Original scientific paper
10.7251/AGRENG1902120G
UDC 636.32/.38:636.085(38)

SUBSTITUTION OF SOYBEAN MEAL WITH LOCAL PRODUCED LEGUME FORAGES IN EWES RATIONS

Vasileios GREVENIOTIS[1*], Dimitrios KANTAS[1], Constandinos DELIGIANNIS[1], Theofanis GEMTOS[2], Athanasios MAVROMATIS[3], Evangelia SIOKI[4]

[1]Department of Agricultural Technologists, Division of Animal Production, Technological Educational Institution (T.E.I.) of Thessaly, 41110 Larissa, Greece
[2]Department of Agriculture, Crop Production and Rural Environment, School of Agricultural Sciences, University of Thessaly, 38446, N. Ionia, Volos, Greece
[3]Department of Agriculture, Faculty of Agriculture, Forestry and Natural Environment, Aristotle University of Thessaloniki, Thessaloniki, Greece
[4]Department of Agricultural Economics, Aristotle University of Thessaloniki, Thessaloniki, Greece
*Corresponding author: vgreveni@mail.com

ABSTRACT

Nutrition of intensive sheep farming in Greece is based mainly on feeding forages and concentrates in the stable, while grazing is provided in a low extend. Feeding cost is the major cost factor and from the protein supplementation side is based on alfalfa hay and soybean meal. The aim of the study was to investigate the substitution of soybean meal with local produced legumes forages. Thirty ewes of the "Karagouniko" breed were split in three groups of ten animals each. In the first group (control group), nutrition was based on alfalfa hay and soybean meal. In the second group, alfalfa hay and soybean meal were entirely substituted with vetch hay. In the third group, alfalfa hay was completely substituted with peas hay and the soybean meal inclusion was increased. Body weight was measured in the beginning and at the end of the trial period. Feed consumption and milk production were recorded daily and milk quality was analyzed weekly. No significant differences were found for all the parameters mentioned. Substitution of imported soybean meal with locally produced legumes is possible and will be an advantage in the differentiation of Greek sheep milk. The economic analysis showed that in farm, the cultivation of vetch and pea hay is more preferable than alfalfa.

Keywords: *Vetch, Peas, Karagouniko, Greece.*

INTRODUCTION

The nutrition of small ruminants reared in traditional farms in Greece is based mainly on soybean meal as a protein source. Among other protein sources, peas have been widely used as livestock feed (Loe *et al.* 2004; Van der Pol *et al.* 2008, Tufarelli *et al.* 2012). For legume seeds to be more efficiently utilized in ruminant

diets as alternative protein source, under certain circumstances, the rate and extent of degradation must be reduced without diminishing the extent of their intestinal digestion (Yu et al., 2002). Straw and hay, mainly originating from wheat, are utilized in Mediterranean countries for feeding small ruminants Hay from leguminous plants could be safely utilized as fiber source for sheep, provided at certain levels. However, its availability depends on climate and other factors (Awawdeh, 2011). Vetch (*Vicia sativa* L.) has been reported in some research works as a component in lamb diet (Gul *et al*., 2005) with satisfactory results, although it has been also shown to have low oil content (Aksoy, 2007). Haddad and Husein (2001) reported that vetch straw had a better nutritive value as fiber source for lambs in comparison to wheat straw, but less than alfalfa or lentil straw. Vicia could be used as a feed for livestock (Kaya *et al*., 2013). Some studies showed no differences of feeding vetch to sheep and that vetch has the potential to be used as an alternative source of high-protein fresh forage in spring to support lactating ewes and their lambs (Marley, 2016). Certain pre-processing methods are required in order to increase the efficiency and digestibility of the plant (Huang *et al.*, 2017). Liu *et al.,* (2018) reported the positive role on lamb nutrition of another legume, alfalfa (*Medicago sativa* L.) a common cultivated crop in many countries. Rong *et al.,* (2014).reported that lambs fed alfalfa had higher intake of dry matter, organic matter, crude protein and fiber than lambs fed only grass hay/crop straw.
The aim of the study was to estimate the substitution of soybean meal with locally produced legume forages based on alfalfa and vetch.

MATERIALS AND METHODS

The study was carried out in the farm of TEI of Thessaly, in Larissa, Greece. Thirty lactating ewes of the "Karagouniko" breed were split in three groups of ten animals each. TMR rations were provided to all experimental animals in the quantity presented in table 1 per animal. In the first group (control group), nutrition was based on alfalfa hay and soybean meal. In the second group, alfalfa hay and soybean meal were totally substituted with vetch hay. In the third group, alfalfa hay was totally substituted with peas' hay and soybean meal. Analysis of diets is presented in Tables 1. Vetch hay and pea hay were analyzed for their moisture content, total nitrogenous substances, total fat, fiber and ash. Nutritional value for each diet is presented in Table 2. Body weight was measured in the beginning and at the end of the trial period. Feed consumption and milk production were recorded daily and milk quality was analyzed weekly. Analysis of milk samples took place in the Laboratory of Milk Quality Control of Larissa, of the Hellenic Agricultural Organization (ELGO – DEMETER), using a Milkoscan 4000 (A/S N. Foss Electric, Hillerod, Denmark). All samples were conserved in potassium dichromate solution and analyzed within 5 days after collection. All ewes were lactating and each group was kept in a pen of 20 m^2 area. Daily feed was given in two meals and water was available *ad libitum*. Records for not-consumed-feed were kept throughout the experimental period. Additionally, barley straw and alfalfa hay were

given every day. General linear model was used to statistically analyse the data through SPSS ver. 17 according to Steel and Torrie (1980).

Table 1. Feed composition (kg per feedstuff)

	Group A Control	Group B (Vetch)	Group C (Peas)
Balancer	0.0230	0.0230	0.0230
Barley straw	0.5000	0.1345	0
Corn	0.5000	0.4265	0.2010
Barley	0.2000	0.2000	0.1400
Marble mill	0.0115	0	0
Wheat bran	0.1833	0	0.2700
Soybean meal 45%	0.1430	0	0.2900
Phosphate mono-calcium	0.0081	0.0276	0.0570
Alfalfa hay	0.6031	0	0
Vetch hay	0	1.5413	0
Pea hay	0	0	1.1791
Cost (per Kg)	0.406€	0.401€	0.402€

Table 2. Nutritional value for each diet

	Group A Control	Group B (Vetch)	Group C (Peas)
Dry Matter (DM) (Kg)	1.97	2.04	1.94
Ash (g)	150.56	188.32	208.72
Total nitrogen (g)	300.00	322.30	301.18
Total fat (TF) (g)	48.38	57.43	46.84
Crude Fibre (CF) (Kg)	0.43	0.45	0.44
Neutral detergent fibre (NDF) (Kg)	0.76	0.73	0.78
Metabolizable energy(ME) (MJ)	11.98	11.98	11.97
Ca (g)	23.30	27.89	40.04
Mg (g)	3.31	3.68	4.33
P (g)	12.26	13.76	19.36
Na (g)	3.80	5.22	3.18
TF (g) : DM (Kg)	24.59	28.17	24.16
CF (Kg) : DM (Kg)	0.22	0.24	0.23
Ca (g) : P (g)	1.90	2.03	2.07
Mg (g) : P (g)	0.27	0.27	0.22

RESULTS AND DISCUSSION

Problems with feed intake and consumption of the daily rations were not recorded in any experimental group. Reed *et al.* (1990) also reported that vetch hay had been

consumed fully by male sheep. For the other parameters recorded the results are as follows:

a) Body weight

The body weight of the animals was the same for all groups at the beginning of the study, as well as at the end. There was no statistically significant difference noted, at significance level of 5%.

The body weight loss during the experimental period was 2.98 ± 0.80 kg for the control group, 2.72 ± 0.95 kg for group B (vetch) and 3.04 ± 1.00 kg for group C (pea), again without statistically significant difference at a 95% confidence level.

Table 3. Average body weight

Group	Beginning	End
Group A (Control)	58.17 [a] ± 1.01	55.19 [a] ± 1.15
Group B (Vetch)	57.84 [a] ± 0.74	55.12 [a] ± 1.25
Group C (Peas)	57.96 [a] ± 0.89	54.92 [a] ± 1.03

There is not a significant difference among different groups.

b) Milk yield and composition

The average daily milk yield throughout the period was: 1.42 ± 0.17 kg for the control group, and 1.41 ± 0.18 kg for group B (vetch hay) and 1.39 ± 0.18 kg for group C (pea hay). Tables 3 and 4 present the average daily milk yield on a weekly basis and milk composition, respectively.

Table 3. Average daily milk yield per week

Group	Week 1	Week 2	Week 3	Week 4
Group A (Control)	1.64 [a] ± 0.10	1.46 [a] ± 0.11	1.33 [a] ± 0.11	1.27 [a] ± 0.05
Group B (Vetch)	1.67 [a] ± 0.07	1.40 [a] ± 0.09	1.30 [a] ± 0.07	1.26 [a] ± 0.07
Group C (Peas)	1.65 [a] ± 0.07	1.41 [a] ± 0.08	1.29 [a] ± 0.08	1.23 [a] ± 0.06

There is not a significant difference among different groups.

Table 4. Milk composition

		Week 1	Week 2	Week 3	Week 4	Total
Fat	Group A Control	6.48 [a] ± 0.28	6.61 [a] ± 0.26	6.86 [a] ± 0.23	6.93 [a] ± 0.30	6.72 [a] ± 0.32
	Group B (Vetch)	6.44 [a] ± 0.27	6.60 [a] ± 0.24	6.83 [a] ± 0.29	6.82 [a] ± 0.21	6.67 [a] ± 0.29
	Group C (Peas)	6.46 [a] ± 0.25	6.61 [a] ± 0.25	6.91[a] ± 0.25	6.92 [a] ± 0.26	6.72 [a] ± 0.31
Protein	Group A Control	5.23 [a] ± 0.27	5.31 [a] ± 0.31	5.46 [a] ± 0.31	5.56 [a] ± 0.37	5.39 [a] ± 0.30
	Group B (Vetch)	5.18 [a] ± 0.28	5.21 [a] ± 0.24	5.42 [a] ± 0.28	5.51 [a] ± 0.29	5.33 [a] ± 0.25
	Group C (Peas)	5.14 [a] ± 0.26	5.20 [a] ± 0.29	5.37 [a] ± 0.30	5.45 [a] ± 0.35	5.29 [a] ± 0.28

Lactose	Group A Control	5.02 [a] ± 0.27	5.01 [a] ± 0.31	4.88 [a] ± 0.31	4.81 [a] ± 0.37	4.93 [a] ± 0.32
	Group B (Vetch)	4.91 [a] ± 0.28	4.84 [a] ± 0.24	4.77 [a] ± 0.28	4.67 [a] ± 0.29	4.80 [a] ± 0.28
	Group C (Peas)	5.00 [a] ± 0.23	4.91 [a] ± 0.28	4.91 [a] ± 0.29	4.91 [a] ± 0.32	4.93 [a] ± 0.28

There is not a significant difference among different groups.

Weight loss, milk yield and quality characteristics of the milk produced, although showing small numerical differences in means, were not statistically significant at a 95% confidence level. Therefore, neither vetch hay or pea hay addition, in order to substitute soybean meal in ewes' diet, affected those characteristics. The results from the present study are in accordance with the results obtained by Marley et al. (2016) for grazing ewes, although in our case the animals were kept under intensive conditions and in contrast with the results obtained from lamps or goat trials. Abbeddou et al., (2011) found that vetch hay was the most valuable forage in terms of energy and protein supply in fat-tailed sheep, concerning the nutritional composition. Berhane and Eik (2006), found a positive effect of vetch hay supplementation that increased milk yield by up to 50%, but decreased percent fat and total solids in the milk of both Begait and Abergelle goats.

The results show that there were no differences between the experimental groups, with regard to the mean body weight of the ewes, and the daily milk yield. This was expected, since the diets of the experimental groups were about of the same nutritional value, due to the study design. In group B (vetch hay), it was possible to completely replace both alfalfa and soybean meal and even offer a larger amount of nitrogenous substances in the final ration. In the case of pea hay, replacement of alfalfa hay has led to increased participation of the soybean meal in the final ration.

CONCLUSION

Based on the current hay market prices for sheep farmers, the cost of rations for all experimental groups is about the same. In the case of self-production, however, it appears that the cultivation of vetch and peas as hay is more advantageous than that of alfalfa.

The substitution of imported soybean meal with local vetch hay may be promising for the "identity" of local production and especially for the cheese factory, as it can enhance the originality and marketing of products.

REFERENCES

Abbeddou S., Rihawi S & Hess H.D., Iniguez L., Mayer C.A., Kreuzer M. (2011). Nutritional composition of lentil straw, vetch hay, olive leaves, and saltbush leaves and their digestibility as measured in fat-tailed sheep. Small Ruminant Research. 96:126-135.

Aksoy E. (2007). Bovine Spongiform Encohalopaty (BSE). Sigirlarin Sungerimsi Beyin Hastaligi. Deli Dana Hastaligi. http://www.etlikvet.halksagligi/bse.htm.

Awawdeh M.S. (2011). Alternative feedstuffs and their effects on performance of Awassi sheep: a review. Tropical animal health and production. 43/(7):1297-1309.

Berhane G., Eik L.O. (2006). Effect of vetch (Vicia sativa) hay supplementation to Begait and Abergelle goats in northern Ethiopia: I. Milk yield and composition. Small Ruminant Research, 64(3):225-232

Gul M., Yoruk M.A., Macit M., Esenbuga N., Karaoglu M., Aksakal V., Aksu M.I. (2005). The effects of diets containing different levels of common vetch (*Vicia sativa*) seed on fattening performance, carcass and meat quality characteristics of Awassi male lambs. Journal of the Science of Food and Agriculture. 85:1439–1443.

Haddad S.G., Husein M.Q. (2001). Nutritive value of lentil and vetch straws as compared with alfalfa hay and wheat straw for replacement ewe lambs. Small Ruminant Research. 40/(3):255-260.

Huang Y.F., Gao X.L., Nan Z.B., y Zhang Z.X. (2017). Potential value of the common vetch (Vicia sativa L.) as an animal feedstuff: a review. Journal of animal physiology and animal nutrition. 110/(5):807-823.

Kaya A., Yoruk M.A. Esenbuga N., Temelli A., Ekinci O. (2013). The Effect of Raw and Processed Common Vetch Seed (*Vicia sativa*) Added to Diets of Laying Hens on Performance, Egg Quality, Blood Parameters and Liver Histopathology. Journal of Poultry Science. 50:228–236.

Liu C., Qu Y.-H., Guo P.-T., Xu Ch.-Ch., Ma Y., Luo H-L. (2018). Effects of dietary supplementation with alfalfa (Medicago sativa L.) saponins on lamb growth performance, nutrient digestibility, and plasma parameters Animal Feed Science and Technology. 236:98-106.

Loe E.R., Bauer M.L., Lardy G.P., Caton J.S., Berg P.T. (2004). Field pea (*Pisum sativum*) inclusion in corn-based lamb finishing diets. Small Ruminant Research 53:39-45

Marley C., Theobald V., Fychan A., Thomas B., Gethin A., Scott M., Sanderson R., McCalman H. (2016). Utilising common vetch (*Vicia sativa*) as a source of forage protein for grazing ewes. In Höglind M., Bakken A.K., Hovstad K.A., Kallioniemi E., Riley H., Steinshamnm H. & Østrem L. (eds), "The multiple roles of grassland in the European bioeconomy". 26th General Meeting of the European Grassland Federation Norwegian Institute of Bioeconomy Research, Norway, Trondheim. 04 September 2016. pp. 516-518.

Reed J.D. Soller H., Woodward A. (1990). Fodder tree and straw diets for sheep: intake, growth, digestibility and the effects of phenolics on nitrogen utilisation. Animal Feed Science and Technology 30/(1-2):39-50.

Rong Y., Yuan F., Johnson D.A. (2014). Addition of alfalfa (Medicago sativa L.) to lamb diets enhances production and profits in northern China. Livestock Research for Rural Development. Volume 26, No 224. Retrieved January 23, 2015. http://www.lrrd.org/lrrd26/12/rong26224.htm

Steel R.G.D., Torrie J.H. (1980). Principles and Procedures of Statistics. A biometrical approach. 2nd edition. McGraw-Hill, New York, USA,

Tufarelli V., Naz S., Khan R.U., Mazzei D., Laudadio V. (2012). Milk quality, manufacturing properties and blood biochemical profile from dairy cows fed peas (*Pisum sativum* L.) as dietary protein supplement. Archives Animal Breeding, 55/(2):132-139.Yu P., Goelema J.O., Leury B.J., Tamminga S., Egan A.R. (2002). An analysis of the nutritive value of heat processed legume seeds for animal production using the DVE/OEB model: a review. Animal Feed Science and Technology 99/(1-4):141-176.

Vander Pol M., Hristov A.N., Zaman S., Delano N. (2008). Peas can replace soybean meal and corn grain in dairy cow diets. Journal of Dairy Science 91:698-703