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INSTITUTE FOR ANIMAL HUSBANDRY
BELGRADE - SERBIA

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Ministry of Education, Science and Technological Development of the Republic of Serbia

ORGANIZER

Institute for Animal Husbandry
Autoput 16, P. Box. 23, 11080, Belgrade-Zemun, Serbia
Tel: +381 11 2691 611;
+381 11 2670 121;
+381 11 2670 541;
Fax: + 381 11 2670 164;
biotechnology.izs@gmail.com
www.istocar.bg.ac.rs

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OPTIMIZATION OF ENERGY AND PROTEIN LEVEL IN DIETS FOR FATTENING LAMBS

D. Ružić-Muslić[1], M. P. Petrović[1], M. M. Petrović[1], Z. Bijelić[1], V. Caro Petrović[1], V. Pantelić[1], P. Perišić[2]

[1]Institute for Animal Husbandry, Belgrade-Zemun, 11080, Serbia
[2] Faculty of Agriculture, University of Belgrade, Zemun, Serbia
Corresponding author: muslic.ruzic@.gmail.com
Invited paper

Abstract: Sheep have the ability to transform the relatively low quality food into high quality protein of animal origin (meat, milk). To increase the efficiency of feed utilization and minimize pollution of the environment, it is necessary to better understand the needs of lambs in nutrients (primarily energy and protein) and their interaction in the organism. Optimal ratio between energy and protein in the diet of lambs optimizes microbial protein synthesis and maximum retention of degradable nitrogen in the rumen. The excess of the energy consumed in the diet, will be transformed into fat, as the degree of increase of muscles and bones is limited. Feeding lambs diets deficient in the protein, leads to the formation of large amounts of fat in the body. The decline in the efficiency of energy use, in case of the surplus of protein in the diet, is associated with energy consumption for the formation and excretion of urea. The results of our study showed that lambs crosses of Pirot Pramenka Wuerttemberg x Ile de France of average body weight of about 15 kg and 30 days of age and fed with a diet containing 4% beef tallow (7.71 MJ NEM and 16% CP) realized significantly ($P<0.05$) higher average daily gain and final body weight compared to animals that have consumed feed with 6% beef tallow and 7.94 MJ NEM. Also, animals on this treatment realized the best conversion of dry matter, protein and energy. The above nutritive treatment did not significantly affect the meat yield, the yield of meat per categories and morphological composition of the carcass side.Bearing this in mind, the aim of this paper is to present our own, and the results of other authors, related to the optimization of energy and protein levels in diets for fattening lambs.

Keywords: lambs, protein, energy, growth, yield, meat quality

Introduction

Interest in increasing the efficiency of lamb meat production, on the one hand, and the concern about the quality of meat, on the other hand, have motivated significant research efforts in the direction of modeling the composition of lambs through diet. This issue has important implications in several fields, including energy metabolism and protein and their interdependencies with the aim to develop a diet that optimizes the relationship between energy and protein in diets for fattening lambs (*Pittroff et al., 2006*).

Energy, quantitatively, is the biggest factor limiting livestock production. Meeting the needs of lambs in energy is the largest item in the cost of food. Hence, the efficiency of use of energy, in terms of quantity and cost of production, is a very important question. Animals can be supplied energy through partial or complete oxidation of carbohydrates, fats and proteins consumed and absorbed from food.

Most of the soluble (sugars and starches) and insoluble carbohydrates (cellulose and hemicellulose) are fermented, through the action of microbial enzymes, into volatile fatty acids (acetic, propionic and butyric), which are absorbed through the rumen wall into the blood, and transported to the different body tissues (*Jovanović et al., 2001*). Catabolic processes (supplying the energy to the body) and biosynthetic processes (biosynthesis of fat from acetic and butyric acids or the synthesis of glucose from propionic acid) take place in them.

As a second source of energy in diets for fattening lambs, fat is used. Because of the small volume of the digestive tract of lambs on one side and a large increase in the intensity of growth on the other, in order to ensure an optimal level of energy in diets for fattening lambs, it is resorted to using some non-conventional feedstuffs such as fats of animal and vegetable origin (tallow, lard, soybean oil) (*Ruzic, 1997*). Researchers in the UK (NRA) have shown that with 4-6% added fat in the meal ruminants produce 34-45% less methane in the rumen, which results in a savings of 2-5% in energy and the big savings in the cost of fattening.

The role of energy involves the provision of requirements for maintenance (blood circulation, respiration, activity of the nervous system, maintenance of muscle tone, thermoregulation, performance of active absorption and transport of chemical compounds, replacement of damaged tissues, the production of hormones and vitamins) and production functions in lambs. While the requirements for maintenance represent a function of the body weight of lambs, increase and ratio of protein and fat in formed gain are main determinants of the energy requirements for production *(Jovanović et al., 2001).*

On the other hand, the protein is also a critical nutrient for young animals growing and most expensive food component. Proteins play a fundamental role in the body of lambs. They participate in the formation and maintenance of tissues, muscle contraction, transport of nutrients and synthesis of hormones and enzymes (*Santos et al., 2006*).

Longer protein deficiency results in a decrease in the efficiency of feed utilization and low immunity of animals (*Santos et al., 2006*). Excess protein can cause a loss of energy. This means that the availability of energy is regulated by adequate protein in the diet. The energy deficit delays puberty, reduces growth, fertility, weight and other production parameters of animals (*Resende et al., 2006*).

Optimal balance between energy and protein in the diet of lambs optimizes microbial protein synthesis and maximum retention in the rumen of degradable nitrogen (*Sinclair et al., 1993*). When the rate of ammonia formed exceeds the rate of fermentation of carbohydrates, nitrogen is not used effectively and a high percentage of nitrogen is excreted through urea (*Huber and Herrera-Saldana, 1994*). Contrary, when the rate of fermentation of carbohydrates exceeds what is metabolised in the rumen and liver, results in acidosis (*Yokoyama and Jonson, 1988*). The effects of protein-energy relationare reflected in the energy balance, and the nature of weight gain (*Pittroff et al., 2006*).

Effect of the level of energy and protein in the diet on performance of fattening lambs

Finding the optimal level of energy and protein in diets for fattening lambs, in order to maximize production in sheep, is the subject of numerous studies in the country and abroad.

In order to achieve higher and more cost-effective growth of lambs, the question of the level of energy is the simplest regulated by adding a by-product of the slaughter industry (animal fat, beef fat) in feed mixtures for feeding offspring. Until recently, in order to adequately supply of sufficient energy, the use of large amounts of carbohydrate nutrients was recommended in ruminant nutrition, that are introduced into the concentrate mixtures. However, this diet had a negative impact on the course of fermentation in the rumen, lowering the pH, which can lead to the incidence of bloat and acidosis. In contrast, the fat in the diet changes the surface tension/voltage of the fluid in the rumen and reduces the tendency of foaming and incidence of bloat. Further comparison of addition of carbohydrate and fat as energy sources, points out the advantage of fat considering that during the fermentation of carbohydrates up to 14% of the energy available in food can be lost, through methane that is unusable for animals (*Ružić, 1997*). The studies (*Ružić, 1997; Ružić et al.1999*) have confirmed that the lambs that consumed isoprotein forage mixture (16% TP) with 4% beef tallow and 7.71 MJ NEM achieved significantly ($P < 0.05$) higher average daily gain and final body weight compared to animals that have consumed feed with 6% beef tallow and 7.94 MJ NEM. Also, animals on this treatment have realized the most favourable feed conversion of dry matter, protein and energy, as shown in Table 1. Rezults similar to ours, in regard to the use of fat as an energy source in diets for lambs, have been obtained by *Ponnampalam et al., (2005).* They found that the fat content of more than 5% in the mixture had negative effect on weight gain of lambs as a result of depressed activity of fatty acids on the rumen microflora and fiber digestion.

Table 1. Production performance of fattening lambs (*Ružić, 1997*)

Traits	Energy levels, MJ NEM		
	7.29	7.71	7.94
Body weight at the beginning of the trial, kg	14.97±2.64	15.12±2.58	15.15±2.82
Age at the beginning of the trial, days	30	30	30
Body weight at the end of the trial, kg	29.81±4.07	31.19^{a}±3.36	29.86^{b}±5.66
Total gain, kg	14.84±1.31	16.07^{a}±1.52	14.71^{b}±1.34
Average daily gain, kg	0.280±1.1	0.303^{a}±1.21	0.277^{b}±1.10
Consumption of dry matter kg/kg of gain	2.68	2.58	2.93
Consumption of total proteins kg/kg of gain	481	450	514
Consumption of NEM, MJ/kg of gain	19.07	18.36	20.71

The difference between a and b is statistically significant at the level ($P<0.05$)

From the perspective of the impact of different energy levels on performance of fattening lambs, *Haddad and Hussain (2004)* examined the effects of two energy levels: 2.92 and 2.40 in Mcal/kgday in isoprotein diet on performance of Awasi lambs, of average body weight of 16.7 kg, determined the final weights: 33.4 : 27.9 kg, and the average daily gain: 0.258 : 0.178 kg, respectively. Feed conversion rate was 3.8 : 5.4 kg/kg gain. Therefore, diets with higher energy level had an impact in improving growth and efficient feed utilization. Similar results are obtained by *Saikia et al. (1995), Shahjalal et al. (2000)* who conducted tests on goats. *Hassan et al. (2011)* carried out the experiment on 18 lambs, aged 3 months, with an average body weight of 22.0 kg, fed isoprotein rations (16.5% TP), with different levels of energy: 10.5 MJ ME/kg/DM : 8.5 MJ ME/kg/DM. The lambs on these treatments realized average daily gain (ADG): 0.282 : 0.193 kg, while the DM conversion was: 5.5 : 9.0 kg/kg gain. *Sayed (2011)* examined the impact of different energy levels (2.90 : 3:20 : 3:50 Mcal/kg) in isoprotein diets (14.7% TP) on the performance of lambs. The aforementioned treatments have achieved average daily gain values: 0.180 : 0.284 : 0.215 kg and feed conversion was: 8.13 : 4.59 : 6.26 kg/kg of gain, respectively.

Haddad and Ata (2009) followed the effects of different levels of energy (2.81 : 2.90 : 2.96 : 3.04 Mcal/kg DM) in isoenergy diets (16% TP) on growth performance of Awasi lambs of average body weight of 17.9 kg. The following average daily gains were realized: 0.244 : 0.250 : 0.185 : 0.161 kg with food consumption: 4.9 : 4.7 : 6.1 : 5.7 kg/kg of gain, resepctively. It is evident that the lambs achieved the best results in the diet containing 2.90 Mcal/ kg DM and 16% TP. So, increasing the energy density of the ration for lambs resulted in improved growth performance and better feed conversion. The explanation for this phenomenon lies in the fact that the increase of energy level enables production of large quantities of ME required for microbial growth, resulting in increased microbial protein synthesis and synthesis of protein in general (*Sayed, 2011*). However, feeding diets containing a high proportion of concentrate feed in ruminant nutrition causes acidosis (*Owens et al., 1998*), which sets new requirements in terms of relations between carbohydrate components as well as protein and energy in diets for feeding fattening lambs. In other words, a balanced diet in terms of protein and energy optimizes growth of lambs and kids. *Dutta et al. (2009)* have studied the effect of different energy : protein relations in the diet on performance of Barbari kids in India. Diets contained 1.98 Mcal/kg DM and 2.16 Mcal/kg DM, and 12% and 14% TP. On treatment with 12% protein, and 2.16 Mcal/kg DM an average daily gain was achieved by 7.2% higher relative to the treatment which included 12% protein and 1.98 Mcal/kg DM, while animals fed diets with 14% TP and 2.16 Mcal/kg/DM achieved growth by 14.5% greater than animals in the control group. In the investigation by *Papi et al., (2011)*, the effects of energy-protein ratio in the diet of male lambs on fattening performance were studied. ME content of treatments was 9.12 : 9.96 : 10.67: 11.34 MJ/kg/DM and protein: 143 : 152 : 161 : 174 g/kg. Lambs, in these treatments, realized the following daily gains: 0.244 : 0.269 : 0.278 : 0.238 kg. Thus, the energy level of 10.67 MJ/kg/DM and protein content of 161 g in diet resulted in the highest daily gain. Poor response of animals to the highest level of energy and protein is explained by incidence of the rumen acidosis. *Karlsson and Martinsson (2011)* indicate that a linear relationship between average daily gain and metabolic energy is stronger than those of the average daily gain and total protein content.

In order to maximize utilization of the genetic potential of high yielding breeds of sheep for meat, in addition to optimal energy: protein ratio in the diet, level of protein non-degradable at the rumen level (NP) is very important. Nutrients whose proteins on a large scale pass through the reticulum-rumen and reach the duodenum non-degraded, cause greater weight gain in lambs, in the presence of sufficient energy (*Zeremski, 1989*). This was confirmed in studies (*Ružić-Muslić 2006, Ružić-Muslić et al., 2007-a, 2007-c, 2007-d*) where the level of non-degradable protein (43 : 51:58%) in mixtures, had significant (P <0.01) influence on the final success of fattening expressed through average daily gain and final body weight of fattening lambs. The highest daily gain (0.227 kg) and the best conversion of dry matter (3.30 kg) were recorded in lambs on treatment with 58% of NP in the mixture. Similar results, in terms of the effects of non-degradable protein sources, have been achieved by *Orskov et al*., *(1971)*, *Miller (1978), Grubić et al*., *(1991), Walz et al*., *(1998), Peter et al*., *(2000)* and *Memiši et al., (2002*). *Grubić et al., (1991)* who analyzed the relationship between average daily gain and protein values expressed in terms of the total, digestible and non-degradable protein in diet, and found the highest correlation coefficient (r = 0.76) between daily gain and the share of non-degradable protein in the diet, slightly lower between gain and crude protein (r = 0.72) and the lowest between gain and digestible protein (r = 0.68). Similar studies have been conducted by *Haddad et al., (2005)* on 30 Awasi lambs, average weight 17.2 kg, fed isoenergy (2.32 Mcal) and isoprotein diets (16% TP), which contained a different proportion of non-degradable 16.1 (I), 22.9 (ii) and 29.9% (III) of the total protein. It was established that lambs on treatment II achieved an average daily gain of 0.265 kg, while the value of the parameter examined in the treatments I and III was: 0.219 and 0.263 kg. It was concluded that the NP 50.3 g/day is needed for maximum growth of Awasi lambs average body weight 17.2 kg. *Galbraith et al. (1997)* have noticed a difference in the rate of weight loss between the two groups of lambs fed isoenergy diets, which differed in terms of supplementation of fish meal as a source of non-degradable protein. Namely, lambs fed diets without the addition of fishmeal have lost 13.3% of body weight in 48 days, while the lambs that were fed fish meal, lost 10.3%.

The effect of the level of energy and protein in the diet on yield and meat quality of lambs

Increased energy levels (7.29 : 7.71 : 7.94 MJ NEM) in isoenergy mixtures (16% tP) for lambs, did not significantly affect the meat yield, the yield of meat per categories and morphological composition of carcass (*(Ružić, 1997; Ružić-Muslić et al. 2009*). The results of these tests are presented in Table 2. The results are consistent with results of *Jordanoski (1981)* who found that the energy level decreased and increased by 8% in treatments A and C with respect to B, had no significant effect on the meat yield of crosses of Ovčepolje x Merino breeds, on treatments A: B: C: 47.45 : 48.21 : 48.92%, as well as the proportion of muscle in the carcass: 60.09 : 60.45 : 59.32%. The influence of the energy levels in the diet of intensively fattened lambs of Tsigai breed was studied by *Negovanović et al., (1983)*. After slaughter, at the average body weight of 31.0 kg, values were determined for yield of 56.36% and 58.61%, which was not affected by the tested treatments. Different concentrations of energy, achieved through different share of concentrate mixture: 50, 70, and 90% in diets for Barbari kids, did not affect the yield and carcass traits (*Ryan et al., 2007*).

Table 2. Meat yield and the proportion of individual tissues,% (*Ružić, 1997*)

Indicators	Energy levels, MJ NEM		
	7.29	7.71	7.94
Warm carcass with offal, kg	57.89 ±2.17	58.63 ±3.20	58.46 ±4.53
Meat yield per categories			
Meat I category,%	40.66 ±1.49	40.35 ±1.60	40.01 ±1.36
Meat II category,%	34.76 ±1.45	36.13 ±1.08	35.48 ±0.75
Meat III category,%	24.18 ±1.41	23.25 ±1.55	24.37±1.74
Share of individual tissues,%			
Muscle tissue	52.05 ±4.11	52.28 ±5.38	53.54 ±3.07
Fat tissue	25.06 ±5.76	27.71 ±4.95	26.80 ±2.75
Bone tissue	21.84 ±0.22	19.04 ±3.99	18.59 ±3.09
Connective tissue	0.640 ±0.26	0.66 ±0.19	0.59 ±0.06

However, in studies by *Abdullah and Musallam (2007)* it is established that goats fed high-energy diets have a higher proportion of body fat, as in the present research. *Papi et al. (2011)* suggest that different levels of energy (9:12 : 9.96 : 10.67 : 11.34 MJ DE/kg DM and protein (143 : 152 : 161 : 174 g/kg) in diets for lambs, had no statistically significant effect on the meat yield: 51.4 : 56.3 : 56.4 : 55.8%, while total fat and subcutaneous adipose tissue were the lowest in the first energy level and the highest in the third level of energy and protein. Rezults of research by *Shadnoush et al. (2004)* showed that reducing energy levels by 10% in mixture for lambs, had no statistically significant effect on carcass characteristics. Similar observations are stated by *Shiran (1995)* in Lori Baktiar lambs fed diets with different energy content: 2.1 : 2.3 : 2.5 : 2.7 Mcal. Share of muscle, fat and bone tissue was not under a significant influence of treatment.

In addition to the energy level, the question of the impact of protein levels in diets for fattening lambs, on the yield and quality of meat, was the subject of research of a significant number of researchers in the country and abroad.

Ljumović (1967), examining the impact of protein content in the supplemental concentrate feed mixtures on fattening performances of crossbred lambs Pivka x Württemberg, concluded that the increase in protein levels of 10 to 18% did not have a statistically justifiable influence (P> 0.05) on the yield: 40.8 and 41.3. *Šokarovski et al. (1988)* found that the proportion of the total protein of 16 and 18% in the mixture, did not affect the yield, given that the values of the analogue treatments were: 46.70 and 47.14%. Similar observations were presented by *Haddad et al. (2011).* In the examination of the impact of the optimal level of total protein: 10, 12, 14, 16 and 18% on growth of Awasi lambs, average body weight of 23.0 kg, the authors have determined the optimal protein content of 16%, and that any increase above this level will not result in improving performance.

Besides the impact of the total protein, the research was conducted related to the impact of non-degradable protein in the diet on yield and meat quality of lambs. *Mekić et al. (1999)* investigated the effect of non-degradable protein (41 : 50 : 60%) in the total mass of diet protein on fattening performance and slaughter results of lamb genotype Ile de France, fattened to the age of 88 days. Average meat yield of warm carcass with head and offal was: 54.16 : 56.54 : 57.36%. Share of I, II and III meat category was: 42.09 : 35.61 : 22.30% in lambs in treatment I and 42.63 : 34.84 : 55.53% for lambs in treatment II and 42.01 : 36.20 : 21.79% for lambs in group III. The level of non-degradable protein in the diet, had no significant effect on the dressing percentage value, meat yield and morphological composition of the carcass side, which has been confirmed in studies *Ružić-Muslić (2006).* The lambs weaned at 60 days of age and an average body weight of about 18.0 kg were fed isoprotein diets (14% TP), but with different proportions of non-degradable protein: 43 : 51 : 58%, to weight of approximately 35.0 kg. Values of warm carcass yield with offal were: 58.70 : 58.02 : 57.42%, respectively. Share of meat of categories I, II and III was 37.27 : 33.19 : 27.78% in treatment I, 37.35 : 32.67 : 29.59% in treatment II and 37.51 : 32.83 : 29.10% in treatment III. The relative share of muscle tissue compared to the weight of three rib cut, was: 43.52 : 42.27 : 41.92%. Fat tissue was present in following values: 26.68 : 31.76 : 30.68%, and bone tissue: 28.23 : 25.06 : 25.93%. The ratio of meat (total muscle and fat tissue) to bone was: 2.5:1, 2.9:1, 2.8:1. The results obtained related to the characteristics of the carcass and the share of individual tissues showed that they were influenced by the treatment, which is consistent with the results of *Atti and Ben Salem (2008).* The explanation lies in the fact that the lambs had similar body weight of empty carcass and carcass composition, as they are slaughtered at similar final weights. These parameters depend mainly on body weight at slaughter (*Colomer-Rocher and Espejo, 1972; Atti and Ben Salem., 2008*).

The results of the study of the surface, chemical and technological characteristics of *Musculus longissimus dorsi* (MLD) are presented in Table 3

Energy levels in isoenergy rations for fattening lambs did not affect the chemical composition and technological properties of meat, as established differences between the treatments were not statistically significant (P> 0.05) (*Ružić-Muslić,2006*). Our results are consistent with data of *Negovanović et al., (1983)*, who examined the impact of the level and the relationship between energy and protein in fattening lambs of Tsigai breed on meat quality, and concluded that the applied nutrition treatment had no significant effect on the chemical properties of meat, considering that the share of water in the samples of *Musculus longissimus dorsi* (MLD) ranged from 75.29-76.28% and of protein 20.77-21.03%.

Table 3. Chemical and technological meat properties (*Ružić,1997*)

	Energy levels, MJ NEM		
	7.29	7.71 7.71 7.94	7.94
		Chemical composition,%	
Water	73.87±0.40	73.29±1.27	73.59±1.16
Proteins	21.5 ±0.80	22.05±0.47	22.19±1.05
Fat	3.51 ±0.80	3.57±1.31	3.02±1.22
Minerals	1.04 ± 0.02	1.06±0.06	1.05±0.04
		Technological properties,%	
Cooking loss	25.3 ±1.78	25.73±1.03	25.86±1.33
Roasting loss	35.95±1.58	34.63 ±3.73	35.22±2.08

Dutta et al. (2009) suggest that different levels of protein (12 and 14%) and energy (1.98 and 2.16ME Mcal/kg DM) in diets for fattening Barbari goats, did not affect the chemical composition of the meat, as there were no significant differences in moisture content, protein, fat and ash content between samples. Several studies have also shown that the chemical properties are independent of the influence of energy and protein level in the diet (*Craddock et al., 1974; Agnihotri et al., 2006; Abdullah and Musallam, 2007*). The level of non-degradable protein in diets for fattening lambs (43 : 51 : 58%) had significant influence on chemical and technological properties of meat, since the amount of water in the investigated MLD samples was: 75.11 : 75.0 : 75.0%. Protein content ranged from 21.46 : 21.62 : 21.77%, while the intramuscular fat content was: 2.28 : 2.16 : 2.12% (*Ružić-Muslić, 2006*). The content of intramuscular fat tissue is associated with the expression of specific sensory properties as well as better culinary quality of meat. *Eric et al., (2003)* state that the content of 2-3% intramuscular fat in muscle is sufficient for acceptable juiciness/succulence and tenderness of meat. When it comes to meat tenderness, the same authors state that it can be changed using a certain type of dietary fat (an important role in it have omega-3 fatty acids) and affect the diaphragm muscle in this way. Flax seed oil contains 60% omega-3 fatty acids and significantly contributes much softer and more tender meat/beef from cattle that were fed with a diet containing linseed oil, compared to meat from cattle that consumed the canola meal (containing 8 -10% omega-3 fatty acids, *Scollan et al., 2001*). So through feeding lambs, the structure and fatty acid composition of lamb meat can be modeled to increase tenderness and content of polyunsaturated fatty acids in fat and muscle tissue of lambs.

Conclusion

Energy or protein deficinacy in the diet prevent full utilization of the genetic potential of lambs. In order to maximize utilization of the genetic potential of high yielding breeds of sheep for meat, in addition to the energy : protein ratio, the level of protein non-degradable at the rumen level is very important.

Nutrients whose proteins pass through reticulum-rumen and reach the duodenum to a greater extent non-degradaed, cause greater weight gain in lambs, in the presence of sufficient energy

Increasing the energy level of isoprotein diets results in an improved growth performance and better feed conversion. However, feeding lambs with a high concentration of energy causes acidosis, which sets new requirements for the ratio of carbohydrate components as well as energy and protein in the diet of fattening lambs.

Different levels of energy and protein in the diet of lambs have no significant impact on the dressing percentage, the yield of meat per categories, morphological composition of carcass sides and chemical and technological properties of meat.

Optimal balance between energy and protein in the diet of lambs optimizes microbial protein synthesis and maximum retention of degradable nitrogen in the rumen and thus affect growth performance.

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Optimizacija nivoa energije i proteina u obrocima za tov jagnjadi

D. Ružić-Muslić, M. P. Petrović, M. M. Petrović, Z. Bijelić, V. Caro Petrović, V. Pantelić, P. Perišić

Rezime

Ovce imaju sposobnost da transformišu hranu relativno niskog kvaliteta u visokokvalitetne proteine animalnog porekla (meso, mleko). Kako bi se povećala efikasnost iskorišćavanja hrane i minimiziralo zagađenje sredine, neophodno je bolje razumevanje potreba jagnjadi u nutrijentima(pre svega u energiji i proteinu), kao i njihovim interakcijama u organizmu.

Optimalan odnos između energije i proteina u obroku jagnjadi optimizuje mikrobiološku sintezu proteina i maksimalno zadržavanje razgradivog azota u buragu.Suvišna količina konzumirane energije u obroku, biće transformisana u mast, obzirom da je stepen porasta mišića i kostiju ograničen.Ishrana jagnjadi, deficitarna u pogledu proteina, dovodi do stvaranja velikih količina masti u organizmu. Opadanje efikasnosti korišćenja energije, pri suficitu proteina u obroku, dovodi se u vezu sa potrošnjom energije za formiranje i ekskreciju uree.

Imajući u vidu navedene činjenice, cilj ovog rada je da prikaže naše, kao i rezultate drugih autora, koji se odnose na optimizaciju nivoa energije i proteina u obrocima za tov jagnjadi.

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