Nutrient utilization of acacia, haloxylon, and atriplex species by Najdi sheep

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Abstract

Two digestibility and nitrogen balance studies were conducted to evaluate nutrient utilization of 3 commonly browsed range plants by the desert sheep in Northern Saudi Arabia. In experiment 1, 15 Najdi wether lambs (40 kg) divided in 3 lots of 5 were randomly allotted to 3 diets of 200 g ground barley (*Hordeum vulgare* L.) grain and 800 g either alfalfa hay (*Medicago sativa* L.), dried *Acacia cynophylla* Lind., or *Haloxylon persicum* Bge. clippings. In experiment 2, 8 Najdi wethers were randomly alloted to treatments of 2 kg green alfalfa or 2 kg green *Atriplex halimus* L. clippings per day. Salt content of the soil and salt bush, *Atriplex* sp., were also determined. The organic matter (OM), crude protein (CP), and crude fiber (CF) on dry matter basis (DMB) were, respectively, 90, 15, 31% for alfalfa; 90, 13, 30% for acacia forage; and 87, 10, 37% for haloxylon shrub. In experiment 1, the OM digestibility was 66, 56, 53%; CP digestibility was 73, 68, and 55%; and CF digestibility was 44, 33, and 16%, respectively, for alfalfa, haloxylon, and acacia diets. The daily nitrogen balance was +4 g for both alfalfa and acacia groups. The haloxylon group had a negative nitrogen balance (-1.9%), showing no apparent retention of absorbed nitrogen. In experiment 2, the atriplex clippings contained 73% OM, 18% CP, and 24% CF on DMB, the respective digestibility values being 61, 79, and 39%. Even though the digestibility of as well as percent retention of absorbed nitrogen in atriplex group were markedly higher than those in alfalfa group, the digestibility of CF was lower ($P<.01$) in the former (39%) as compared to that in latter group (54%). The sodium, potassium, and chloride concentration of soils of high and low salinity had no influence on their contents in atriplex forage, with average values being 10, 2.5, and 16.5% respectively.

Key Words: ***Medicago sativa, Acacia cynophylla, Haloxylon persicum, Atriplex halimus,* shrubs, desert sheep, Northern Saudi Arabia, salinity, digestibility, nitrogen retention**

Rangelands cover more than 90% of the area of northern Saudi Arabia and are of major importance for the livestock industry in the kingdom. The land units consist principally of sand dunes, wadis, gravel plains, and stone hills. Best soils are found in the large wadis and around oases where silt and clays have been deposited as a result of occasional floods. Usually vegetation is restricted to drainages and depressions, leaving the rest of the land bare with a few annuals. Dwarf shrubs and annual forbs form the best part of vegetation. Bedouins raise most of the livestock in the desert ranges. Native fat-tailed sheep which are dominant in the area make chief use of the rangeland resources along with goats and camels.

Systematic studies for nutritional evaluation of desert range shrubs of Saudi Arabia by in vivo or in vitro techniques are lacking. Feed values calculated from standard chemical analysis using prediction equations derived from conventional feeds are not applicable for desert shrubs. Further, native sheep adapted to dry, hot and saline desert conditions might have different nutrient utilization efficiency than other breeds in different environments. There is a great need to determine the nutrient availability of forage shrubs to assess their deficiencies and contribution towards the requirements of the range-based livestock. The objective of this study was to evaluate nutrient utilization of 3 commonly grazed browse species of the range by the native sheep of northern Saudi Arabia.

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Materials and Methods

Experiment 1

A digestion and nitrogen balance trial was conducted with 15 Najdi wether lambs with an average initial body weight of 40 kg. The treatment design consisted of 3 groups of 5 wethers each with similar average body weights. Three diets of 200 g ground barley grain (*Hordeum vulgare* L.) and 800 g of either ground alfalfa (*Medicago sativa* L.) hay, sun-cured *Acacia cynophylla* Lind. foliage, or dried clippings of *Haloxylon persicum* Bge. were randomly allotted to 3 groups of sheep. The ingredients and chemical composition of the experimental diets are in Table 1. The alfalfa forage grown in Tabarjal, Al-jouf was harvested at a mid-bloom stage and was sun-cured. The foliages of *Acacia* sp. consisting of green leaves and tender twigs in a vegetative stage were harvested in early autumn and were sun dried. The clippings of *Haloxylon* sp. were collected from sand dune areas of the Wadi Sirhan range of Al-jouf province in northern Saudi Arabia and were sun-cured. The area is arid with a very erratic annual rainfall of 30–70 mm, the range of high temperature being 40–45° C in summers and 2–4° C in winters. All dry forages were coarsely ground in a hammer mill with a screen of .64 m mesh size. Diet ingredients were mixed by hand just before feeding twice daily. Iodized salt was fed with the diet at the rate 10 g per head per day. Daily samples of feed were composited for future analysis. Water was available at all times.

After a 3-week adjustment period in the digestion and metabolism stalls, the trial consisted of a 10-day preliminary period followed by a 7-day total collection of feces and urine. The daily feces were dried for 24 hours at 55° C and composited for later analysis. Urine was collected in plastic jars containing 20 ml of dil. sulfuric acid (1:1 by weight) and 500 ml of water. Each 24-hour collection was diluted to a definite volume with water and a 2% sample by volume was taken; the daily samples were composited in tightly covered jars under refrigeration. Urine was analysed for nitrogen and feed and feces for proximate components according to A.O.A.C. (1980) methods. Calcium was determined by using an atomic absorption spectrophotometer while phosphorus determination was according to Fiske and Subbarow method (1925). All digestible energy (DE) and metabolizable energy (ME) values of the forages were calculated from their digestible organic matter contents (DOM) using the following equation (NRC 1981): 1 kg DOM = 4.62 Mcal DE = 3.77 Mcal ME. The DOM of the forages were calculated by difference from the values of the respective diets (Lloyd et al. 1978). The standard errors of data were calculated according to Steel and Torrie (1980). Relevant data were subjected to analysis of variance and the difference between treatment means

Table 1. Ingredient and chemical composition of diets (Experiments 1 and 2).

Experiment no.	I			II	
Ration no.	1	2	3	1	2
Ingredients, gm					
Barley grain	200	200	200		
Alfalfa hay	800	—	—		
Dry acacia foliage	—	800	—		
Dry haloxylon shrub	—	—	800		
Green alfalfa				2000	
Green atriplex clippings					2000
Chemical composition					
Dry matter, %	91	91	91	20	28
Percent composition of dry matter					
Organic matter	92	91	89	91	73
Crude protein	14	13	10	22	18
Ether extract	1.4	1.3	1.4	5.6	7.6
Crude fiber	26	31	31	32	24
NFE	50	47	47	32	23
Calcium	1.1	2.0	0.55	2.0	0.85
Phosphorus	0.25	0.23	.16	0.21	0.17

Table 2. Chemical composition of alfalfa hay, acacia foliage and atriplex clippings (Experiment 1).

	Alfalfa	Acacia	Haloxylon
Dry matter, %	91.3	91.6	92
Percent composition of dry matter			
Organic matter	90.4	89.5	87.3
Crude protein	15.1	13.3	9.9
Ether extract	1.34	1.20	1.30
Crude fiber	31.0	29.6	37.4
NFE	50.5	46.0	38.7
Calcium	1.35	2.5	0.66
Phosphorus	0.25	0.22	0.14

were tested by multiple range test (Duncan 1955).

Experiment II.

A digestion and metabolism trial was conducted with 8 Najdi yearling wethers divided into 2 groups 4 each with similar body weights; 2 diets of either 2 kg green alfalfa or green atriplex clippings (Table 1) were randomly allotted to the 2 groups of sheep.

A perennial salt bush, *Atriplex halimus* prevalent in the drainage basin area and around Wadi Sirhan range of northern Saudi Arabia was collected every other day during spring (May), when regrowth was abundant. The clippings collected from atriplex plants represented parts consisting of leaves and tender twigs that are mostly annual regrowth and are usually browsed by grazing sheep. Samples of soils at depths of 0, 25, and 50 cm from the area with visually apparent surface salt deposits as well as of atriplex plants grown on it were collected at random and compared with

Table 3. Apparent digestion coefficients of nutrients in diets (Experiments 1 and 2).

Experiment no.	I			S.E.	II		S.E.
Diet no.	1	2	3		1	2	
Kind of roughage	Alfalfa	Acacia	Haloxylon		Alfalfa	Atriplex	
Apparent digestibility (%)							
Dry matter	64[a]	52[b]	54[b]	±0.75	60[b]	65[a]	±1.00
Organic matter	65[a]	53[b]	55[b]	±0.75	65[a]	61[b]	±1.25
Crude protein	73[a]	55[c]	68[b]	±1.64	71[b]	79[a]	±0.50
Crude fiber	44[a]	16[c]	33[b]	±1.19	54[a]	39[b]	±1.50

[a,b,c]Means on the same line of each experiment with different superscripts are significantly different ($P<.05$)

Table 4. Nitrogen utilization of diets (Experiment 1 and 2).[1]

Experiment no.	I			II	
Diet no.	1	2	3	1	2
King of roughage	Alfalfa	Acacia	Haloxylon	Alfalfa	Atriplex
Nitrogen consumed, g/d	20.5	18.2	13.4	14.0	15.9
Nitrogen excreted, g/d					
Fecal	5.6	8.1	4.3	4.0	3.3
Urinary	10.5	6.2	10.9	7.1	8.0
Nitrogen retention, g/d	4.4[a]	3.9[b]	-1.8[c]	2.9[a]	4.6[b]
Percent of intake	21.3[a]	21.5[a]	—	20.7[a]	28.8[b]
Percent of absorbed	29.3[a]	38.8[b]	—	29.0[a]	36.0[b]

[a,b,c]Means on the same line of each experiment with different superscripts are significantly different ($P<.05$).

salinity of soils and the plants from areas without any visible surface deposits of salt.

The green alfalfa harvested simultaneously as a control forage was at the late vegetative stage of growth and was grown under irrigation at the experimental farm at Tabarjal along the range tract. Both the green alfalfa and green atriplex were cut in small pieces (3–5 cm) and fed twice daily in equal amounts; samples were taken at each feeding to determine dry matter. All experimental procedures followed in this digestion and metabolism trial including collection and analysis of biological samples, calculation of energy values and statistical interpretation were similar to those described in experiment 1; sodium, potassium in soils as well as in plant samples were analysed with the help of a Perkin & Elmer 403 Atomic Absorption Spectrophotometer, after wet ashing the samples (Sandel 1950). Chloride was analyzed according to Bradsley and Lancaster (1965).

Results and Discussion

Experiment 1.

Crude protein content of haloxylon (10%) was markedly lower than that of alfalfa (15%), with acacia at an intermediate level (13%) (Table 2). Similar values have been reported previously from this area (Bhattacharya 1987) and elsewhere (ILCA 1980, NRC 1971). Both the calcium and phosphorus content of haloxylon were lower than those of the other 2 forages studied here.

The composition and digestibilities of the dietary nutrients are given in Tables 1 and 3. Crude protein digestibility decreased ($P<.01$) from 73% for alfalfa, to 68% for haloxylon, and to 55% for the acacia diet; the same trend was observed in the digestibilities of dietary organic matter and crude fiber, respective values being 66 and 44% for alfalfa, 56 and 33% for haloxylon, and 53 and 16% for acacia. Wilson (1977) in Australia reported digestibilities of 14% and 63% for fiber and crude protein respectively for acacia forage fed to sheep. Calculated digestibilities from the prediction equation (digestible protein = 0.897 cr. protein - 3.43) reported by IFI (1979), however, were 76% for acacia and 66% for haloxylon forages. Daily nitrogen retention for both the alfalfa and haloxylon diets was 4 g, or 21% of nitrogen intake (Table 4). Nitrogen balance in the group fed haloxylon, however, was negative (-1.9 g/day). Thus, even though the percent nitrogen absorbed out of intake was higher in haloxylon group (67%) than in the acacia-fed group (55%), there seemed to be no retention of the absorbed nitrogen in the former group. The digestible protein, digestible energy, and metabolizable energy values of acacia and haloxylon forages were not markedly different from each other (Table 5), the average values being 7%, 2 Mcal/kg and 1.6 Mcal/kg, respectively. The protein quality of haloxylon forage was questionable and requires further studies. The metabolizable energy value of acacia leaves reported by Economides and Hadjidemetrion (1964) was 1.1 Mcal/kg. Thus, acacia and haloxylon forage can be compared to poor quality roughages such as cereal straw as a feed for livestock.

Table 5. Feed values of alfalfa, acacia, atriplex and haloxylon forages for Najdi sheep (on dry matter basis).

Forages	Digestible protein (%)	Digestible energy	Metabolizable energy
		(Mcal/Kg)	
	Experiment I		
Alfalfa hay, sun-cured	10.8	2.55	2.08
Acacia foliage, sun-cured	7.3	1.90	1.55
Haloxylon clippings, sun-cured	6.7	1.96	1.60
	Experiment II		
Alfalfa, green	17.3	2.73	2.23
Atriplex clippings	14.2	2.05	1.67

Experiment 2.

Sodium, potassium, and chloride contents of the soil surface in the saline area of 5.52, 0.18, and 8.70%, respectively, were significantly higher than the respective values of 0.74, 0.03 and 1.64% for the normal soil surface on the same range (Table 6). However, the soil-salt content of both areas was similar at the 25 and 50 cm depths. The atriplex clippings collected from both areas were not different in their salt contents, the average values being 10.2% sodium, 2.5% potassium, and 16.6% chloride, on a dry matter basis (Table 6). Wilson (1965) reported values of 8.2% sodium, 2.7% potassium, and 7.1% chloride in *Atriplex nummularia* in Australia; the leaf of *Atriplex vesicaria* in their study was as high as 9.6% sodium, 2.8 potassium, and 13.4% chloride. The Middle East feed data (IFI 1979), however, showed 4.41% sodium and 1.35% potassium for *Atriplex halimus*, on a dry matter basis. The chemical composition of the atriplex clippings analyzed (Table 1) had high crude protein (18.5%) yet low crude fiber (23.7%) for a forage, on a dry matter basis. Crude protein was similar to the 18.8% reported by Wilson (1966) for *Atriplex nummularia*. Organic matter content of atriplex was low (73%). Organic matter digestibility of atriplex was 4.8 percentage units lower than that of alfalfa hay (Table 3). Crude fiber digestibility of atriplex was lower ($P<.01$) than that of alfalfa (39 vs 54%). Crude protein digestibility, however, was higher in atriplex (79%) than in alfalfa (71%). Wilson (1966) reported that *Atriplex nummularia* in semi-arid Australia had organic matter digestibility of 55% and crude protein digestibility of 78%, which are not markedly different from the data reported here. Nitrogen utilization values in Table 4 show that not only the nitrogen absorption from atriplex was higher than that from alfalfa, but both nitrogen retention, as well as percent nitrogen retained out of that consumed or absorbed, were also higher than those of alfalfa reflecting the superior quality of atriplex crude protein. Energy and protein values of atriplex presented in Table 5 show that the shrub, even though low in energy value, its digestible protein content approaching that of a legume forage.

Table 6. Sodium, potassium and chloride contents (dry matter basis) of soil at various depths and of salt bush *(Atriplex halimus)* in Wadi Sirhan Range of Northern Saudi Arabia.

	Normal soil[1] site				Saline soil[2] site			
	Soil depth				Soil depth			
Minerals	Surface	25 cm	50 cm	*Atriplex halimus*	Surface	24 cm	50 cm	*Atriplex halimus*
Sodium, %	0.74	0.69	0.68	10.66	5.52	0.87	0.75	9.76
Potassium, %	0.03	0.06	0.05	2.56	0.18	0.06	0.05	2.56
Chloride, %	1.64	1.38	1.33	16.98	8.70	1.38	1.11	16.21

[1]Soil surface without any salt deposit.
[2]Soil surface with salt deposit.

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