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Effects of Feeding Pistachio By-Products on Hematology and Performance of Balouchi Lambs

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Abstract: A study was carried out to investigate the possibility of feeding high level of Pistachio By-products (PB) to Balouchi lambs. Twenty-eight male lambs, with initial weight of 18.3±1.9 kg were allocated to 4 dietary treatments in a completely randomized designed for a period of 3 months. Four diets containing 0, 10, 20 and 30% PB were fed to the lambs in TMR *ad-labium* form. The average final live weight of lambs that allocated to diets contained 0, 10, 20 and 30% of PB were 40.0, 41.0, 38.7 and 40.0 kg at the end of the experiment, respectively. Mean daily weight gain was also 224.5, 259.4, 221.0 and 215.6 g day^{-1}, respectively. The respective average feed intake was 1182.8, 1215.7, 1181.1 and 1161.5 g day^{-1}. Feed conversion ratio was 6.73, 6.22, 7.56 and 7.11 for the above diets. Diet containing high levels of PB did not affected the daily weight gain, live weight and feed conversion ratio of the lambs ($p>0.05$). Such trend was found for some other parameters such as slaughter and dissection data of the experimental animals. There were no significant effect of treatments on all hematology parameters ($p>0.05$). It can be concluded that PB could be fed up to 30% to the fattening lambs without any adverse effects on performance and health parameters.

Key words: Pistachio by-products, performance, hematology, Balouchi lamb, weight, feed intake

INTRODUCTION

Adverse climatic conditions and shortage of water resources had increased costs of animal feeds in many countries. Utilization of agricultural by-products obtained after processing of fruits, vegetables, crops and nuts, such as Pistachio By-products (PB) is often a useful way of overcoming this problem. Soon after pistachio harvesting the fresh nuts must be de-hulled and their moisture content reduced to <10% what is called pistachio by-products weigh 1.5 times of the de-hulled dry nuts and comprise of 64.5% soft external hull, 25% twinges, 10% leaves, 0.5% kernel and woody shell (Vahmani *et al.*, 2006; Bagheripour *et al.*, 2008).

The annual production of fresh PB is around 400,000 tones year^{-1} of PB in Iran (Bagheripour *et al.*, 2008). This by-product can be deteriorated in open fields because of its high content of moisture and nutrients and it can be an environmental pollution threat (Seied, 2003; Vahmani *et al.*, 2006). Therefore, PB utilization as animal feed not only lowers feed shortage and cost in the area but also reduces the risk of environmental pollution.

For the first time Labavitch *et al.* (1982) reported that Crude Protein (CP), fiber and fat contents of PB are similar to the almond by-products. These researchers also reported that phenolic compounds of PB were 5-7 times more than almond by-products. Seied (2003) reported that amount of total phenolic compounds and tannins in PB were 15.6 and 10.2%, respectively. Bagheripour *et al.* (2008) stated that total phenols and tannins as tannic acid equivalents contents of the sun-dried PB were 15.2 and 9.0%, respectively.

General effects of tannins like decreasing in *in vivo* nutrient utilization particular protein by ruminants, growth retarding, palatability and feed intake reduction and decrease in various enzyme activities have been discussed by Makkar (2003) but there were no complete study of the effect of PB on health, hematological parameters and performance of lambs. Therefore, this study was conducted to investigate the effect of inclusion of high levels of PB on hematological parameters and performance of Balouchi lambs. This breed of sheep (Balouchi) is the dominant breed in Iran and distributed mainly in dry areas which are suitable for pistachio tress.

MATERIALS AND METHODS

Dry pistachio by-products containing soft hulls, twigs, leaves, little amount of hard shells and green kernels obtained from de-hulling factories in Sirjan town (Kerman Province, Iran). Other feed ingredients (Table 1) were locally purchased, ground in a hammer mill (4 mm screen) and blended in an Alvan Blanch mixer.

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Table 1: Ingredients and chemical composition of the experimental diets (% DM)

Items/ Ingredients	Dietary treatments[1] 1	2	3	4
Corn	43.00	43.00	43.00	43.00
Soybean meal	10.00	10.00	10.00	10.00
Alfalfa hay	25.00	22.00	19.00	16.00
Pistachio By-products	0.00	10.00	20.00	30.00
Beet pulp	21.00	14.00	7.00	0.00
Vitamin-mineral premix[2]	0.40	0.40	0.40	0.40
Salt	0.20	0.20	0.20	0.20
Limestone	0.40	0.40	0.40	0.40
Chemical composition (%)				
DM	89.10	90.10	90.90	91.30
CP	14.80	14.70	14.66	14.62
NDF	24.50	23.80	23.20	22.50
ADF	14.90	14.60	14.20	13.90
EE	2.54	2.55	2.57	2.58
NFC[3]	53.00	53.60	54.00	54.50
TP[3]	0.11	1.40	2.67	3.89
TT[3]	0.06	0.97	1.64	2.72

[1]Treatments were: 1) The control, diets containing 10% (2), 20% (3) and 30% (4) PB. [2]Each kg of Vitamin-mineral premix contained: Vitamin A (50,000 IU), Vitamin D3 (10,000 IU), Vitamin E (0.1 g), Calcium (196 g), Phosphorus (96 g), Sodium (71 g), Magnesium (19 g), Iron (3 g), Copper (0.3 g), Manganese (2 g), Zinc (3 g), Cobalt (0.1 g), Iodine (0.1 g), Selenium (0.001 g). [3]NFC: Non-fiber Carbohydrates calculated as 100-(CP + Ash + NDF + EE), TP: Total Phenolic and TT: Total Tannin

Twenty-eight male Balouchi lambs aged 5-6 months, weighing 18.3±1.9 kg from the Ferdowsi University flock (Mashhad, Iran) were allocated to 4 dietary treatments in a completely randomized design by the stratified randomization based on their body weights. The dietary treatments were complete diets from the feeds indicated in Table 1, which prepared in form of Total Mixed Ration (TMR). Water and salt blocks of were freely provided for all groups. Lambs were gradually introduced to the ration in order to minimize the risk of gastro-intestinal disorders. All sheep were weighed when they entered the feedlot area and then at the end of each week at the same time of day until the end of the experiment.

All lambs were kept in individual pens. The diets were fed *ad libitum*, half being given at 07:00 h and the other half at 16:00 h. DM intake and daily weight gain were measured as the main parameters during the lambs feeding periods. Lamb height, length and chest width were measured weekly.

BP and refusals samples were analyzed for DM, ash, Ether Extract (EE) and crud protein NDF and ADF (Van Soest *et al*., 1991), NFC (NRC, 2001), Total Phenols (TP) and Total Tannins (TT) (Makkar *et al*., 1992).

Jugular blood samples were taken before allocation the lambs to experimental diets (day 0) and at the end of each week until the end of the experiment. Two milliliters of blood samples was anti-coagulated with EDTA for hematological analysis and plain tubes supplied serum for analysis of total protein. The serum was separated after centrifugation at 1800 g for 10 min and stored at -18°C until analysis. Anti-coagulated blood samples were analyzed shortly after collection for: Packed Cell Volume (PCV) and total leukocyte count (WBC) by an automatic veterinary hematology cell counter (Nihon kohden, Celltac a, Tokyo, Japan). Differential leukocyte counts were performed on routinely prepared Giemsa stained blood films using the cross-sectional technique. Fibrinogen concentration was estimated by heat precipitation method (Jain, 1986). The stored serum samples were analyzed for total protein (TP, Biuret method (Thomas, 1998)) by commercial kits (Pars Azmoon, Tehran, Iran) using a spectrophotometer (Jenway 6105, Jenway, Felstead, England).

The animals were slaughtered at 90 days of age following 12 h fasting period for subsequent carcass analysis. After slaughtering, feet, skin, offal and the head were separated and weighed. The carcasses were chilled at 3°C for 24 h after dressing. The weight of wholesale cuts, liver, lungs, kidney and heart were measured for each lamb separately.

The statistical analysis was performed using the GLM procedure (SAS Institute, 1997) and significant means were separated by Duncan multiple range test. Because blood parameters and performance factors were measured over the time, a repeated measures approach using ANOVA with mixed linear models in SAS was used.

RESULTS AND DISCUSSION

The four diets contained similar concentrations of CP, NDF, ADF and NFC but inclusion of BP into control diet increased TP and TT as indicated in Table 1. Concentration of TP and TT were 0.11, 1.4, 2.67, 3.89 and 0.06, 0.97, 1.64 and 2.72% for treatments 1, 2, 3 and 4, respectively. The concentration of TP and TT in PB DM was 13.9 and 8.9%, which is similar to report of 15.2 and 8.2% by Bagheripour *et al*. (2008), respectively.

The animals were in good conditions throughout the trial as evidenced by lack of any signs of ill health. Feeding the PB did not affect their health, although it contained tannin. Hematological data were used as an indication of the health status of experimental animals. During the course of the experiment, all of the blood values recorded was within the normal reference range for animals of similar age group (Table 2). The only significant effect was that of the time of bleeding. Values for WBC and total protein were lower at the 90 days of the experiment than on day 1, whereas the rest of the parameters showed an opposite trend. In ruminants the tannins especially condensed type are not absorbed into

Table 2: Effects of dietary treatments on hematological parameters

	Treatments[1]					Effects	
Parameters[2]	1	2	3	4	SEM	Treatment	Time
PCV (%)	36.16	34.83	35.55	34.44	0.86	0.51	0.08
WBC (109 L^{-1})	14.06	12.91	12.63	13.53	0.98	0.73	0.05
Neut (109 L^{-1})	6.83	6.31	6.11	6.30	0.60	0.85	0.09
Lymph (109 L^{-1})	6.91	6.57	6.31	6.93	0.85	0.94	0.27
Mono (109 L^{-1})	0.19	0.15	0.11	0.19	0.05	0.70	0.06
Fib (g L^{-1})	2.94	2.83	3.22	3.50	0.35	0.41	0.54
TP (g L^{-1})	62.5	62.05	58.60	63.11	2.47	0.57	0.02

[1]Treatments were: 1) The control, diets containing 10% (2), 20% (3) and 30% (4) PB. [2]PCV: Packed Cell Volume; WBC: White Blood Cell Count; Neut: Neutrophil; Lymph: Lymphocyte; Mono: Monocyte; Fib: Fibrinogen; TP: Total Protein

Table 3: Performance and body characteristics of experimental lambs

	Treatments[1]					Effects	
Measurements	1	2	3	4	SEM	Treatment	Time
DMI (g day^{-1})	1182.80	1215.70	1181.10	1161.50	16.20	0.16	<0.01
ADG (g day^{-1})	224.50	259.40	221.00	215.60	14.90	0.18	<0.01
FCR[2]	6.73	6.22	7.56	7.11	0.54	0.38	<0.01
Chest width (cm)	20.02	21.00	20.73	18.84	0.85	0.30	<0.01
Withers height (cm)	56.29	56.54	54.64	55.75	1.25	0.72	<0.01
Body length (cm)	54.12	53.80	54.20	54.12	1.42	0.98	<0.01

[1]Treatments were: 1) The control, diets containing 10% (2), 20% (3) and 30% (4) PB: [2]Feed Conversion Ratio

the blood stream (Terrill *et al.*, 1994), these therefore under normal physiological conditions are not likely to damage organs such as liver, kidney, spleen, etc. (McSweeney *et al.*, 2001). Drying PB could be another reason for lack of adverse effect on hematological parameters. Probably drying process has deactivated phenolic components as reported by Makkar (2003). This researcher has noted that drying was effective in decreasing tannin levels in oak leaves.

Table 3 summarizes the voluntary DM intake and FCR by the lambs during consecutive feeding periods of the experiment. Generally, there were no significant differences between the measured DM intakes of the experimental diets ($p = 0.16$). DM intake of lambs given the diet containing high levels of PB was similar to those on the control diet (1182.8 vs. 1161.5 for the control and treatment 4 containing 30% PB, respectively). Although, it has been reported that forages containing high concentrations of condensed tannins are not palatable (Cooper and Owen-Smith, 1985) but in this experiment inclusion of PB up to 30% did not affect the palatability of TMR containing PB. Inclusion of high levels of PB led to worse FCR but its difference was not significant ($p = 0.38$). According to these results, it was suggested that the diet containing 30% PB was palatable if it be fed as mixed ration. The lambs can be efficiency able to eat diets contained PB up to 30%. The ADG ($p = 0.18$), chest width ($p = 0.30$), Withers height (0.72) and body length (0.98) did not differed significantly between the treatments (Table 3). The effect of time were significant ($p<0.01$) for all performance factors and increased with the age of animals (Table 3). Use of PB up to 30% had no effect on slaughter, Empty Body Weight (EBW), hot and cold carcass weights and dressing percentage ($p>0.05$) (Table 4). The average dressing percentage for the lambs allocated to treatments 1, 2, 3 and 4 were 50.13, 52.22, 50.82 and 50.16%, respectively.

The weight of internal organs and dissection data were not affected by experimental diets ($p>0.05$) although, the measured values were within the normal ranges for yearling Balouchi lambs in the area. Therefore, measuring such carcass parameters which are highly variable based to the undertaken techniques and procedures can not be determinant in practical decisions.

Results of performance and carcass data in this experiment are inconsistent with other studies that used feeds containing tannin in growing lambs. In the study of Priolo *et al.* (1998, 2000), the lambs fed maize-containing diets had higher carcass weight, carcass yield and carcass fatness than lambs given the tannin-containing diet. In their experiments, lambs were fed by diets containing 20 and 56% of *Ceratonia siliqua* (carob) pulp, which provide 1.1 and 2.5% condensed tannins, respectively. In current study, high levels of PB in diet were not able to exert a large effect on voluntary feed intake and lamb growth. It seems that the inconsistent results of the effects of feeds containing tannin on performance and growth of lamb emphasizes the importance of the type of condensed tannins as well as its concentration in animal nutrition. Highly potent or effective sources of condensed tannins have been termed astringent (Mangan, 1988) and the condensed tannins in BP appears to be less astringent than condensed tannins in many temperate plant species. Research based on carob (*Ceratonia siliqua*) pulp has

Table 4: Slaughter and dissection data of the experimental lambs

	Treatments[1]					
Measurements	1	2	3	4	SEM	p-value
Slaughter weight (kg)	40.01	41.08	38.70	40.01	1.90	0.53
Empty Body Weight (EBW) (kg)	37.08	38.40	35.91	36.73	1.85	0.51
Hot carcass weight (kg)	19.06	20.53	18.73	18.90	1.23	0.32
Cold Carcass Weight (CCW) (kg)	18.59	20.03	18.27	18.44	1.20	0.33
Dressing percentage (%)	50.13	52.22	50.82	50.16	1.72	0.45
Internal organs and body parts (EBW%)						
Heart	0.42	0.41	0.46	0.39	0.04	0.27
Liver	1.42	1.54	1.50	1.49	0.15	0.81
Lungs	1.27	1.31	1.41	1.28	0.11	0.47
Kidneys	0.26	0.30	0.28	0.30	0.05	0.70
Omental and mesenteric fat	1.15	1.56	1.24	1.14	0.30	0.40
Fat-tail	6.81	7.03	6.90	6.59	0.45	0.68
Head	6.07	6.23	5.99	5.79	0.56	0.82
Feet	3.37	2.89	3.20	3.06	0.39	0.53
Dissection data (CCW%)						
Loin	16.46	17.65	17.53	17.33	1.78	0.84
Pelvic limb	31.16	30.86	28.12	28.67	2.99	0.53
Brisket	22.50	22.94	25.24	23.80	2.05	0.41
Neck	10.99	11.46	12.28	12.42	1.91	0.77
Shoulder	18.89	17.07	16.82	17.78	1.63	0.45

[1]Treatments were: 1) The control, diets containing 10% (2), 20% (3) and 30% (4) PB

indicated that very low concentrations of condensed tannins were able to exert a large effect on digestion, voluntary feed intake and lamb growth (Priolo *et al*., 1998, 2000). Reversely research based on *Lotus* species has showed that condensed tannin could improve animal performance when present up to 4% of the DM in sheep diets (Waghorn *et al*., 1990), thus the results from this trial underscore the differences in the astringency or reactivity of condensed tannins from different plant species according to Mangan (1988) and Barahona *et al.* (1997). Astringency has been attributed to differences in molecular weight (Mangan, 1988) and the composition of the condensed tannins molecule (Foo *et al*., 1996, 1997) but the chemistry responsible for reactivity has not been defined (Priolo *et al*., 2000).

CONCLUSION

The results of this experiment indicated a possibility of feeding high level of PB to ruminants even to the animals with high level of requirements such as finishing lambs. Inclusion of 30% of PB in finishing lambs diet has no adverse effects on performance and health parameters. This recommendation is important in an area with low rainfall and feed shortage. However, more researches are needed for upgrading the nutritional value of PB as well as the feeding methods to ruminants regarding local conditions.

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