Proc. 3rd All Africa Conf.Anim.Agric.& 11th Conf. Egyptian Soc. Anim. Prod., Alexandria, Egypt,6-9 November 2000: 109-115

UTILIZATION OF LESS AND UNPALATABLE HALOPHYTES AS NONCONVENTIONAL FEEDS FOR SHEEP UNDER THE ARID CONDITIONS IN EGYPT

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SUMMARY

Halophytic plants constitute a major part of the indigenous rangelands of Egypt; they have great biomass production allover the year. Utilization of these halophytic plants is becoming a must to provide alternative feed resources in desert areas. This work aimed to study the possibility of utilizing some halophytic shrubs by sheep during dry seasons.

Three natural halophytic shrubs (*Tamarix mannifera, Zygophyllum album, and Halocenemum strobilaceum*) and two cultivated halophytes *(Atriplex nummularia and Acacia saligna)* were ensiled in different proportions with some feed ingredients to formulate six types of silage. The first three were made from a mixture of the natural shrubs alone (S1), or with dried broiler litter (S2) or with anaerobic digested manure (S3). The other three were formulated from a mixture of the natural and cultivated halophytic shrubs alone (S4) or with broiler litter (S5) or with anaerobic digested manure (S6).

Thirty adult Barki rams were divided randomly and equally into 6 treatments for 30 days as a preliminary period followed by a metabolism trail. Animals in the first three treatments: T1, T2 and T3 were fed on silage (S1, S2 and S3, respectively) in addition to a mixture of the fresh cultivated shrubs whereas those in T4, T5 and T6 were fed on S4, S5 and S6, in respective order, only as a sole basal diet. Intake, nutrient utilization, nutritive values, water utilization, nitrogen utilization, sodium and potassium balance were evaluated.

Data from the metabolism trial indicated that the highest silage intake ($P<0.01$) was attained for sheep fed silage 5 (26.5g DM/kg BW and 4.ll g CP/kg BW) which contained the ensiled materials of natural and cultivated shrubs. Meanwhile, the lowest intakes ($P<0.01$) were recorded for animals in T6. Not only digestibility coefficients of DM and CP varied significantly but also NDF, ADF and ADL digestion coefficients. The maximum TDN and DCP intakes were attained by sheep fed silage 5 (T5). Nitrogen retention was positive in all animals except for those in T4 and T6. Water consumption by sheep in T5 was the highest whereas those fed silage 6 (T6) showed the lowest value. Animals in all treatments showed a positive Na balance and retained various amount of Na. Similar trends were showed for K retention except for those in T1. Blood urea-nitrogen, creatinine concentrations, GOT, GPT, sodium and potassium concentrations were, in the normal ranges for all animals. Silage 5 that contained a mixture of the natural and cultivated halophytic shrubs ensiled with dehydrated broiler litter, would be highly recommended as a good quality basal diet for sheep under the arid conditions of Sinai in Egypt.

***Keywords:** Arid conditions, sheep, silage, halophytic shrubs, nutritive values, nitrogen balance, mineral utilization*

INTRODUCTION

Animal production practice in the Egyptian deserts is mainly based on feeding natural vegetation. The native rangelands of Sinai is greatly affected by the annual rainfall precipitation which ranges from 30-70 mm/ annum. These rangelands, as described by Gihad and El Shaer (1994) are an open shrubs vegetation, most likely salt and / or drought tolerant plant species. They vary in their green biomass production, distribution and nutritive value from year to year due mainly, to environmental changes. They are characterized by a short grazing season usually not more than four month / year. They are also characterized by dominance less and unpalatable halophytic shrubs such as *Tamarix mannifera*, *Zygophyllum album*, *Halocnemum strobilaceum*, *Salsalo tetrandra and Haloxylon salicornicum.* The palatable and good quality shrubs are always deteriorated because of over grazing (El Shaer, 1981 and 1996), resulted in scarcity of animal feed resources in such region. The increase of feed resources availability for livestock on range has been in urgent need. Different approaches have been applied including processing of less palatable and non palatable shrubs to improve their quality and quantity (Khamis,1988). Also, the cultivation of some salt and drought tolerant shrubs such as *Acacia saligna* and *Atriplex spp* (Abou El Nasr *et al.*, 1996) was recommended as another proper approache. This study aimed to evaluate the utilization of six halophytic silage made from some natural and cultivated salt shrubs by sheep.

MATERIALS AND METHODS

This study was carried out at Ras Sudr Research Station (Desert Research Canter) south of Sinai. The soil in this area is loamy and has sandy texture and pH of 7.7 . The soil contains 6100 ppm total salt of which 3.6 ppm $SO4^{--}$, 11.5 ppm $CO3^{-}$, 1200 ppm Cl^{-}, 510 ppm Na^{+}, 12ppm K^{+}, 270 ppm Ca^{++} and 170ppm Mg^{++}.

Tamarix mannifera, Zygophllum album and Halocnemum strobilaceum are dominant naturally growing unpalatable shrubs in this area. They were used in the experimental rations. On the other hand, two shrubs (*Atriplex nummularia and Acacia saligna*) were cultivated to be used in experimental rations as they tolerate drought and salinity. Both cultivated and naturally growing shrubs were used as animal feeds in the form of silages . Only fresh green parts of the shrubs were collected in Spring season and used in the silage making after being cut into pieces of 2.5-5.0 cm long using chopping machine. Silage mixture were made by mixing different proportions of chopped shrubs, dried broiler litter, dried anaerobic digested manure (ADM) and molasses as indicated in Table 1.

Table 1. Ensiling materials of the tested silages (%, on DM basis)

Ingredients	Silage 1	Silage 2	Silage 3	Silage 4	Silage 5	Silage 6
Natural shrubs :						
Tamarix mannifera	30	20	20	15	10	10
Zygophyllum album	30	20	20	15	10	10
H. strobilaceum	30	20	20	15	10	10
Cultivated shrubs:						
Atriplex nummularia	-	-	-	18	12	12
Acacia saligna	-	-	-	27	18	18
Broiler litter	-	30	-	-	30	-
*ADM	-	-	30	-	-	30
Molasses	10	10	10	10	10	10
Total	100	100	100	100	100	100

* Anaerobic digested manure (ADM)

The ensiling procedures, physical and fermentative traits of the silages were reported by Fahmy *et al.* (1999). During the feeding trial (30 days), thirty mature Barki rams(averaged 45.3 ± 1.2kg body weight) were divided randomly into six separate treatments (5 rams/treatment) in a complete randomized block design. Animals in the first three treatments(T1,T2,T3) were offered S1,S2 and S3, respectively in addition to a mixture of the fresh cultivated *Atriplex nummularia* and *Acacia saligna* (50% silage + 20% fresh *Atriplex nummularia*+ 30 % fresh. *Acacia*). Animals in T4, T5 and T6 were given S4, S5 and S6, in respective order as sole basal diets without addition of any fresh shrubby materials. All basal diets were offered *ad libitum* in addition to approximately 10 g DM/ Kg BW of concentrate feed mixture (CFM) to cover 50% of the maintenance requirements of energy (Kearl, 1982). Daily voluntary intake of diets was determined for each group. Drinking water was offered for a fixed time. Animals were weighed biweekly and body weight was recorded for each animal during the feeding trial.

Three animals from each group were selected to be used in a metabolism trial (15 days) immediately after the end the feeding trial. Feed intake and drinking water were determined for each animal. During a 7-day collection period , representative samples of feed ingredients , feed offered and residues, feces and urine were collected for proximate analysis (A.O.A.C.,1990). Fiber constituents (neutral detergent fiber, NDF; acid detergent fiber, ADF and acid detergent lignin, ADL) were determined (Goering and Van Soest, 1970). Sodium (Na) and potassium (K) concentrations were measured (Jackson, 1958). Blood samples were tested for enzymes of liver function glutamic oxalacetic aminotransferase (GOT) and glutamic pyruvic transferase (GPT) using calorimetric method end point (Schmidt and Schmidt, 1963). Blood urea- nitrogen (BUN) levels were determined (Coulombe and larreau, 1963) and creatinine levels were also tested (Jaffe, 1986). Data were subjected to the statistical analysis (SAS,1990). Significant differences among treatments were, also, tested.

RESULTS AND DISCUSSION

Table 2 showed that *Atriplex nummularia* contained more ash than that of *Acacia saligna* by 140%. All silages contained a comparable values of ash averaged by 22.9%. Concerning crude protein (CP) percentage, all silages contained moderate CP levels . Silage 5 exceeded by, approximately 50% that of silage 1 due to including broiler litters in the ensiled materials (Abou El Nasr *et al* .. 1996). The highest NDF values were attained in the fresh cultivated shrubs compared to those of the silages. The lowest NDF concentration (40.6%) were recorded in S5 and relatively lower ADL (11.0%) indicating that such silage could be efficiently utilized (El Shaer *et al.*, 1990). Mineral content as percentages on DM basis in the cultivated shrubs and silages are also presented in Table (2) . It was noticed that *Atriplex nummularia* contained highest concentration of sodium (Na) and potassium (K) and exceeded by approximately 309 and 109 % that of *Acacia saligna*. Sodium (Na) concentration in silage 3 was the highest (2.25%) whereas the minimum (1.3%) was recorded in silage 1. Potassium concentration in silage 6 was the highest one (1.73%) followed by silage 5, Silage 3 , silage 2, silage 4 and silage 1 in descending order. Sodium and potassium concentrations of all silages were above dietary requirements of the Keral (1982) but without any harmful effects. Data showed that (Na) and (K) contents of all types of silages decreased as result of ensiling process. The results are in harmony with those obtained by El Shaer *et al.* (1991) and Gihad and El Shaer (1994).

Table 2. Chemical composition, sodium and potassium concentrations and fiber constituents of diets (% on DM basis)

Criteria	DM	Ash	CP	NDF	ADF	ADL	Na	K
Silage 1	45.0	22.7	7.10	51.1	28.9	7.50	1.30	0.88
Silage 2	59.2	22.7	9.10	52.0	34.1	13.8	1.67	1.07
Silage 3	45.7	30.8	8.40	42.7	28.6	13.2	2.25	1.20
Silage 4	47.4	22.6	7.20	50.5	33.5	13.8	1.60	0.95
Silage 5	48.1	23.4	13.9	40.6	25.4	11.0	2.00	1.40
Silage 6	49.2	23.3	9.50	47.4	33.8	15.4	2.10	1.73
Concentrate feed mixture	87.5	8.50	18.0	39.7	14.0	7.10	0.74	0.37
Atriplex nummularia	40.4	25.5	12.2	60.5	33.1	10.3	4.50	2.30
Acacia saligna	44.8	10.6	8.80	63.0	44.1	18.4	1.10	1.10

Data on dry matter (DM), crude protein (CP) intakes of basal diets and total diets , nutrients digestibilites and nutritive values of different diets fed to sheep are presented in Table 3. Both dry matter (DM) and crude protein (CP) intakes of basal diets were significantly varied ($P<0.01$) among treatments. The minimum DM and CP intake of basal diets were recorded by sheep fed silage 6 whereas the maximum crude protein intake (CPI) was recorded for those fed silage 5. Digestion coefficients of DM and organic matter (OM) did not significantly vary among treatments but CP, NDF, ADF and ADL digestion coefficients significantly varied due to treatments effect. It was noticed that digestibility coefficients of CP, NDF,ADF and ADL were the highest in T6 that could be due to the lowest feed consumption; on the other hand digestibility coefficients of OM, NDF, ADF and ADL were the minimum in T2 attributed to higher ADF content of diet T2 (Conrad , 1966). Sheep fed diet 5 of T5 showed the highest nutritive values in terms of total digestible nutrients (TDN) and digestible crude protein (DCP). Animals in T5 consumed the greatest amounts of TDN (14.1g/kg BW) and DCP (2.77 g/kg BW). It means that diet 5 of T5 which contained the ensiled halophytic natural and cultivated shrubs in addition to broiler litter appeared to be more palatable and nutritious for sheep . The results are in harmony with the findings of Abd El Rahman (1996) and Fahmy *et al* . (1999).

Nitrogen intake, excretion and retention significantly varied due to treatment effect (Table 4). Sheep fed diet T5 showed the highest nitrogen intake due to higher feed consumption and nitrogen content. All sheep were in positive N balance except those in T4 and T6 because of lower nitrogen intake in T4 and T6 (Abou El Nasr *et al.*, 1996) . Sheep in T5 retained the greatest amount of N which caused an increase in their body weights. This means that diet 5 of T 5 was the most nutritious diet for sheep. The obtained results are close to the findings of Kandil and El Shaer (1988) and El Shaer *et al.* (1991).

Sodium (Na) intake and excretion were significantly varied among animal groups but sodium retention did not significantly vary among treatments. Sheep fed diet 5 of T5 consumed and excreted the maximum values of sodium whereas those fed diet 4 and diet 6 consumed and excreted the least amounts of sodium. All animals were in positive Na balance and retained various amounts of sodium. Potassium intake, excretion and retention were also significantly ($P<0.001$) differed among treatments, Sheep fed diet 2 of T2 consumed the greatest amounts of potassium whereas those fed diet 6 consumed the lowest amounts. The highest K retention was attained by animals in T3 followed by those in T5, T2, T4 and T6 in descending order. Meanwhile those fed diet 1 of T1 lost potassium from their bodies because of lower K intake in relative to higher K excretion. The results of Na and K utilization are in harmony with those reported by Gad (1990) on small ruminants.

Table 3. Dry matter, crude protein intake, digestibility coefficients and nutritive values of diets fed to sheep

Criteria	T1	T2	T3	T4	T5	T6	± SE	F. test
No. of animals	3	3	3	3	3	3		
Live body weight, Kg	46.6	49.0	45.0	46.0	42.0	41.0	1.45	NS
DMI, g/Kg BW								
Basal	26.7^{a}	27.2^{a}	20.6^{ab}	16.6^{ab}	26.5^{a}	12.2^{b}	7.93	**
Total	36.7^{a}	37.2^{a}	30.6^{ab}	26.6^{ab}	36.5^{a}	22.2^{b}	7.93	**
CPI, g/Kg BW								
Basal	2.08^{c}	2.99^{b}	2.28^{bc}	1.46^{c}	4.11^{a}	1.63^{c}	0.23	***
Total	3.49^{c}	4.39^{b}	3.67^{bc}	2.86^{c}	5.51^{a}	3.04^{c}	0.23	***
Digestibility coefficients%								
DM	38.4	38.6	52.1	43.1	45.6	46.2	0.41	ns
CP	45.5^{b}	45.1^{b}	47.0^{b}	41.4^{b}	49.9^{b}	62.0^{a}	3.23	**
OM	37.6	37.7	47.3	43.1	44.8	45.8	1.48	Ns
NDF	32.2^{b}	32.3^{b}	42.8^{a}	36.4^{ab}	35.8^{b}	43.3^{a}	1.37	*
ADF	21.2^{cd}	17.1^{d}	25.7^{c}	27.9^{c}	35.4^{b}	42.7^{a}	2.21	***
ADL	7.20^{bc}	3.63^{c}	11.0^{ab}	11.9^{ab}	8.23^{bc}	14.7^{a}	1.09	*
Nutritive values:								
TDN, %	29.0	33.1	40.1	37.2	38.2	41.0	1.26	ns
DCP, %	5.36^{bc}	5.33^{bc}	5.66^{b}	4.47^{c}	7.53^{a}	8.50^{a}	0.35	***
Digested nutrients intake:								
TDN, g/Kg BW	10.0^{ab}	12.3^{ab}	12.3^{ab}	9.90^{ab}	14.1^{a}	8.92^{b}	1.84	**
DCP, g/Kg BW	1.59^{bc}	1.98^{b}	1.73^{bc}	1.20^{c}	2.77^{a}	1.89^{bc}	0.14	***

a,b,c values with different letters on the same row differ at 5%.
ns = not significant ;* = P<0.05 ;** = P<0.01 ; *** = P<0.001

Table 4. Nitrogen (N), Sodium (Na) and Potassium (K) utilization by sheep

g/Kg BW$^{0.75}$	T1	T2	T3	T4	T5	T6	± SE	F. test
Nitrogen:								
Intake	1455^{cd}	1859^{b}	1533^{c}	1205^{d}	2233^{a}	1218^{d}	93.2	***
Total excretion	1318^{b}	1491^{b}	1244^{b}	1321^{b}	1837^{a}	1336^{b}	60.6	*
Balance	137^{ab}	368^{a}	289^{a}	-116^{b}	396^{a}	-118^{b}	58.9	***
Sodium:								
Intake	1509^{bc}	2057^{a}	1738^{b}	1234^{c}	1724^{b}	908^{d}	95.7	***
Total excretion	1421^{b}	1992^{a}	1629^{b}	1088^{c}	1600^{b}	836^{c}	96.7	***
Balance	88	65	109	146	124	72	11.7	ns
Potassium:								
Intake	918^{c}	1250^{a}	988^{bc}	693^{d}	1119^{ab}	636^{d}	56.8	***
Total excretion	1045^{ab}	1238^{a}	956^{b}	689^{c}	1100^{ab}	632^{c}	56.8	***
Balance	-127^{c}	12^{ab}	32^{a}	4.00^{b}	19^{ab}	4.00^{b}	13.1	***

a,b,c values with different letters on the same row differ at 5%,
ns = not significant ; *=p<0.05 ; **=p<0.01 ; ***=p<0.001

Average values of water intake and excretion by sheep are presented in Table 5. Free water intake expressed as ml/kg $W^{0.82}$ or ml /g DMI did not significantly (P>0.05) vary due to treatments effect.

The maximum free water consumption was showed in T2 whereas the minimum values was recorded in T6 since the feed consumption pattern was varied as shown in Table 3. Combined water (feed moisture) significantly varied among treatments. Combined water intake ranged from 26.1 ml/kg $W^{0.82}$ in T6 to 57.5 ml /kg $W^{0.82}$ in T5. Metabolic water consumption did not vary (P>0.05) among treatments. It ranged from 10.4 ml/kg $W^{0.82}$ in T6 to 16.5 ml/kg $W^{0.82}$ in T5. Summation of free water, combined water and metabolic water values resembled the total water intake. Total water intake varied (P<0.05)due to treatments effect. The maximum total water intake (319 ml/kg $W^{0.82}$) was recorded by sheep in T2 due to highest feed consumption followed by those in T5, whereas the lowest values (193 ml/kg $W^{0.82}$) was recorded in T6 due to the lowest feed consumption. Data are in agreement with those obtained by several investigators (Khamis, 1988; Kandil and El Shaer, 1990 and El Shaer *et al.*, 1991). Summation of water excreted via faeces and urine resembling the total water excretion which significantly varied ($P<0.05$)among treatments. Water excreted through sweat and respiration which called insensible water loss significantly varied ($P<0.01$) among treatments. Animals in all treatments except those in T6 are vital significance to best regulation under the intensive heat load of arid desert conditions . Such results are in harmony with the findings of Khamis, (1988) and El Shaer *et al.* (1990).

Table 5. Water utilization by sheep fed different types of diets

ml/Kg $BW^{0.82}$	T1	T2	T3	T4	T5	T6	± SE	F. test
Free water intake	181	247	160	199	240	156	11.9	ns
Combined water	54.9^{a}	57.0^{a}	54.2^{2}	41.8^{b}	57.5^{a}	26.1^{c}	2.99	***
Metabolic water *	12.0	14.8	14.8	11.9	16.5	10.4	0.72	ns
Faecal water excretion	34.0^{abc}	50.0^{a}	31.6^{abc}	24.8^{bc}	40.4^{ab}	18.8^{c}	3.15	*
Urinary water excretion	90.4	120	64.7	97.4	133	114	7.56	ns
Total water excretion	124.4^{ab}	170^{a}	96.3^{b}	122^{ab}	173^{a}	133^{ab}	8.89	*
Insensible water loss	123.5^{a}	149^{a}	132^{a}	130^{a}	141^{a}	60.0^{b}	8.21	**

* Metabolic water was calculated from TDN intake and a yield of 0.6 gram water per gram TDN (the carbohydrate factor). ns= not significant ; *=p<0.05 ; **=p<0.01 ; ***= p<0.001

a,b,c values with different letters on the same row differ at 5%

Data of blood urea – nitrogen (BUN), creatinine, glutamic oxalactic acid transaminase (GOT), glutamic pyruvic transaminase (GPT), Sodium (Na) and Potassium (K) concentration are presented in Table 6. It was found that blood urea level was significantly differed due to treatments effect. There was a slight increase in urea nitrogen levels as a result of inclusion of broiler litter or anaerobic digested manure in T2, T3, T5 and T6 in comparison with those of T1 and T4 since such feed materials contained large proportions of non-protein nitrogen (NPN). Data on BUN concentrations were within the normal levels in all treatments as recorded by Rakha (1985) which ranged from 8 to 40 mg/100 ml. Such values of BUN concentrations indicated that feeding sheep on the ensiled halophytic shrubs mixed with broiler litter or anaerobic digested manure had no adverse effect on kidney function. These results are close to those obtained by Bayoumi *et al.* (1990) and Sayed (1996).

Creatinine level did not significantly vary among treatments. It ranged from 0.97 mg/100 ml in T2 to 2.57 mg/100 ml in T6. From previous data , it was found that the values of creatinine for sheep were within the normal levels as reported by Puls (1988).Therefore , it could be concluded that there in no any adverse effects on health situation of animal kidney function when halophytic shrubs silage used as sole diet . Results are in harmony with those obtained by Aly (1995).

Glutamic oxalacetic transaminase (GOT) and Glutamic pyruvic transaminase (GPT) concentrations did not significantly vary among treatments. The maximum GOT and GPT levels were recorded in T6 (17.3 and 11.3 U/L), meanwhile the minimum values were attained in T5 and T3, respectively. However the values of GOT concentrations were within the normal levels as reported by Puls (1988) indicating that there is no any adverse effect on liver function as result of utilizing halophytic plants mixed with broiler litter or anaerobic digested manure in feeding sheep .

Table 6. Some blood metabolites of sheep fed different types of diets

Criteria	T1	T2	T3	T4	T5	T6	± SE	F. test
BUN level, mg/100 ml	21.7^{b}	33.3^{a}	34.7^{a}	23.3^{b}	29.4^{ab}	31.3^{ab}	0.54	*
Creatinine level,mg/100 ml	1.10	0.97	1.10	1.23	1.33	2.57	0.07	ns
GOT concentration, U/L	15.7	16.7	15.3	14.0	8.3	17.3	0.38	ns
GPT concentration , U/L	7.67	7.33	8.33	9.20	10.3	11.3	0.18	ns
Sodium level , mg/100 ml	360	329	340	363	381	363	3.50	ns
Potassium level,mg/100 ml	16.8	17.0	16.8	13.5	17.7	17.7	0.44	ns

a,b,c values with different letters on the same row differ at 5%

ns = not significant ; *=p<0.05 ; ** =p<0.01 ; ***=p<0.001

Sodium (Na) and Potassium (K) levels in serum (Table 6) did not significantly vary due to treatments effect. The normal sodium levels of sheep ranged from 320 to 360 mg/100 ml whereas the normal potassium levels of sheep ranged from 15 to 21 mg/100 ml as reported by Puls (1988).

Therefore, Na concentration was, in general, within the normal levels. The highest sodium concentration of sheep was recorded in T5 with slight an increase above normal values . Potassium levels ranged from 13.5 mg/100ml in T4 to 17.7 mg / 100 ml in T5. Potassium levels in all treatments were within the normal levels. Data are nearly close to those obtained by Fahmy (1993) and Ahmed

(1995).

From the previous data on BUN, Creatinine, GOT, GPT, Na and K concentrations of sheep, it could be concluded that all animals were in normal status and good health since the values of these parameters were within normal levels. Therefore, such basal diet, particularly silage No.5 which contained the ensiled halophytic shrubs (either naturally growing and cultivated) and dried broiler litter could be recommended as good animal diets.

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