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FEEDING OF LAMBS WITH IMPROVED PELLETED FEED

Srekkjo Gjorgjievski[1], Dimitar Nakov[2*], Aco Kuzelov[2], Tamara Todorovska[3], Fidanka Ilieva[2], Kristina Vanevska[2]

[1]Faculty of Agricultural Science and Food, University "Ss. Cyril and Methodius" in Skopje, Republic of North Macedonia
[2]Faculty of Agriculture, "Goce Delcev" University in Stip, Republic of North Macedonia
[3]Palladium International LLC, Skopje, Republic of North Macedonia
**Corresponding author: dimitar.nakov@ugd.edu.mk*

Abstract

The feed costs are the major expenses for the farmers and the main input that influenced the economics of livestock production. The physical form of diet is one of the main drivers for better digestibility of feed and improved growth performance of farm animals. This study aimed to evaluate the effect of using two different physical forms of diet (ground feed mixtures and pelleted feed mixtures) on the growth performance of fattening lambs. Seventy-two fattening lambs were randomly assigned to two groups with 36 fattening lambs to assess the effects of feeding with pelleted (test group) and ground feed mixtures (control group) on growth performance. Two physical forms (pelleted vs. ground) were equal in ingredient and chemical composition. The duration of the experiment was 42 days. At the beginning of the trial, the lambs in the test group had lower average live body weight and daily gain compared with the lambs in the control group. However, at the end of the feeding trial, the lambs feeding with a pelleted feed mixture had achieved a higher average live body weight and better daily gain. The results from the ANOVA for growth performance of lambs depending from the physical form of diet indicate that there was a statistically significant difference ($p<0.05$) between the test and control groups of lambs in the 5th and the 6th week of the feeding trial. These results support the possibility of using pelleted feeds in intensive fattening of lambs for improving the growth performance, increasing average daily gain and reducing the duration of the fattening period.

Keywords: *fattening lambs, diet, growth performance*

INTRODUCTION

Sheep breeding and fattening of lambs for export have a long tradition in North Macedonia. It is an essential source of income for sheep farmers that require minimum investment, care and management. According to data from the Statistical Yearbook of the Republic of North Macedonia (2021), the sheep population in North Macedonia is around 700.000 sheep with the production of around 3.183 tons of sheep meat. Several factors affect the economy of sheep husbandry. One of them is nutrition, which in the total production costs per unit of livestock product contributes up to 80%. The healthy breeding of livestock and the production of high-quality animal products require a stable supply of complete feed (Xu et al., 2017). In the current intensive rearing system for lambs in many countries are usually fed ground concentrates and roughages in separate or a loose total mixed ration (TMR) (Joy et al., 2008; Rodríguez et al., 2008). The productivity of lambs can be increased by improving nutrition through supplementation of concentrates or compound feed. Complete pelleted feed is a good option in this regard to ensure balanced nutrition for the lambs in intensive rearing system since pellet feeding gives nutrition to lambs in a balanced form (Islam et al., 2017; Zhong et al., 2018). Additionally, seasonal oscillations and climatic variability also affected forage quality, quantity and availability. Moreover, low-quality feed supply has hindered lambs' capacity to

achieve their productivity potential (Nardone et al., 2010; Sultana et al., 2011). The ration's characteristics, such as ingredients, shape, smell, taste, and particle size, could affect the palatability and animals' feed intake. In addition, the physical form of rations is extremely important for efficiency and can affect rumen fermentation. Compared with ground feed, pelleted feed has been regarded as an efficient form for improving the intake, digestibility, feed conversion, and reducing animal ingredient selection. Thus, better digestion and usability of nutrients enhance animal growth and lead to better conversion into animal products (Blanco et al., 2014). Pelletized feed is defined as "agglomerated feedstuff" formed by grinding and extruding individual feed or mixtures (Zimonja et al., 2007), by compaction and passing through sieve openings in a mechanical process. Mechanical pressure can partly break down complicated fibre structures and promote starch gelatinization resulting in increases of feed voluntary intake and nutritional digestibility. These pellet products are easier to handle, tastier, more digestible and usually result in improved feeding results when compared to non-pelleted animal feed (Zhao et al., 2011). Long-term conditioning of pellets (85^0C, for 3 minutes) has a positive effect on their physical quality, reducing power fraction (Svihus and Zimonja, 2011), and improving the hygienic quality of pelleted feeds (Peisker, 2006; Jones, 2011).

Due to the limited natural resources in North Macedonia, and in order to achieve the benefit of the produced compound feed, the present experiment was designed to develop a total mixed ration based on complete pelleted feed and evaluate its utilization for commercial lamb fattening under intensive or stall-fed condition. It was hypothesized that feeding the lambs with complete pelleted feed (pelleted Total Mixed Ratio - PTMR) can enhance growth performance by improving the daily feed intake, average daily gain and feed conversion ratio compared to feeding lambs with ground fodder mixtures (unpelleted Total Mixed Ratio – UPTMR).

MATERIALS AND METHODS

After the total mixing of ingredients, the preparation of the pelleted feed was done in the pelleting machine. The two dietary treatments were PTMR and UPTMR. Both diets had the same chemical and ingredient composition. The approximate diameter of the complete pellet was 6-8 mm.

The feed chemical analysis was done at the Faculty of Agricultural Sciences and Food, Ss. Cyril and Methodius University in Skopje, Republic of North Macedonia. Before the chemical analysis pellet and other feed samples of the experimental diets were dried and ground in a grinding mill through 2-mm sieve. The crude protein (CP) content of the experimental diet was determined using the Kjeldahl method (MKC EN ISO 5983- 1:2010 corrigendum). The moisture content of the feed was determined by drying the samples at 105^0C overnight (MKC ISO 6496:2012), while ash was measured by burning further at 500^0C for 4 hours (MKC ISO 5984:2012). Solvent extraction methods were used for crude fat analysis (MKC ISO 6492:2012). Crude fibre determination in animal feed was done according to the standard MKC EN ISO 6865:2010.

Seventy-two healthy lambs from the indigenous Ovchepolian breed at approximately 15 to 20 days of age with similar body live weights were randomly allocated into two pens with 36 lambs in each pen. The pens were randomly assigned to two dietary treatments. The control treatment group was fed with un-pelleted feed while the test treatment group received a pelleted feed. This experiment consisted of a 42 days fattening period for data collection. Experimental diets were formulated to meet the lambs' nutrient requirements for growing and fattening lambs (Feeding Standard for lambs in growing and fattening according to the Rule book for feed quality in the Republic of North Macedonia, Official Gazette 54/2014). The diet compositions and nutritional contents are shown in Table 1. Sufficient diets were made in one batch to make sure there was no batch effect on dietary treatments. During the whole experimental period, all lambs had free access to the assigned diets. Diets were offered ad libitum. All the animals had free access to fresh tap water. During the whole experimental period, all lambs in a pen were individually measured on days 0, 7, 14, 21, 28, 35 and 42.

Average daily gain (ADG) was calculated for day 0-7 (week 1); 7-14 (week 2); 14-21 (week 3); 21-28 (week 4); 28-35 (week 5) and 35-42 (week 6) by dividing the difference of measured weights by the period interval. The consumed feed by groups were calculated to determine average daily feed intake ADFI. Feed conversion ratio (FCR) was calculated by dividing ADFI with ADG.

Using one-way analysis of variance (ANOVA), the statistically significant differences were tested in the growth performance of lambs in test and control group, depending from the physical form of diet.

RESULTS AND DISCUSSION

Table 1 shows the diet compositions and nutritional contents that were used for fattening lambs during the trial. The pelleted and ground feed had the same ingredient composition.

Table 1. Ingredient composition of experimental mixtures.

Diet Ingredients (% or gr/100gr)	Diet for growing and fattening lambs under 15 kg live weight	Diet for growing and fattening lambs from 15-30 kg live weight
Maize	37.00	36.00
Barley	30.00	42.00
Soybean meal	23.00	12.00
Alfalfa hay	8.00	8.00
Vitamin-mineral premix	2.00	2.00
Total (%)	100.00	100.00
Metabolizable energy, OU/kg DM	1.33	1.31
Crude protein	18.11	14.13

Table 2. Chemical composition of experimental mixtures

Feed	Chemical composition of mixture				
	Moisture, %	Ash, %	Crude proteins, %	Crude fat, %	Crude fiber, %
Un-pelleted ground feed	12.71	4.17	18.16	4.02	4.93
Pelleted feed	12.65	7.37	18.11	4.10	5.08

The lambs in the test group were included in the experiment at the approximate age of 15.80 days, while the lambs in the control group were older 5 days in average (20.68 days). Respectively, the lambs in the control group at the start of the experiment were a little bit heavier than the lambs in the test group (Table 3 and Table 4).

Table 3. Structure of the lamb population involved in the trial.

Period	Groups	N	Days of age	Days in feeding
Initial point	Test	36	15.80	0
	Control	36	20.68	
week 1	Test	36	22.80	7
	Control	36	27.68	
week 2	Test	36	31.80	14
	Control	36	36.68	
week 3	Test	36	38.80	21
	Control	36	43.68	
week 4	Test	36	45.80	28
	Control	36	50.68	
week 5	Test	36	52.80	35
	Control	36	57.68	
week 6	Test	36	59.80	42
	Control	36	64.68	

Table 4. Growth performance of lambs.

Period	Group of lambs	Average lamb live weight (kg)	Weekly weight gain of group (kg)	Daily weight gain of lamb (kg)
Initial point	Test	13.30±1.79		
	Control	13.76±2.21		
week 1	Test	14.90±2.35	57.46	0.32
	Control	14.98±2.28	58.32	0.34
week 2	Test	16.98±2.50	75.02	0.30
	Control	17.27±2.39	82.37	0.33
week 3	Test	19.28±2.03	82.94	0.33
	Control	19.24±1.89	76.61	0.28
week 4	Test	21.59±3.01	82.94	0.33
	Control	21.55±2.71	77.43	0.33
week 5	Test	24.73±2.06	98.71	0.39
	Control	24.17±1.97	92.04	0.37
week 6	Test	27.87±3.34	118.87	0.47
	Control	27.14±3.50	111.94	0.42

However, at the end of the experiment, the lambs in the test group achieved a higher daily weight gain and better feed conversion rate than the lambs in the control group (Table 4 and Table 5). Higher daily weight gain was observed in the pelleted-fed group indicating that pelleting increased the digestibility and non-selectivity in feed intake. A similar result was also found by Roy et al. (2010) and Ahmed et al. (2020).

Table 5. Feed intake and feed conversion rate in groups of lambs.

Period	Group of lambs	Total weekly feed intake by group (kg)	Total daily feed intake by group (kg)	Daily feed intake by lamb (kg)	Feed conversion rate (kg)
Start point	Test	88.20	12.60	0.35	
	Control	100.80	14.40	0.40	
week 1	Test	88.20	12.60	0.35	1.54
	Control	100.80	14.40	0.40	1.73
week 2	Test	88.20	12.60	0.35	1.18
	Control	100.80	14.40	0.40	1.22
week 3	Test	141.75	20.25	0.56	1.71
	Control	148.68	21.24	0.59	1.94
week 4	Test	141.75	23.46	0.65	1.98
	Control	153.72	25.66	0.71	2.32
week 5	Test	166.95	34.27	0.95	2.43
	Control	181.44	36.29	1.01	2.76
week 6	Test	177.03	49.08	1.36	2.89
	Control	189.00	49.89	1.38	3.12

The results from the ANOVA for the growth performance of lambs depending from the physical form of diet indicate that there was a statistically significant difference ($p<0.05$) between the test and control group of lambs in the 5th and the 6th week of the feeding trial (Table 6).

Table 6. Effects of feeding treatment on growth performance of fattening lambs.

Dependent variable: Groups of lambs related to the type of diet			
Source of variation	df between groups	df in groups	F-value
Initial control	1	70	0.428^{NS}
Control week 1	1	70	0.896^{NS}
Control week 2	1	70	0.681^{NS}
Control week 3	1	70	0.955^{NS}
Control week 4	1	70	0.651^{NS}
Control week 5	1	70	0.046*
Control week 6	1	70	0.045*

Ruminants are able to select rations according to their needs or preferences (Askar et al., 2006). Feeding PTMR is a great method to prevent lambs selecting rations when comparing to traditional feeding systems (feeding concentrate and long fibre separately). Although pelleting increases feed production costs by at least 10% (Jahan et al., 2006), it greatly expands potential sources of fibrous feedstuff, saves storage space and labour costs, which promotes development of a precision animal feeding industry. The farmer can choose locally available, cheaper roughage for pelleting according to season, region, and market to reduce production costs.

Feeding PTMR increased growth rate of fattening lambs in the present study, largely attributed to better FCR. The increased ADG (50 g/d) was consistent with the findings of Coufal-Majewski et al. (2017) and Zhang et al. (2019), in which they found that fattening lambs fed completely pelleted mixtures had around 60 g/d greater ADG than those fed mash diets. Consistent with the results of Blanco et al. (2014, 2015) obtained from fattening lambs, the increased ADG and daily feed consumption could reduce the duration of the fattening period, the most direct way to improve efficiency of sheep production in an extensive system. The results of this study demonstrated that feeding fattening lambs PTMR enhanced their growth performance in terms of ADG and better FCR. Zhong et al. (2018) found that feeding PTMR increased the feed consumption and growth rate of fattening lambs.

CONCLUDING REMARKS

In the intensive feedlot rearing system, providing stable and high-quality rations is necessary for improving animal growth performance and producing high-quality animal products. The use of ground feed mixtures in animal nutrition is associated with certain weaknesses that reduce the profitability of livestock breeders. The production of pelleted feed mixtures increases the competitiveness of both the feed producer and the animal breeder. Non-floury (pellets, flakes, popcorn forms) products have advantages in homogeneity, density-hectolitre mass, and also have a longer shelf life, due to the reduced initial number of microorganisms (saprophytic and pathogenic) as a result of the technological process of pelleting, but also the smaller surface of the pellets which is exposed to contamination. Feeding pelleted instead of mash diet increased dry matter intake and average daily gain of fattening lambs without causing any health issues, consequently reducing the duration of the fattening period. This feeding regime is beneficial to increase profitability.

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REFERENCES

Ahmed, S., Rakib, M., Hemayet, M., Roy, B.K., Jahan, N. (2020). Effect of Total Mixed Ration Based Complete Pellet Feed on the Performances of Stall Fed Native Sheep. *SAARC Journal of Agriculture*, *18*(2), 157–166.

Askar, A.R., Guada, J.A., González, J. M., de Vega, A., Castrillo, C. (2006). Diet selection by growing lambs offered whole barley and a protein supplement, free choice: Effects on performance and digestion. Livest. Sci. 101, 81-93.

Ates, S., Keles, G., Demirci, U., Dogan, S., Ben Salem, H. (2017). Biomass yield and feeding value of rye, triticale, and wheat straw produced under a dual-purpose management system. *J. Anim. Sci.* 95, 4893–4903.

Blanco, C., Bodas, R., Prieto, N., Andres, S., Lopez, S., Giraldez, F.J. (2014). Concentrate plus ground barley straw pellets can replace conventional feeding systems for light fattening lambs. *Small Rumin. Res.* 116, 137–143.

Blanco, C., Giraldez, F.J., Prieto, N., Benavides, J., Wattegedera, S., Moran, L., Andres, S., Bodas, R. (2015). Total mixed ration pellets for light fattening lambs: effects on animal health. *Animal* 9, 258–266.

Coufal-Majewski, S., Stanford, K., Mcallister, T., Wang, Y., Blakley, B., Mckinnon, J., Chaves, A.V. (2017). Effects of pelleting diets containing cereal ergot alkaloids on nutrient digestibility, growth performance and carcass traits of lambs. *Anim. Feed Sci. Technol.* 230, 103–113.

Islam, R., Redoy, M., Shuvo, A., Sarker, M., Akbar, M., Al-Mamun, M. (2017). Effect of pellet from total mixed ration on growth performance, blood metabolomics, carcass and meat characteristics of Bangladeshi garole sheep. *Prog. Agric.* 28, 222–229.

ISO 5983 - 1:2010 corrigendum EN ISO 5983 - 1:2010/AC. (2010). Animal feeding stuffs - Determination of nitrogen content and calculation of crude protein content – Part 1: Kjeldahl method. European Committee for Standardization.

ISO 6865. (2010). Animal feeding stuffs - Determination of crude fibre content – Method of intermediate filtration. European Committee for Standardization.

ISO 5984. (2012). Animal feeding stuffs - Determination of crude ash. European Committee for Standardization.

ISO 6492. (2012). Animal feeding stuffs - Determination of fat content. European Committee for Standardization.

ISO 6496. (2012). Animal feeding stuffs - Determination of moisture and other volatile matter content. European Committee for Standardization.

Jahan, M., Asaduzzaman, M., Sarkar, A. (2006). Performance of broiler fed on mash, pellet and crumble. *Int. J. Poult. Sci.* 5, 265–270.

Jones, F.T. (2011). A review of practical Salmonella control measures in animal feed. Journal of Applied Poultry Research 20, 102–113.

Joy, M., Ripoll, G., Delfa, R. (2008). Effects of feeding system on carcass and non-carcass composition of Churra Tensina light lambs. *Small Rumin. Res.* 78, 123–133.

Министерство за земјоделство, шумарство и водостопанство. Правилник за видовите на храна за животни која се става во промет, стандардите за квалитет, дозволените количини на додатоци во храната за животни, начинот на пакување, означување, транспорт и складирање. Службен весник на РМ, бр. 54 од 20.03.2014 година.

Nardone, A., Ronchi, B., Lacetera, N., Ranieri, M.S., Bernabucci, U. (2010). Effects of climate changes on animal production and sustainability of livestock systems. *Livest. Sci.* 130, 57–69.

Peisker, M. (2006). Feed processing - impacts on nutritive value and hygienic status in broiler feeds. In: Proceedings of the Australian Poultry Science Symposium. Australia-Sydney. pp. 7-16.

Rodríguez, A.B., Bodas, R., Prieto, N., Landa, R., Mantecón, A.R., Giráldez, F.J. (2008). Effect of sex and feeding system on feed intake, growth, and meat and carcass characteristics of fattening Assaf lambs. *Livest. Sci.* 116, 118–125.

Roy, B.K., Ahmed, S., Sarker, N.R., Roy, A. and Singh, Y. (2010). The effect of feeding different roughages in pelleted diets on growth performance of Black Bengal Goats. Indian Veterinary Journal, 87:905-907.

Statistical Office of the Republic of Macedonia (2021). Statistical yearbooks of the Republic of Macedonia. Retrieved from http://www.stat.gov.mk

Sultana, N., Hasan, M.N., Iqbal, A., Ershaduzzaman, M., Dey, S. (2011). Effect of intensive and semi-intensive feeding system on productive and reproductive performances of native sheep. *J. Sci. Res.* 3, 693–698.

Svihus, B. and Zimonja, O. (2011). Chemical alterations with nutritional consequences due to pelleting animal feeds: a review. *Animal Production Science*, 51, 590-596.

Xu, T., Xu, S., Hu, L., Zhao, N., Liu, Z., Ma, L., Liu, H., Zhao, X. (2017). Effect of dietary types on feed intakes, growth performance and economic benefit in Tibetan sheep and yaks on the Qinghai Tibet plateau during cold season. *PLoS One* 12, e0169187.

Zhang, C., Li, M.M., Al-Marashdeh, O., Gan, L.P., Zhang, C.Y., Zhang, G.G. (2019). Performance, rumen fermentation, and gastrointestinal microflora of lambs fed pelleted or unpelleted total mixed ration, *Anim. Feed Sci. Technol*, 253, 22-31.

Zhao, X.H., Zhang, T., Xu, M., Yao, J.H. (2011). Effects of physically effective fiber on chewing activity, ruminal fermentation, and digestibility in goats. J. Anim. Sci. 89, 501-509.

Zhong, R.Z., Fang, Y., Zhou, D.W., Sun, X.Z., Zhou, C.S., He, Y.Q. (2018). Pelleted total mixed ration improves growth performance of fattening lambs. *Anim. Feed Sci. Technol.*, S0377840118303304-.

ИСХРАНА НА ЈАГНИЊА СО ПОДОБРЕНИ ПЕЛЕТИРАНИ КРМНИ СМЕСИ

Срећко Ѓорѓиевски[1], Димитар Наков[2*], Ацо Кузелов[2], Тамара Тодоровска[3], Фиданка Илиева[2], Кристина Ваневска[2]

[1]Факултет за земјоделски науки и храна, Универзитет „Св. Кирил и Методиј" - Скопје, Република Северна Македонија

[2]Земјоделски факултет, Универзитет „Гоце Делчев" - Штип, Република Северна Македонија

[3]Паладиум ЛЛЦ, Скопје, Република Северна Македонија

**Контакт-автор: dimitar.nakov@ugd.edu.mk*

Резиме

Исхраната на фармските животни претставува најголемиот трошок за фармерите и главен фактор кој влијае врз економиката на сточарското производство. Физичката форма на добиточната храна има значајно влијание врз искористливоста на хранливите материи и постигнување на добри производни резултати во сточарското производство. Главна цел на истражувањето беше воведување на подобрена и избалансирана пелетирана крмна смеса за гоење на јагнињa. За следење на производните резултати во гоењето на јагнињата беа формирани две групи по 36 јагнињa. Јагнињата во тест групата беа хранети со пелетирана крмна смеса, а јагнињата во контролната група со брашнеста крмна смеса. Товот на јагнињата во експериментот траеше 42 денови. Забележително беше дека на почеток на експериментот јагнињата во тест групата имаа помала просечна маса и помал прираст во споредба со јагнињата во контролната група. Меѓутоа, на крајот од експериментот јагнињата во тест групата постигнаа поголема просечна телесна тежина и подобар прираст во споредба со јагнињата во контролната група. Анализата на варијанса (ANOVA) за производните показатели на јагнињата, зависно од исхраната со пелетирани или брашнести крмни смеси, покажа дека постои статистички значајна разлика ($p<0,05$) во средните вредности од производните показатели меѓу групите јагнињa при направената контрола во петтата и шестата недела од експериментот. Употребата на пелетирани крмни смеси во овчарското производство, во интензивни услови на одгледување и тов на јагнињa, овозможува подобрување на производните перформанси, зголемување на дневниот прираст и скратување на времето на гоење на јагнињата.

Клучни зборови: *исхрана, гоење на јагнињa, производни резултати*