each kilogram of realized gain. Data on feed conversion and conversion of nutrients obtained in this study are in concordance with results of *Kozarovski (1988*), *Grubić et al. (1991)* and *Mekić (1994)*. *Grubić et al. (1991*), in the research of the effect of concentrate mixtures with 9 and 12% of fish meal, i.e. share of UP in total proteins of 38:55:62% established conversion of DM on analogue treatments: 3.75 : 3.44 : 3.30 kg. In fattening of lambs of Ile de France genotype, fed concentrate mixtures with different content of UP in total proteins (40:50:60%), to the age of 90 days, *Mekić (1994)* established that with the increase of level of UP the intake of concentrate decreased: 2512 : 2493 : 2357 g per kilogram of gain of lambs.

The effect of undegradable protein on digestibility of nutrients

The level of adoption of proteins in lambs is not under significant effect of undegradable protein in mixtures, whereas the digestibility of fat, fibre and nitrogen free extracts is under the influence of mentioned treatment *(Ružić-Muslić, 2006, 2007c)*. *Matras et al. (2000)* in their study of nutrient digestibility in lambs fed diet I based on ground barley and urea (high level of degradable protein in rumen) and diet II which contained cracked corn and corn gluten flour (high level of undegradable protein), established average coefficients of protein digestibility: 60.2% (I) and 63.5% (II). Similar results are reported also by *Christensen et al. (1993*) who established the difference (P>0.05) in digestibility between low degradable proteins (55%) and proteins of high degradability (70%). In the research by *Tiwari et al. (2000*) no difference in protein digestibility was established in calves fed diets containing protein components, which were different in regard to degradability (untreated walnut meal, walnut meal treated with formaldehyde and fish meal). Similar conclusion was reached by *Viswanathana and Fontenota (2009)*, *Keery et al. (1993)*, *Ludden and Cecava (1995)*, stating that the level of adoption of protein showed no significant differences between protein sources (P>0.05), which were different in regard to degree of degradability.

With the increase of share of undegradable proteins in mixtures (43:51:58%) tendency of increase of fat digestibility was observed *(Ružić-Muslić, 2006)*. Obviously, optimal conditions in regard to degradable/undegradable protein ratio and available energy were realized on treatment III, which are obviously optimal conditions for activity of rumen micro-organisms. Our results are in concordance with results obtained by *Ljumović et al. (1967)* who established, in the study of the effect of different protein sources (alfalfa hay and sunflower meal) in diets for fattening lambs on nutrient digestibility, that the digestibility of fat was 74.99% and 62.60%, respectively. Also, our data is in concordance with results obtained by *Jovanović et al. (1972)*, *Negovanović et al. (1983*) and *Ružić (1997). Pejić et al. (1986*) point out that digestibility of fat depends on its triglyceride structure, length of fatty acid chain and diameter of fat particles, since only particles of certain size have enough energy to enter the digestion and resporbtion system. This is explained by Km/e which represents the ratio between particles of mycelar and emulsion phase and increases significantly with the decrease of the length of fatty acids chain.

Digestibility of crude fibre shows trend of decrease with the increase of level of undegradable protein in mixtures for nutrition of fattening lambs *(Ružić-Muslić, 2006)*. This trend is in accordance with research by *Husein et al. (1991)* who reported noticeable improvement in fibre digestion in rumen on treatments with high degradable protein. This is explained by the fact that increase of micro-organisms and their activity depend on the quantity of degradable protein and available energy. If the level of undegradable protein is higher, conditions for growth and activity of micro flora are inadequate resulting in decreasing trend of the degree of fibre digestion. At the same time, if fish meal is main protein component in the diet structure, and corn is main energy component, larger quantities of propionic, butyric and lactic acids are formed and the rumen pH value decreases on this type of nutrition with lower fibre content and higher amount of easy digestible carbon hydrates. Usual mechanisms of buffering of rumen pH in this case is not enough, so lower pH value inhibits the growth of cellulolytic bacteria resulting in depression in fibre digestion. Our results differ from results obtained by *Milis et al. (2004)* who established following fibre digestibility coefficients - 65% : 66% : 64% : 73%, respectively, on treatments with 35%:34%:43%:42% of undegradable protein in diets for sheep nutrition, which is associated with structure of the diet and associative effect of used feeds (cotton meal, wheat bran, corn gluten, combination of corn gluten and gluten feed).

Table 2. Digestibility of nutrients, %

Nutrients	Level of undegradable protein,%		
	43	51	58
Total protein	52.58±5.98	51.30±3.51	55.12±1.95
Crude fat	$76.13^{a\pm}$3.49	77.98^{a}±1.95	87.17^{b}±1.30
Crude fibre	67.40^{ad}±6.19	45.87^{c}±4.32	22.39^{ae}1.91
NFE	83.87^{a}±3.21	76.05^{b}±3.13	82.96±1.52

Difference between a and b is statistically important at the level of (P<0,05), between a and c at the level (P<0,01), and between d and e at the level (P<0,001)

The effect of undegradable proteins on yield and quality of lamb meat

Level of undegradable protein in mixtures used in fattening of lambs doesn't have significant effect on dressing percentage values, meat yield according to categories and morphological composition of the carcass side *(Ružić-Muslić, 2006,2007b)*. Results of mentioned study are presented in Table 3.

Table 3. Yield of meat and share of individual tissues, %

Indicators	Level of undegradable protein,%		
	43	51	58
Dressing perc. Cold carcass with offal, kg	56.49±1.37	55.97±1.78	55.38±1.22
Yield of meat according to categories			
Meat category I,%	32.27±2.68	37.35±1.35	37.51±2.11
Meat category II,%	33.19±2.21	32.67±1.68	32.83±1.36
Meat category III,%	27.78±2.71	29.59±2.53	29.10±2.35
Share of individual tissues,%			
Muscle	43.52±4.61	42.27±1.80	41.92±3.12
Fat	26.68±6.68	31.76±3.07	30.68±4.42
Bone	28.23±6.33	25.06±3.14	25.93±5.60
Connective	1.19±0.64	0.93±0.52	1.01±0.53

Established differences in dressing percentage values were within the range of random deviations (P>0.05), which means that different levels of UP in diets for lambs had no significant effect on studied trait. Obtained results are in concordance with results obtained in the study of the effect of different shares of undegradable proteins (41:50:60%) in total mass of the diet on fattening and slaughter properties of Il de France lambs to the age of 88 days, by *Mekić et al. (1999)* who established

that different levels of UP protein had no effect on value of dressing percentage – warm carcass with offal, considering that obtained values were: 54.16 : 56.54 : 57.36%. Also, *Shahrbabak et al. (2009)* state that different levels of undegradable protein - 19.86 : 26.47 : 33.08 g/kg of DM in diets used in fattening of Kermani breed lambs, had no effect on weight of edible carcass parts and surface of MLD. *Al Jassim et al. (1991)* point out that the effect of rumen undegradable protein was greater in lambs compared to goats and expressed on food efficiency and utilization, but not on carcass quality.

According the data presented in Table 3, share of I category meat (leg and loin) in the mass of left carcass side of lambs on treatments 43:51:58% was: 37.27 : 37.35 : 37.51%, respectively. Meat of the II category (back, shoulder, neck) was determined in following percentages: 33.19 : 32.67 : 32.83%. Relative share of III category meat (chest with second fore thigh, second thigh) was: 27.78 : 29.59: 29.10%. So, studied nutrition treatment had no effect on carcass side mass and share of individual meat categories, considering that determined differences were not statistically significant (P>0.05). This is in accordance to results obtained by many authors *(McClelland et al., 1976; Butterfield, 1988, quote Petrović, 2000, Shahrbabak et al., 2009)* who point out that the variability relating to the quality of meat mainly depends on the genotype and pre-slaughter age, and less on paragenetic factors.

Morphological composition of carcass side was determined based on tissue ratio in three rib cut, and presented in Table 3.

Results of the relative shares of individual tissues in three rib cut show that the levels of undegradable protein in mixtures for nutrition of lambs had no statistically significant effect on morphological composition of carcass sides (P>0,05). However, the most favourable meat/bone ratio was determined in animal on treatments with 51% and 58% of UP. Lambs on treatments with 43% realized per 1 kg of bones by 0.4 kg less meat compared to animals on treatment with 51% and by 0.3 kg less compared to lambs on treatment with 58%. Confirmation of these results we find in studies by *Šokarovski et al. (1988)*, *Tahirović and Mašnić (1979)*.

Obtained results relating to carcass quality, as well as share of individual tissues (muscle, fat, bone and connective tissue) showed that they were not under the effect of the nutrition treatment, which is in concordance with results obtained by *Attija et al. (2007)*. Explanation is in the fact that lambs had similar weights of the empty carcass and carcass composition, considering that their pre-slaughter weights are similar. These parameters mainly depend on pre-slaughter body mass *(Colomer-Rocher and Espejo, 1972; Atti et al., 2003)*.

Conclusion

In order to utilize to the maximum the genetic potential of high yielding sheep breeds for production of meat, the share of UP in diet must be considered since microbial synthesis of protein from usual sources of protein and energy is not enough to satisfy the high requirements of lambs in intensive rearing system.

Feeds with proteins which pass through reticulum – rumen and reach duodenum undegraded induce higher yield in lambs, provided that there is sufficient amount of energy.

Level of undegraded protein in mixtures used in lamb nutrition has no significant effect on level of protein adoption, whereas the digestibility of fat, fibre and nitrogen free extracts was under the influence of said treatment.

Different levels of UP in diets for lambs have no significant effect on dressing percentage values, yield of meat according to different categories and morphological composition of carcass sides.

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Nerazgradiv protein – značajan faktor balansiranja obroka za jagnjad u tovu

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Rezime

Iako ovčarska proizvodnja u našoj zemlji ima uglavnom ekstenzivan karakter, u njoj ipak ima mesta za primenu novog koncepta izražavanja hranidbene vrednosti proteina, pre svega u tovu jagnjadi.

U cilju maksimalnog iskorišćavanja genetskog potencijala visokoproizvodnih rasa ovaca za meso, mora se voditi računa o udelu nerazgradivog proteina u obroku, s obzirom da se mikrobiološkom sintezom proteina iz uobičajenih izvora proteina i energije ne mogu zadovoljiti visoke potrebe takvih grla u proteinima.

Zbog toga, u savremenim, naučno zasnovanim sistemima za ocenu proteinske vrednosti hraniva, važno mesto zauzima razgradivost proteina hrane u buragu.

U nedostatku domaćih podataka o nerazgradivosti proteina pojedinih hraniva, rezultate istraživanja u ovom radu treba shvatiti kao davanje određenih rešenja i putokaz za normiranje obroka za tov jagnjadi u intenzivnom sistemu gajenja.

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