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Feeding Value of Kangar (*Gandelia tournefortii*) Hay and the Growth Performance of Bluchi Lambs Fed by Diets Containing this Hay

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Abstract: This research investigated the feeding value of Kangar (*Gandelia tournefortii*) hay and the effect of diets containing this hay on growth performance of Baluchi lambs. Kangar hay was collected from the Khorasan natural rangeland at the stage of late maturity and evaluated in terms of chemical composition, *in sacco* degradability and a growth study with lambs. Twenty-four male and 24 female lambs were allocated to 4 dietary treatments in a feedlot condition. All groups received a concentrate mixture of 60 and 40% roughage including alfalfa hay (25%), dry wheat straw (15%), soaked what straw (15%), dry Kangar hay (15%) and soaked Kangar hay (15%) as treatments 1-4, respectively. Chemical composition mainly CP of Kangar hay was much higher than wheat straw and even comparable to alfalfa hay. The average DM degradability of Kangar hay was 67.2% after 120 h incubation, but >76% of the incubated DM degraded during the 1st 24 h. These values for CP and NDF were 73.5 and 54.5%, respectively. These parameters ranked Kangar hay as medium-quality forage. Male lambs fed by TMR containing the soaked Kangar hay gained better than other groups. Average daily gains of male and female lambs on dietary treatments of 1-4 were 218, 237, 241, 276 and 197, 215, 229 and 259 g, respectively. The best feed conversion ratio was also recorded for the male lambs on diet containing 15% soaked Kangar hay (6.5 kg feed consumed kg^{-1} of weight gain). The mean dressing percentage for the lambs allocated to treatments 1-4 were 54.7, 54, 9, 53.4 and 53.5 for males and 53.1, 52.7, 54.0 and 55.7 for females, respectively. It was concluded that inclusion of Kangar hay can be beneficial mainly for smallholder farmers during periods of low rainfall and forage scarcity.

Key words: Kangar, Baluchi lambs, *in sacco*, daily gain, carcass, Kanger hay

INTRODUCTION

In most parts of Iran, low rainfall and availability of water resources are the major limitations to the farmers. Feed shortage is a common feature of Iranian animal production industry. Continuous grazing, especially with high stocking rates has made rangelands bare, caused soil erosion and native pasture deterioration mainly through the loss of useful vegetation and animal productivity.

The largest enterprise of Iranian animal agriculture is sheep industry. Sheep numbers in Iran is about 52 million which amounts to nearly 42% of the available total animal units. During the dry period and cold winter when green forages are scarce, crop by-products such as cereal straws, farm wastes such as baggas and collected forages from rangelands such as Kangar represent the important sources of feeds for ruminant animals.

Kangar (*Gundelia tournefortii*) as a perennial spiny natural herbage of Iran origin is collected and dried by some farmers for feeding to herbivour animals as a fodder when the quality and quantity of other forages and feed resources are limited in Khorasan province. Although, the use of this plant as a medicinal herb for human is quite ancient, but nowadays it grows as an aggressive wild weed within the rangelands. However, few studies have been carried-out to evaluate the nutritional concepts and quality of wild *G. tournefortii* fodder in the area. Therefore, the aims of this research were to determine the chemical composition, *in sacco* degradability and lot- feeding of male and female Baluchi lambs for better understanding of its effectiveness on daily gains in comparison with the tradional low-quality roughage, wheat straw.

MATERIALS AND METHODS

Naturally-grown *Gundelia tournefortii* plants were hand harvested at the stage of late maturity form the Frize

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area, 40 km west of Mashhad, similar to the common practice undertaken by the farmers in the country. Representative dry samples (approximately 5 kg) were taken to the laboratory and milled for subsequent analysis.

Dry Matter (DM) content of the samples was determined by drying at 105°C for 24 h, ash by igniting in a muffle furnace at 550°C for 8 h. Nitrogen concentration was obtained by Kjeltec Auto system. Neutral Detergent Fiber (NDF) content was measured by the recommended methods.

Twenty-four male and 24 female Baluchi lambs aged 9-11 months, weighing 26.4±4 kg from the University flock were allocated to the dietary treatments in a completely randomized design with the factorial arrangement of 4×2×6. Male and female lambs were divided into 4 groups by the stratified randomization based on their body weights. The dietary treatments were full diets made from the feeds indicated in Table 1 in the form of Total Mixed Ration (TMR). The diets were formulated to provide around 13.5% Crude Protein (CP), 70% TDN, 0.37% Ca, 0.23% P and the ratio of Ca: P about 1.6.

Alfalfa hay, wheat straw and Kangar hay were chopped by a tractor-operated chapper. The soaked feeds were prepared by soaking batches of straw and Kangar in jute bags in tap water overnight. After soaking, the bags containing roughages were transferred to a metal basket 3 h before feeding for allowing the free liquid to drain. The DM content of these soaked and prepared roughages was about 40% before TMR preparation.

Water and block licks of salt were freely provided for all groups. The total experimental period of 68 days was divided into 4 periods of 17 days. 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 period 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 0700 h and the other half at 1600 h. DM intake and daily weight gain were measured as the main parameters during the lambs feeding periods.

In sacco dry matter degradability of Kangar hay was carried out according to the procedure described by Orskov *et al*. (1980). The nylon bags were 12×8 cm in dimensions and a pore size of 44 micron. Four bags were used for each sample. Bags were inserted via permanent fistula into the rumen of 4 mature male Baluchi sheep for 0, 2, 4, 8, 16, 24, 48, 72, 96 and 120 h. The harvested dry Kangar hay samples were milled through 3 mm sieve. Around 3 g ground samples were placed in bags. In order to minimize the bag floating a steel ball bearing of 8 g weight was also placed in each bag before tightly closing with drawstring. The draw strings were tied and the bags were secured at random at approximately 1 cm intervals near the end of a weighted 30 cm strong nylon line. The line was attached to a wooden handle out side the fistula. The tied bags containing samples were wetted by placing in tap water for around 1 min and then inserted into the rumen before morning feeding. On removal the bags were washed under a gentle stream of tap water until the rinsing water was clear. Bags were oven-dried at 65°C for 48 h to constant weight. The DM degradation data were fitted to the exponential equation:

Table 1: Composition of the experimental diets (DM% basis)

	Dietary treatment			
Feedstuff	1	2	3	4
Alfalfa hay dry	25	25	25	25
Wheat straw dry	15	-	-	-
Wheat straw soaked	-	15	-	-
Kangar dry	-	-	15	-
Kangar soaked	-	-	-	15
Corn grain	30	30	30	30
Barley grain	20	20	20	20
Sunflower meal	5	5	5	5
Soybean meal	5	5	5	5
Total	100	100	100	100

$$P = a + b\,(1 - e^{-ct})$$

where:

P = Degradation of DM at time t
a = The rapidly soluble fraction
b = The potentially degradable DM
c = The constant rate of degradation of b parameter (percentage/h)

The statistical analysis was performed using the GLM procedure of SAS software and significant means were separated by Duncan multiple range test.

At the end of experiment, 3 lambs from each treatment, whose weights were closet to the group average weight were slaughtered by the conventional method 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, heart and spleen were measured for each lamb separately.

RESULTS AND DISCUSSION

Table 2 presents the chemical composition of forages including Kangar hay, which were fed to lambs in this experiment. Most of the measured nutrients reported in

Table 2: Chemical composition of wheat straw, Kangar and alfalfa hay (DM% basis)

	Forage		
Constituent	Kangar hay	Alfalfa hay	Wheat straw
DM	92±1.3	92±1.7	91±1.2
CP	12±1.4	17±0.9	3.0±0.5
Ash	10±1.6	8.0±0.5	7.0±0.9
EE*	3.0±0.9	2.0±0.5	2.0±0.4
NDF	47±1.7	48±2.1	68±3.0

*EE = Ether Extract

Table 3: *In sacco* DM, CP and NDF degradability (%) of Kangar hay incubated in the rumen of permanently fistulated sheep

	Nutrient		
Incubation time (h)	DM	CP	NDF
0	25.0±0.18	23.1±0.17	11.0±0.26
2	26.5±0.35	24.7±0.24	10.9±0.23
4	28.1±0.69	25.6±0.22	11.9±0.34
8	30.6±0.91	26.5±0.32	14.0±0.80
16	40.9±1.01	37.5±1.57	27.4±0.72
24	51.1±1.47	44.1±0.98	34.5±1.35
48	60.7±0.97	50.5±0.67	44.8±1.16
72	65.1±1.38	54.6±0.84	52.8±0.47
96	66.8±0.62	58.3±0.48	56.4±0.84
120	67.2±0.48	60.0±1.46	63.2±1.53

Table 2 for alfalfa hay and wheat straw are similar to the published data elsewhere (Karabulut *et al*., 2006). Although, alfalfa and Kangar hays had similar NDF concentration, but CP content of Kangar was lower and quite closed to the reported value by Karabulut *et al*. (2006). From the chemical composition point of view (Table 2) it was suggested that Kangar can be regarded as medium-quality forage for ruminants and even comparable to the locally produced low grade alfalfa hay. In an area with huge feed scarcity such feed resource must be well investigate and used to meet the nutritional requirement of ruminant with lower cost.

Nutrients degradation from the ruminally incubated bags increased with increasing the incubation time (Table 3). More than 76% of the highest DM degradability measured after 120 h, degraded during the 1st 24 h of incubation. These values for CP and NDF degradability's were 73.5 and 54.5%, respectively. Although, NDF degradability was significantly ($p<0.001$) lower than the similar data for DM and CP during the early hours of incubation but it reached to a figure of 63.2% after 120 h of incubation which is 3.2% higher than the similar measured value for CP. Therefore, this trend of NDF degradation can be an interesting nutritional fact of Kangar hay for ruminants such as dairy cow with high production. Feeding these animals with high amount of concentrate is required but inclusion of hay with slow release of NDF is necessary for keeping animals healthy and productive. However, more researches are needed in this context and Kangar hay feeding to dairy cow.

Table 4: Average DM intake of lambs fed by the experimental diets during different periods

	Diet					
Parameters	1	2	3	4	p-value	SE
Male						
Period[1]						
1	1176^{a}	1393^{c}	1266^{b}	1384^{c}	0.0001	103.5
2	1777^{b}	1727^{b}	1584^{a}	1624^{a}	0.0001	89.40
3	1815^{a}	1793^{a}	1853^{a}	2037^{b}	0.0001	111.1
4	1938^{a}	1808^{a}	1962^{a}	2129^{b}	0.0001	131.8
Whole period	1677^{a}	1680^{a}	1666^{a}	1797^{b}	0.0010	60.10
FCR[2]	7.7^{b}	7.1^{a}	6.9^{a}	6.5^{a}	0.0010	0.500
Female						
Period						
1	1162^{a}	1335^{b}	1426^{b}	1418^{b}	0.0001	122.6
2	1392^{a}	1474^{a}	1640^{b}	1663^{b}	0.0010	130.8
3	1709^{a}	1743^{ab}	1689^{a}	1787^{b}	0.0010	44.60
4	1886^{b}	1807^{b}	1745^{a}	2064^{c}	0.0010	138.3
Whole period	1537^{a}	1590^{a}	1625^{b}	1733^{c}	0.0010	82.80
FCR1	7.8^{a}	7.4^{a}	7.1^{b}	6.7^{b}	0.0010	0.470

[1]The total 68 days of the experiment divided into 4 periods of 17 days, [2]FCR Feed Conversion Ratios (kg feed consumed per kg of weight gain)

Some of the measure parameters were in agreement with the findings of Kamalak *et al*. (2005). CP degradability was lower in comparison with DM and NDF, possibly due to high proportion of N bound to cell wall constituents such as NDF. Low CP degradability in association with the stage of maturity and cell wall complex for other forages has been reported by Sanderson and Wedin (1989), Hoffman *et al*. (1993) and Ozturk *et al*. (2006).

Table 4 summarizes the voluntary DM intake and FCR by the lambs during consecutive feeding periods of the experiment. Generally, there were significant differences between the measured DM intakes of the experimental diets. DM intake of lambs given the diet containing soaked Kangar hay was significantly ($p<0.001$) higher than those of lambs fed other diets (Table 4). Feed conversion ratio of diet 4 (containing the 15% soaked Kangar hay) was also better than the obtained ratios for other diets. According to these results, it was suggested that not only the diet containing Kangar hay was palatable but also provided more digestible nutrients.

As it was predictable DM intake and FCR of female lambs were lower than those of male lambs (Table 4). Lambs on all diets showed slightly higher DM intake with advancing the experimental periods, but probably due to higher body weight. Based on the metabolic body weight ((body w)$^{0.75}$) average DM intakes were 100 and 99 g kgw$^{-0.75}$ for male and female lambs in all groups. Accordingly, the average DM intake for male and female lambs at the beginning and the end of experiment were 110, 115, 115 and 114.5 g kg^{-1} w$^{0.75}$, respectively. Therefore, DM intake expressed on metabolic weight basis show no significant differences between the male

and female lambs possibly due to the nature of metabolic body weight which regards the active body weight of all animals in a metabolically similar basis.

FCR of lambs of diets containing Kangar hay were significantly ($p<0.001$) better than the lambs on other diets. However, these values for all groups of lambs in this experiment were higher than the reported FCR for Arabi lambs by Heydari *et al.* (2008). These differences might be due to the differences in diet characteristics and studied lambs. For example the CP content of the diet fed to Arabi lambs was 16.7%, which is significantly higher than CP of diets fed to lambs in this experiment (13.5%).

The ADG (Table 5) show that lambs fed the diet containing soaked Kangar hay gained significantly ($p<0.001$) better than lambs fed by other diets. The inclusion of Kangar hay in the TMR diets even in dry form improved daily live weight gains of all lambs (male and femals). These observations therefore, indicate that Kangar hay has potentials' to improve feed intake, FCR and stimulate growth. Although, the traditional chemical composition of Kangar hay and performance of lambs in form of TMR were studied in this experiment, but the positive effects of this hay can attributed, to its content of unconventional constituents such as steroids and growth promoters. The improved daily protein intake of lambs on diets containing Kangar hay could be another reason for better performance by the experimental lambs. Soaking low-quality roughages is an old-traditionally used method between Iranian farmers. Generally, soaking wheat straw and Kangar hay in this experiment led to better performance.

The mean carcass characteristics for the slaughtered male and female lambs are shown in Table 6. The average dressing percentage for the lambs allocated to treatments 1-4 were 54.7, 54.9, 53.4 and 53.5 for males and 53.1, 52.7, 54.0 and 55.7 females, respectively. Similar dressing percentages were reported by Heydari *et al.* (2008) for Arabi lams in Iran and Macit *et al.* (2003) for Morlcaraman lambs in Turkey, However, these values were significantly higher than the reported dressing percentage for Pramenka lambs on Croatia by Moic *et al.* (2007).

Generally, the weight of carcass parts (Table 6) of male lambs were higher than those for the female lambs but, it seems the weight of internal organs were not affected by neither diets nor sexes, although, the measured values were within the normal ranges for yearling Baluchi lambs in the area. Therefore, measuring

Table 5: Growth performance of lambs fed by the experimental diets

	Diet			
Parameters	1	2	3	4
Male				
Body weigh (kg)				
Initial	25.9±1.8	26.8±1.2	28.5±1.3	27.2±0.9
Final	40.7±2.0	42.9±1.3	44.9±1.4	46.0±0.8
ADG[1] (g)	218[a]	237[a]	241[a]	276[b]
ADG[2] (g) kg^{-1} $w^{0.75}$	15.7[a]	16.5[a]	16.2[a]	18.6[b]
Female				
Body weight (kg)				
Initial	26.6±2.0	24.7±0.7	28.3±2.2	25.8±1.7
Final	40.0±2.4	39.3±0.7	43.9±2.2	43.4±1.9
ADG(g)	197[a]	215[ab]	229[b]	259[c]
ADG kg^{-1} $w^{0.75}$	14.2[a]	16.0[b]	15.6[ab]	18.2[c]

[1]ADG = Average Daily Gain, [2]kgw $^{0.75}$ = kg metabolic body weight (Body weight$^{0.75}$)

Table 6: Carcass characteristics of slaughtered lambs fed the experimental diets

	1		2		3		4	
Measurements	M[1]	F[2]	M	F	M	F	M	F
Slaughter weight (kg)	39.1±0.82	40.9±2.10	41.2±0.62	38.9±1.34	42.9±2.15	42.8±1.93	44.3±1.05	44.2±3.11
Carcass weight (kg)	21.4±1.16	21.7±0.67	22.6±2.3	20.5±1.66	22.9±1.91	23.1±20.8	23.7±1.78	24.6±2.24
Dressing percentage (%)	54.7±2.01	53.1±1.76	54.9±0.93	52.7±2.42	53.4±1.57	54.0±1.88	53.5±1.83	55.7±2.02
Weight of cuts (kg)								
Loin	2.8	2.4	2.8	2.3	2.5	2.4	2.5	2.6
Shoulder	3.28	2.88	3.44	2.75	3.50	2.81	3.58	2.93
Thigh	4.75	3.93	4.95	3.83	4.95	3.84	4.98	4.40
Ribs	2.60	2.55	2.75	2.40	2.73	2.38	2.94	2.75
Fat (tail)	2.44	1.6	2.2	1.7	2.3	1.9	2.4	2.1
Weight of parts (kg)								
Neck	2.2	1.5	2.1	1.6	2.2	1.5	2.3	1.6
Hide	4.30	3.6	4.2	3.5	4.3	3.9	4.2	3.7
Leg	0.99	0.90	0.80	0.85	0.98	0.83	1.07	0.75
Head	2.2	1.9	2.1	1.8	2.1	1.7	2.3	1.9
Digestive tract (emptied)	2.70	2.4	2.9	2.3	3.1	2.4	3.0	2.6
Liver	0.58	0.51	0.53	0.49	0.55	0.59	0.58	0.62
Kidney	0.07	0.06	0.06	0.08	0.07	0.07	0.08	0.07
Heart	0.15	0.16	0.14	0.15	0.15	0.15	0.18	0.15
Spleen	0.08	0.06	0.06	0.05	0.07	0.05	0.08	0.05
Lungs	0.45	0.55	0.53	0.50	0.57	0.47	0.59	0.49
Testes	0.53	-	0.50	-	0.55	-	0.56	-

[1]M = Male, [2]F = Female

such carcass parameters which are highly variable based to the undertaken techniques and procedures can not be determinant in practical decisions.

CONCLUSION

The results of this research indicated a possibility of feeding Kangar (*Gandelia tournefortii*) hay to ruminants even at the high level of production such as finishing lambs. Inclusion of 15% Kangar hay resulted in more daily gain, carcass weight and dressing percentage of lambs. This recommendation is important in an area with low rainfall, feed shortage and a vast deteriorated rangelands occupied by highly resistant plants, such as Kangar. However, more researches in harvesting technology and storage techniques as well as feeding methods to ruminants regarding the local conditions are required.

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