

Effect of Broccoli Steam and Leaves on Sheep Performance and Milk Production

Nawzad Mohammed Aziz

Department of Animal Resources, College of Agricultural Engineering Sciences, Salahaddin University, Erbil, Kurdistan Region Iraq.

Corresponding author E-mail: nawzad.aziz@su.edu.krd

Abstract:

This research was conducted at the research field belongs to Animal Resources department, College of Agriculture, Salahuddin, in order to evaluate the effects of adding different amount of broccoli waste to the ration in diets for lactating ewes. The studied traits included the body weight gain, daily milk production and milk composition. The groups (treatments) were control (without Broccoli wastes), T1 (250 g and 750 g of Broccoli wastes were added in the first and second months respectively) and T2 (500 g and 1000 g of Broccoli wastes were added in the first and second months respectively). SAS programme used to analyze the collected data, and correlation coefficients among studied traits were also estimated.

The effect of adding Broccoli wastes levels on body weight gain and average daily milk production showed significant differences among all treatments with an average 3.583 kg and 827.84 g respectively. Body weight gain of ewes having T1 was significantly higher than the other groups. The ewes fed on T1 surpassed those fed on T2 and control groups in the percentages of fat and solid non-fat of their milk, while the differences in protein and lactose percentages were not significant due to different treatments. All traits of milk composition yield were registered significantly higher in T2 comparing with those registered in both groups T1 and control.

The lowest value (-0.47) of correlation was calculated between ADMP and lactose % and was not significant, while the highest correlation (0.81) registered between lactose and solid non-fat percentages.

Keywords: Kurdiewes, broccoli wastes, body weight gain, milk production and composition.

Introduction:

The Karadi (Kurdi) breed of sheep considered as the most popular at the northeastern mountain, and villages of Kurdistan region of Iraq. Milk yield is very necessary for lamb survival and growth and approximately 70% of the variation in weaning weight is due to the variation in milk intake, so increasing its production and improving its quality are important (Oramari and Hermiz, 2012).

To face protein shortage problem and to decrease the feeding costs, as well due to the currently increasing cost of protein feed ingredients, it is very important to use untraditional feed ingredients (Mahmoud, 2016). Agri-food by-products, whether coming from stubbles left in the field or the canning industry, constitute a supply of alternative forage for livestock, allowing the use of local resources and reducing feed costs without damaging animal performance and productivity, as long as the rations that include these feeds are balanced. The use of these by-products can also be a solution to minimize residues produced by the agro-food industry and thus reduce removal costs and emissions of polluting gases caused by uncontrolled fermentation of these agricultural wastes. In addition, the use of agro-food by-products reduces the land and supplies dedicated to the development of livestock feed, thus aiding the circular economy (Monllor et al., 2020). The use of local resources, especially if recovered from by-products, may significantly enhance milk sustainability. Ahuja et al. (2011) stated that the broccoli by-product (*Brassica oleracea*) that belonging to the family Brassicaceae used as untraditional feed ingredients in the form of dried whole plant considered as a rich source of chemo

protective molecules including glucosinolates, which considered a class of organic compounds that contain sulfur and nitrogen (Omirou et al., 2009). The inclusion of agricultural by-products in ruminant diets does not have to affect the sensory quality of dairy products (Monllor et al., 2020).

Broccoli (*Brassica oleracea* L. var. *italica*) byproduct (BB) comprised of stem and leaves could be an alternative. The broccoli flower bud is harvested for human consumption and more than two-thirds of the plant (outer leaves and stems) is left in the field (Partovi et al., 2020). USDA (2011) reported that this food is low in saturated fat, and very low in cholesterol. It is also a good source of protein, thiamin, niacin, pantothenic acid, calcium, iron, and selenium and a very good source of vitamin A, Vitamin C, riboflavin, vitamin B6, magnesium, phosphorus, potassium and manganese. These materials are often regarded as crop remains and a small percentage is used without treatment in animal feeds. Campas-Baypoli et al. (2009) presents an alternative to utilize the broccoli residues produced in the field, which constitutes the largest volume of vegetable and represents a problem for the farmer, with respect to its handling and disposal. Broccoli (*Brassica oleracea* var. *italica*) crops generate large quantities of by-products. Globally, 20 million tons of cauliflower and broccoli crops are produced yearly and 15 million tons of byproduct is left in the field (Jian et al., 2017). According to Food and Agriculture Organization of the United Nations (FAO, 2019), 25,984,758 t of broccoli were harvested worldwide in 2017. Since fresh BB contains about 186 g/kg dry matter (DM) soluble sugars (Wadhwa et al., 2006), mixing BB with dry feeds, such as straw, before ensiling probably results in good preservation of this forage (Jian et al., 2017). Fresh BB is a good source of crude protein (CP; 270 g/kg DM) with relatively low neutral detergent fiber (NDF; 280 g/kg DM) and a metabolizable energy (ME) content of 9.87 MJ/kg DM (Hu et al. 2011) and an *in vivo* organic matter (OM) digestibility of 86.9% (Wadhwa et al. 2006).

Therefore, this study was carried out to evaluate the effects of adding different amount of broccoli waste to the ration in diets for lactating ewes depending on some performance traits including their body weight gain, daily milk production and milk composition.

Materials and Methods:

This research was conducted at the research field belongs to Animal Resources department, College of Agriculture, Salahaddien. Twelve Kurdi (Karadi) ewes aged 2-3 years were distributed randomly into three groups to ensure a non-significant difference between the groups with average body weight 62.75 kg (Table 3), 4 ewes in each group. The groups (treatments) were control (without Broccoli wastes), T1 (250 g and 750 g of Broccoli wastes were added in the first and second months respectively) and T2 (500 g and 1000 g of Broccoli wastes were added in the first and second months respectively). For two months before the experiment, the daily amount of feed intake (feed concentrate) in each groups were 8 kg (2 kg for each individual), then for the first and second months of the experiment were raised to 10 kg for each groups (2.5 kg for each heed) until the end of the experiment. Table 1 includes the sample analysis report of the feed and table 2 contains the feed concentrate analysis.

Table 1. Sample Analysis Report:

References	Results (%)	Tests
IR 600 (KJELDAHL)	17.6	Protein
ISO 5984	4.7	Ash
By Oven (Mommert)	8.64	Moisture
ISO 6492 EEG (SOXELETT)	0.7	Fat
ISO 5498/1981	6.3	Fiber

Table 2. Feed Concentrate Analysis:

Results (%)	Compositions
50	Barley
28	Bran

<http://annalsofscb.ro>

10	Soybean
10	Corn
1	Lime
1	NaCl

All individuals were weighed weekly and the body weight gain calculated as a difference between the initial body weight and the final body weight at the end of the experiment. Ewes were milked individually twice daily, total milk yield per day was calculated by adding the milk yield of the second milking in the evening to that of the first milking in the morning. Milk Composition with approximately 10 ml of raw milk was collected from each ewe weekly. Milk samples were collected in order to determine the percentages of fat, protein, lactose, solid non-fat by apparatus EKO TOTAL MILK¹. Milk samples were obtained from both milk produced by each ewe in the morning and evening to get a homogeneous mixture of milk and then transferred to the laboratory for chemical analysis. The traits of milk composition yield were calculated by multiplying their percentages with the daily milk production.

The statistical programme SAS (2005) used to analyze the collected data to determine if there were any significant effect for the treatment on the studied traits and assuming the following model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where:

Y_{ij} = the individual observation,

μ = overall mean,

T_i = effect of i^{th} treatment, $i = \text{Co, T1, and T2}$,

e_{ij} = error term NID (0, σ^2e).

Duncan multiple range test (Duncan, 1959) used diagnosing the significant differences between the levels of the treatment. Correlation coefficients among body weight gain, average daily milk production and milk composition (percentages of fat, protein, lactose and solid non-fat) were also estimated.

Results and Discussion:

The effect of adding Broccoli wastes levels on body weight gain showed significant differences among all treatments with an average 3.583 ± 0.763 kg (Table 3). Body weight gain of ewes (7.000 kg) having T1 was significantly higher than those in control (2.500 kg) and T2 (1.250 kg) groups. Earlier studies conducted using male crossbred lambs (Mahmoud, 2016) and lactating goat (Monllor et al., 2020) fed on different percentages of broccoli by-product and revealed to a highly significant differences in their body weight gain and the average daily weight gain were significantly higher with broccoli diets compared with control one. They indicated that body weight is an indicator of the health status of the animal and optimizing the inclusion of by-products involves assuring the proper health status of the goats. While, Partovi et al., 2020) found that average daily gain as well the final weight of lambs didn't affect by feeding the experimental diets when they evaluated the effects of a mixed BB-wheat straw silage (BBWS) substituted only up to 20% of the forage ration in finishing diets for fattening lambs.

The overall average daily milk production resulted from this study was 827.84 ± 76.38 g and the milk produced daily increased significantly with increasing the amount of Broccoli waste (Table 3). The highest daily milk production 1155.45 g were recorded for T2 followed by T1 (789.01) and control (539.06) groups and the differences among them were significant. Also Monllor et al. (2020) presented a highly significant differences in milk yielded from goat fed on different levels of the diet, where a decrease in milk yield was observed as the percentage of inclusion of by-products increased. Yi et al. (2015) concluded that replacing concentrate mixture with 20% pelletized broccoli by-products increased milk production numerically and increased milk fat

¹ Eon Trading LLC, USA.

content significantly in lactating dairy cows. The increased use of broccoli by-product in the future would be beneficial for developing a more efficient use of resources and make ruminant milk production more environmentally friendly (Mahmoud, 2016). Generally, Madrid et al. (2002) suggested that the effective use of by-products from agricultural industries as feedstuffs is dependent on several factors including the production, nutrient composition in relation to the nutrient requirements of the available animals, processing cost, and the marked availability of competitively priced feedstuffs.

Table 3. Means \pm standard errors for the effects on body weight gain (kg) and average daily milk production (g).

Treatment:	Initial Body Weight (kg)	Body Weight Gain (kg)	Average Daily Milk Production (g)
Overall mean	62.75 \pm 1.67	3.583 \pm 0.763	827.84 \pm 76.38
Co.	65.00 \pm 2.12a	2.500 \pm 0.288b	539.06 \pm 5.98c
T1	59.25 \pm 1.65 a	7.000 \pm 0.408 a	789.01 \pm 6.13 b
T2	64.00 \pm 4.14a	1.250 \pm 0.250c	1155.45 \pm 3.80 a

Means having different letters within each column differ significantly ($P < 0.05$).

The results of milk composition are presented in table (4), the overall mean of the percentages of fat, protein, lactose and solid non-fat were 3.398 \pm 0.06, 4.339 \pm 0.06, 5.990 \pm 0.06 and 10.991 \pm 0.10 % respectively. It could be shown that the ewes fed on T1 surpassed those fed on T2 and control groups in the percentages of fat and solid non-fat of their milk, while the differences in protein and lactose percentages were not significant due to different treatments. Table (5) includes the traits of milk composition yield namely fat, protein, lactose and solid non-fat and their overall means were 28.226 \pm 2.64, 36.216 \pm 3.64, 49.409 \pm 4.41 and 91.120 \pm 8.33 g respectively. All traits of milk composition yield were registered significantly higher in T2 comparing with those registered in both groups T1 and control. The milk composition yields in T2 were 38.688, 51.799, 67.881 and 125.886 g for the traits in the same order as mentioned above. These results were not the same as in the percentages and might that could be due to the differences in daily milk production. Monllor et al. (2020) used different levels of the diet in feeding goat to investigate if there any effect on milk composition traits and reported that the diet only had significant effects on fat % while its effect on protein, lactose and solid non-fat were not significant.

Table 4. Means \pm standard errors for the effects on milk composition percentages.

Treatment:	Fat (%)	Protein (%)	Lactose (%)	Solid Non Fat (%)
Overall mean	3.398 \pm 0.06	4.339 \pm 0.06	5.990 \pm 0.06	10.991 \pm 0.10
Co.	3.256 \pm 0.06b	4.194 \pm 0.02a	6.060 \pm 0.06a	10.865 \pm 0.09b
T1	3.648 \pm 0.07 a	4.347 \pm 0.15 a	6.074 \pm 0.15 a	11.288 \pm 0.21a
T2	3.291 \pm 0.08b	4.475 \pm 0.04a	5.835 \pm 0.06a	10.819 \pm 0.08b

Means having different letters within each column differ significantly ($P < 0.05$).

Table 5. Means \pm standard errors for the effects on milk composition yield (g).

Treatment:	Fat (g)	Protein (g)	Lactose (g)	Solid Non Fat (g)
Overall mean	28.226 \pm 2.64	36.216 \pm 3.64	49.409 \pm 4.41	91.120 \pm 8.33
Co.	17.458 \pm 0.44c	22.582 \pm 0.28c	32.398 \pm 0.49c	58.505 \pm 0.85c
T1	28.532 \pm 0.61b	34.267 \pm 1.29b	47.949 \pm 1.40b	88.969 \pm 2.00b
T2	38.688 \pm 0.97a	51.799 \pm 0.33 a	67.881 \pm 0.59 a	125.886 \pm 0.51a

Means having different letters within each column differ significantly (P<0.05).

Table (6) includes the correlation coefficients calculated between the body weight gains (BWG), average daily milk production (ADMP) and milk composition percentages. The lowest (-0.30) and highest (0.80) correlations for BWG were registered with ADMP and fat % respectively. Correlations between ADMP with milk compositions including fat, lactose and solid non-fat percentages were all negative and non-significant, while that with protein % was positive and significant (0.59). The calculated correlations among milk composition traits were all positive and non-significant except those between solid non-fat % with each of fat % (0.64) and lactose % (0.81) which was significant. Such positive correlation means any increase of one trait will cause an increasing in the second trait, while the negative correlation means any increase of the first trait will cause a decreasing in the second trait. Most of the earlier studies revealed to the same trend of the correlation among studied traits (Pavic et al., 2002; Sinapis et al., 2007; Kuchtik et al., 2008; and Oramari and Hermiz, 2012).

Table 6. Correlations between body weight gain (BWG), average daily milk production (ADMP) and milk compositions in EWES.

Traits	ADMP	Fat %	Protein %	Lactose%	Solid Non Fat%
BWG	-0.30	0.80 **	-0.01	0.44	0.70 **
ADMP		-0.02	0.59 *	-0.47	-0.12
Fat %			0.27	0.32	0.64 *
Protein%				0.38	0.56
Lactose%					0.81 **

* P<0.05

** P<0.01

Conclusion:

It appears that adding Broccoli wastes increased the body weight gain but with low level. Also milk produced daily and the milk composition increased significantly with increasing the amount of Broccoli waste. Accordingly it could be recommended to use the Broccoli wastes in feeding the ewes in order to improve their body weight gain as well their production of milk and its composition, on the same time to reduce the cost of feeding.

References:

- [1] Ahuja, I., B.H. Borgen, M. Hansen, B.I. Honne, C. Müller, J. Rohloff, J.T. Rossiter and A.M. Bones. (2011). Oilseed rape seeds with ablated defense cells of the glucosinolate-myrosinase system. Production and characteristics of double haploid MINELESS plants of *Brassica napus* L. *J. Exp. Bot.*, 62(14): 4975-4993.
- [2] Campas-Baypoli, O.N., D.I. Sanchez-Machado, C. Bueno-Solano, J.A. Núñez-Gastélum, C. Reyes-Moreno and J. Lopez-Cervantes. (2009). Biochemical composition and physicochemical properties of broccoli flours. *International Journal of Food Sciences and Nutrition*, 60(Sup 4): 163-173.
- [3] Duncan, D.B. (1955). Multiple Range and Multiple Test. *Biometrics*. 11: 1-42.
- [4] FAO. (2019). Food and Agriculture Organization of the United Nations. Available online: <http://www.fao.org/faostat/en/#data/FO> (accessed on 4 April 2019).
- [5] Hu, C.H., A.Y. Zuo, D.G. Wang, H.Y. Pan, W.B. Zheng, Z.C. Qian, and X.T. Zou. (2011). Effects of broccoli stems and leaves meal on production performance and egg quality of laying hens. *Animal Feed Science and Technology*, 170:117–121.
- [6] Jian, W., C. Lei, X-j. Yuan, G. Gang, J-f. Li, Y-f. Bai, and S. Tao. (2017). Effects of molasses on the fermentation characteristics of mixed silage prepared with rice straw, local vegetable by-products and alfalfa in Southeast China. *J. Integr. Agr.* 16:664-670.
- [7] Kuchtik, J., K. Sustova, T. Urban, and D. Zapletal. (2008). Effect of the stage of lactation on milk composition, its properties and the quality of rennet curdling in East Friesian ewes. *Czech J. Anim. Sci.*, 53: 55-63.
- [8] Madrid, J., M. Dolores-Megias and F. Hernandez. (2002). In vitro determination of ruminal dry matter and cell wall degradation and production of fermentation end-products of various by-products. *Anim. Res.*, 51:189-199.
- [9] Mahmoud, Y.M. (2016). Using Broccoli Plant Wastes in Sheep Rations. *Egyptian Journal of Nutrition and Feeds*, 19(2): 277-287.
- [10] Monllor, P., G. Romero, A.S. Atzori, C.A. Sandoval-Castro, A.J. Ayala-Burgos, A. Roca, E. Sendra and J.R. Díaz. (2020). Composition, mineral and fatty acid profiles of milk from goats fed with different proportions of broccoli and artichoke plant by-products. *Foods*, 9(6): 700; doi:10.3390/foods9060700.
- [11] Omirou, M.D., K.K. Papadopoulou, I. Papastylianou, M. Constantinou, D.G. Karpouzias, I. Asimakopoulos and C. Ehaliotis. (2009). Impact of nitrogen and sulfur fertilization on the composition of glucosinolates in relation to sulfur assimilation in different plant organs of broccoli. *J. Agric Food Chem.*, 28, 57(20): 9408-9417.
- [12] Oramari, R.A.S. and H.N. Hermiz. (2012). Non-genetic factors and estimates of repeatability for milk yield traits and compositions in Karadi sheep. 1st Scientific Agricultural Conference. University of Dohuk. 10-12 April 2012. *J. of University of Duhok*, 15(1): 163-171 (Special Issue).
- [13] Partovi, E., Y. Rouzbehan, H. Fazaeli and J. Rezaei. (2020). Broccoli byproduct-wheat straw silage as a feed resource for fattening lambs. *Translational Animal Science*, 4(3): 1-11, doi: 10.1093/tas/txaa078
- [14] Pavic, V., N. Antunac, B. Mioc, A. Ivankovic and J.L. Havranek. (2002). Influence of stage of lactation on the chemical composition and physical properties of sheep milk. *Czech, J. Anim. Sci.*, 47(2):80-84.
- [15] SAS. (2005). SAS/STAT' User's Guide for Personal Computers. Release 8.2. SAS Institute Inc., Cary, NC, USA.
- [16] Sinapis, E. (2007). The effect of machine or hand milking on milk production, composition and SCC in mountainous Greek breed (Boutsiko) ewes. *Small Rumin. Res.*, 69:242-246.
- [17] USDA, (2011). Nutritive value of broccoli leaves (cited from <http://nutritiondata.self.com/facts/vegetables-and-vegetables-products/broccoli/leaves>).
- [18] Wadhwa, M., S. Kaushal, and M.P.S. Bakshi. (2006). Nutritive evaluation of vegetable wastes as complete feed for goat bucks. *Small Rumin. Res.* 64:279-284.
- [19] Yi, X.W., F. Yang, Y. Chen, J.X. Liu and J.K. Wang. (2015). Effects of replacement of concentrate mixture by broccoli by-products on lactating performance in dairy cows. *Asian-Australas J. Anim. Sci.*, 28(10):1449-1453.