

INTAKE AND NUTRITIVE VALUE OF SOME SALT TOLERANT FODDER GRASSES FED TO SHEEP UNDER SALINE CONDITIONS OF SOUTH SINAI.

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SUMMARY

Utilization of salt tolerant plants has become an appropriate approach to solve the problems of animal feed shortage. This study aimed to evaluate the palatability and nutritional values of three cultivated salt tolerant grasses (Sudan grass, Pear millet and Sorghum grass) irrigated with two levels of water salinity (level 1, L1, 4000 ppm and level 2, L2, 7000 ppm total salts). Six equal number groups of adult Barki rams were offered one of the three grasses for each group. A palatability trial followed by a digestibility trial was conducted where some nutritional measurements were evaluated. The results showed that grasses irrigated with L1 and L2 water salinity appeared to be nutritious for sheep since it contained enough concentrations of CP with low contents of ADF and ADL. The VFI of the grasses was slightly affected by the level of water salinity. Digestion of all nutrients were varied and affected to some extents by levels of water salinity. Digestion of DM, CF and NFE were higher for animals of L1 compared to those of L2. The nutritive values of the grasses were influenced by the levels of water salinity. All grasses irrigated by L2 attained significant higher DCP values than those irrigated by L1. Regardless plant species, animals fed the grasses of L2 retained around 38% more nitrogen than those of L1. Sheep fed the three grasses irrigated with L2, generally, retained positive various amounts of copper, zinc and cobalt but they should be supplemented with such trace elements if they fed on grasses irrigated with L1. The forages production for all grasses of L1 was greater than those of L2.

Keywords: sheep, salt tolerant grasses, feeding value, grass yield, salinity

INTRODUCTION

Salinity is a global problem worldwide in particular in arid and semi- arid zones in countries of North Africa and the Near East regions. Saline soils of various nature and degree occupy over 80 million hectares in the Mediterranean basin (Anon, 2006). The cultivation of salt-tolerant crops or halophytes on saline soil has significant social and economic potential that needs to be further explored and developed. The problems confronting farmers in Egypt are associated with how to prevent salinification and to produce economic fodder crops to overcome the problems of feed shortage and high

feeding costs. Promising results have been obtained in different countries in the region with rehabilitation of potential halophytic species (Nemati, 1976 and El Shaer, 2004) particularly for fodders production. Several investigators concluded that cultivation of salt and drought tolerant fodder shrubs (i.e, *Atriplex spp*, *Acacia saligna* and *kochia indica* etc.) and salt and drought tolerant grasses and legumes (sorghum, pearl millet, sudan grass, alfalfa, sanfoin, etc.) may consider the appropriate solutions for filling the gab of feed deficiency in arid and saline areas (El Shaer, 2006; Khafaga, 1999 and Hanfy, *et al.*, 2007). This study aimed to evaluate the palatability and nutritional values of three annual salt tolerant grasses irrigated with two levels of salinity in ground water using sheep. The biomass production of the grasses and the nutritional performance of sheep were tested.

MATERIALS AND METHODS

The study was undertaken at South Sinai Research Station, Desert Research Center, Sinai Peninsula, (200 Km southeast of Cairo) during late summer of 2007.

Cultivation and preparation of experimental plants:

Three annual salt tolerant grasses: Sudan grass (*Sorghum sudanense*), Pearl millet grass (*Pennisetum americanum*) and Sorghum grass (*Sorghum bicolor*) were cultivated in the salt affected soil of South Sinai Research Station. Two levels of underground water salinity were used for irrigation: level 1 (L1, 4000 ppm) and level 2 (L2, 7000 ppm total salts). Chemical composition of irrigation water is shown in Table 1. The daily harvested plant materials were mechanically chopped into small pieces(averaged 10 cm length) to be offered to the experimental animals. The total fresh and dry yields of the cultivated grasses were determined and recorded. Salinity concentration (EC) in level 2 of salinity (L2) was almost doubled that of the level 1 (L1) most of minerals of L2 such as Na, K and Cl concentrations were higher than those of the L1. The soil of the field in the Research Station is characterized as loamy sand texture where EC was around 10 ds/m which was considered as strongly saline. The CaCO₃, Cl, Na, Ca, Mg and K concentrations were : 40, 42, 11.6, 15.2, 10.8 and 7.5 mg/ 100mg, respectively.

Table (1): Averages of chemical analysis of ground water irrigation at South Sinai Research Station.

Item	Level 1 of salinity*	Level 2 of salinity*
pH	7.67	7.39
EC, ds/m	7.53	13.9
Na ⁺ mg/100 mg	30.3	40.2
Ca ⁺⁺ mg/100 mg	20.6	23.94
Mg ⁺⁺ mg/100 mg	11.9	16.6
K ⁺ mg/100 mg	0.99	2.88
Cl mg/100 mg	29.1	42.43
HcO ₃ mg/100 mg	3.28	3.28
So ₄ mg/100 mg	20.2	24.3

*Level 1 of salinity (L1) and Level 2 of salinity (L2).

Animal feeding and measurements:

Eighteen adult Barki rams were used in six groups (3 rams per group) in a randomized design (two by three factorial designs: two salinity levels X three plant species). Each rams group was offered one of the following six grasses: Sudan grass, pear millet and sorghum grass irrigated with L1 and L2 ground water salinity (Group 1, Group 2 and Group 3, Group 4, Group 5 and Group 6, respectively). The animals were housed in separate shaded pens for 30 days period in a palatability trial, and then moved to individual metabolic cages for additional 15 days as digestibility trials. During the palatability trial, the initial live body weight of rams were 38.7 ± 2.03 , 39.3 ± 2.92 , 39.7 ± 4.34 , 40.5 ± 1.38 , 40.7 ± 1.83 , 41.1 ± 3.84 Kg for 1st, 2nd, 3rd, 4th, 5th and 6th group, respectively. All animals were individually offered weighed amount of each grasses *ad libitum* twice daily at 08:00 and 16:00 and concentrate feed mixture (CFM) was given, as feed supplement, to cover 50% of their energy maintenance requirements according to the recommendations of Kearn (1982). The CFM consisted of 30% cotton seed cake, 47% yellow corn, 20% wheat bran, 2% limestone and 1% common salt; which contained: 91.2, 8.2, 20.8, 11.1, 6.9 and 53 % for DM, Ash, CP, CF, EE, NFE, respectively. The daily voluntary feed intake (VFI) of grasses was calculated for each animal. All animals were weighed at the beginning of the experiment and every other week and biweekly body weight changes were recorded. Drinking water was offered free choice.

Metabolism trials:

At the end of palatability period, the animals were moved to the metabolism cages for two weeks, the first week was an adaptation period followed by another week as a collection period where 90% of the VFI of each grasses were offered to animal according to their groups and total feed intakes was recorded. Drinking water was available for one hour daily, measured and recorded. Composite samples from each grass species was collected, oven dried at 65 °C for 48 hours and ground, then kept for proximate chemical analyses and mineral composition. Urine and feces were collected, measured and sampled for proximate analysis.

Analytical and statistical analyses:

Proximate analysis of diets (grasses and CFM), faeces were tested A.O.A.C, (1990). Total nitrogen in urine was determined by the micro Kjeldahl methods. Fiber constituents (neutral detergent fiber, NDF, acid detergent fiber, ADF, acid detergent lignin, ADL) were determined according to Goering and Van Soest, 1970. Hemicellulose and cellulose values were calculated by difference. Sodium (Na) and potassium (K) were determined in feed, refusal, faeces, urine and drinking water by using the standard flame photometry (Jackson, 1958) while Copper (Cu), Zinc (Zn) and Cobalt (Co) concentrations were tested using atomic absorption techniques.

The data were statistically analyzed using two way analysis of variance (2 levels of salinity X 3 forage species factorial design). Data were subjected to the statistical analysis system according to SAS (1993). Differences in mean values among groups were compared by Duncan's Multiple Range Test, (Duncan, 1955).

RESULTS AND DISCUSSION

Chemical and mineral composition of the experimental diets:

Regardless the plant species, as illustrated in (Table 2) plants irrigated with L2 contained higher CP, ADL, ash and the trace elements (Cu, Zn and CO) contents in comparison with those irrigated with L1 of water salinity. On the other hands, CF, EE, and NDF, Na, K concentrations were not affected by salinity levels in irrigation water.

Table (2): Chemical composition, fiber constituents and mineral contents of the experimental fodder grasses.

Item	level 1 of salinity (L1)			Level 2 of salinity (L2)		
	Sudan Grass	Pearl Millet	Sorghum	Sudan Grass	Pearl Millet	Sorghum
Chemical composition, %						
DM	91.1	91.7	90.4	88.2	89.1	88.5
Ash	10.4	14.9	10.9	12.6	14.4	14.5
CP	12.3	13.4	11.8	13.6	13.6	13.2
CF	24.1	25.8	24.9	24.3	26.1	24.9
EE	2.1	2.8	1.65	1.85	1.49	2.86
NFE	51.1	43.1	50.75	47.65	44.41	44.56
Fiber constituents, %						
NDF	76.8	81.2	77.0	73.1	82.4	76.6
ADF	32.8	32.3	37.6	29.7	33.5	28.3
ADL	3.13	2.32	2.58	4.10	4.90	3.20
Mineral contents :						
Sodium (Na), %	2.1	1.8	1.7	2.1	2.1	1.9
Potassium (K), %	3.7	3.0	2.5	3.8	3.1	2.5
Cobalt (Co), PPM	81	85	88	91	105	102
Zinc (Zn), PPM	78	53	48	81	80	80
Copper (Cu), PPM	12	11	14	15	18	16

Regardless the level of salinity, CP content was relatively similar in all forage species (averaged 13.0, 13.5 and 12.5 % for Sudan grass, Pear millet and Sorghum grass, respectively whereas Pear millet grass attained more concentrations of ash and CF. Comparable values were obtained by several investigators using Pearl millet (El Shaer *et al.*, 1987; Messman *et al.*, 1992 and Fahmy, 2001), Sorghum (Gabra, 1984) and Sudan (Moawd, 1998). The experimental grasses irrigated with two salinity levels L1 and L2 appeared to be nutritious for small ruminants since it contained enough contents of CP (averaged 13%) to cover their protein requirements with low concentrations of ADF and ADL (averaged 31.0 and 3.62% for Sudan grass; 32.9 and 3.61% for Pearl millet; 33.0 and 2.39 % for Sorghum grass, respectively). All grasses irrigated with L2 of water salinity attained higher concentrations of all minerals particularly the trace elements. However the grasses contained more than enough of the tested minerals (Na, K and Zn) with moderate concentrations of Cu and Co. Although some minerals concentrations (Na, K and Zn) were higher than the recommended levels, they were still within the maximum tolerance levels and far from the toxic levels for sheep (Kearl, 1982).

Voluntary feed intake (VFI) of grasses:

During the palatability trial, the VFI's of the grasses were affected to some extents by level of salinity in the irrigated water. The VFI were slightly improved when fed the grasses irrigated with L1 as shown in (Table 3). All animals in different groups appeared to consume enough amounts (approximately 2 % of their body weight) of the grasses to cover their nutritional requirements and also tended to gain appreciable weight (Kearl, 1982 and Fahmy 2001). The highest value (approximately 23g DM/Kg BW) was recorded for sheep fed on Sorghum irrigated with L1, whereas Sudan grass attained the highest (about 21g DM/ Kg BW) among the grasses irrigated with L2.

Table (3): Voluntary feed intake (FVI) and body weight changes of sheep fed the grasses during the palatability trial.

Item	*L1			*L2		
	Sudan grass	Pearl millet	Sorghum	Sudan grass	Pearl millet	Sorghum
No. of animals	3	3	3	3	3	3
Initial live weight, Kg	38.7	39.3	39.7	40.5	40.7	41.1
Final body weight, kg	40.6	40.7	41.2	41.8	42.2	42.5
Body weight change, Kg	1.90	1.40	1.50	1.30	1.50	1.40
VFI, g DM/Kg BW	21.2	21.0	22.9	20.7	19.2	19.6

* Level of water salinity (L1, L2)

Feed intake, digestibility and nutritive values:

Data in Table (4) revealed that all animal groups tended to consume comparable amounts of each grass irrigated by both L1 and L2 with averages of 18.9, 18.4 and 19.2 g DM/kg BW, respectively. Regardless the plant species, it seems that the consumption of grasses was not affected significantly (19.72 vs. 17.99 g DM/ Kg BW) by irrigated water salinity. Dry matter intake from Sudan grass, pearl millet and sorghum grasses irrigated with L1 of salinity were 21.2, 21 and 22.9g/KgBW. These findings are in agreement with those obtained by Mowad (1998) found that dry matter intake by sheep fed *ad libitum* from first and second cuts of pearl millet were 27.3 and 25.2 g/Kg BW. Similar trends were reported for crude protein intake.

Digestion of DM, CP, CF and other nutrients were varied and affected to some extents by levels of salinity of irrigation. Digestion of DM, CF and NFE were higher for animals fed the grasses irrigated by L1 compared to those with L2, whereas CP digestion was superior without significant differences for animals fed grasses irrigated by L2 (66.2 vs. 60.6 %) due to high content of CP in grasses irrigated by L2 water salinity. As presented in table 4, the nutritive values of the grasses, in terms of total digestible nutrients (TDN) and digestible crude protein (DCP) values were significantly ($P < 0.05$) influenced by the levels of salinity in irrigation water but did not varied significantly among the plant species. All grasses irrigated by L2 water salinity attained significant higher DCP values than the other grasses (10.5 vs. 9.37 %). Such results supported by the earlier trends of

sheep and goats fed Pearl millet and sorghum in studies conducted by Gabra (1984), Messman, *et al.* (1992) and Abd el Baky, *et al.* (1994). Regardless salinity level, the present values of TDN (57.3%) for pearl millet are nearly similar to those (60.6%) obtained by Mowad (1998).

Concerning nitrogen utilization data, it was pointed out (table 5) that both nitrogen intake and fecal nitrogen were not affected significantly ($P>0.05$) by the levels of salinity in irrigation water. However, total nitrogen excretion was significantly influenced by plant species while nitrogen retention was affected only by water irrigation salinity. It appears that all animals consumed similar amounts of nitrogen (approximately 645 mg/kg BW) since the animals consumed comparable amounts of grasses dry matter (Table 3) in addition to similar CP content in the forages as well (Table 2). It was surprising that, regardless plant species, animals fed the grasses irrigated with L2 retained around 38% more nitrogen (as percentage of N intake or mg/kg BW) than those fed the grasses with L1. Similar findings on nitrogen retention from feeding the same grasses species irrigated with fresh water (approximately 450 ppm total salts) were obtained by Madan Mohan *et al.* (1977); El Gendy (1990) and Abd El Hamid (1998).

Data in (Table 6) indicated that the measured parameters for water utilization were influenced to some extents by the two factors: irrigation water salinity and grasses species. Animals fed Pearl millet grass (irrigated with L1 or L2) tended to consume 14 and 25% drinking water more than those fed Sudan grass and Sorghum grass, respectively. Similar trends were obtained for the total water intake value which recorded 12 and 25% higher for sheep fed the Pearl Millet compared to their mates fed Sudan and Sorghum grasses, respectively. However, total water intake indicated herein for the experimental sheep were slightly higher than those reported by Fahmy (2001) and Shehata *et al.*, 2001 since their sheep on similar grasses species contained less concentrations of ash contents. It was interesting to notice that all sheep fed the three grasses irrigated with the two levels of salinity retained relatively similar amounts of water (55.8, 53.8 and 54.7 % of intake, for Sudan grass, Pearl Millet and Sorghum grasses groups, respectively).

Sodium (Na) and Potassium (K) utilization (table 7) revealed that Na intake from the grasses, Na excretion and retention did not significantly affect by either the levels of salinity in irrigation water or by plant species while all parameters of K utilization were significantly influenced by the two factors. Sheep fed Sudan grass irrigated by L1 or L2 consumed slightly higher ($P>0.05$) amounts of Na but with significant amounts of K compared to those fed Pearl millet and Sorghum grasses. Such higher intake could be attributed to high Na and K concentrations in Sudan grass (as shown in Table 2). The same trends were obtained with regards to Na and K retention.

Sheep fed the three grasses irrigated with L1 or L2 tended to consume relatively comparable amounts of Cobalt while Zink and Copper intakes were influenced significantly by grasses species or levels of salinity of irrigated water. High intake of Zink ($P<0.05$) recorded by sheep fed Sudan grass might be attributed to its higher content of Zink (79.3 ppm) compared to other grasses (Table 2 & 7). It seems that all sheep fed the three grasses irrigated with L1 water salinity showed variable trends in Cu, Zn and Co retention. The obtained negative retention might be attributed to lower concentrations of those minerals in forages irrigated with L1 compared with those irrigated with L2 (Table 2). It could be recommended that sheep fed on such grasses irrigated with L1 should be supplemented with Cobalt, Zinc and Copper to cover their requirements since they did not able to retain any amounts of these trace elements. On the other hands, feeding the L2

irrigated grasses improved the retention of such trace elements since the animals retained positively various appreciable amounts of these elements, in particular Zn element.

The forage crop yields, as fresh or in terms of DM, TDN or DCP yield per acre on average bases, of the three grasses irrigated with L1 were (approximately 50%) greater than the same grasses species irrigated with L2 (Table 8). Among the grasses, Sorghum grass irrigated with L1 water was superior, and attained the highest yields of DM, CP, TDN and DCP due mainly to its higher fresh and dry yields. From the data presented in table 8 and based on the recommended nutritional requirements by Kears (1982) it appeared that the yield of these nutrients per an acre from Sorghum grass (irrigated with L1) could cover the maintenance and lactation requirements of 55 and 24 sheep, respectively for 90 days.

CONCLUSION

The experimental grasses cultivated in strongly saline soils (10 dS/m^{-1}) and irrigated with water contained level 1 of salinity (L1, 4000 ppm total salts) or level 2 of salinity (L2, 7000 ppm total salts) appeared to be nutritious for small ruminants as it contained enough contents of nutrients to cover their nutritional requirements in addition to promising forage crop yields in particular Sorghum grass irrigated with saline water (4000 ppm total salts). Such salt tolerant grasses could be used successively and safely as good quality summer fodders to solve the problems of feed shortage during summer and autumn seasons and, also, to increase the economical value of the marginal saline resources in Egypt.

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المأكول والقيمة الغذائية لبعض الأعلاف النجيلية المغذاة للأغنام تحت ظروف الملوحة في جنوب سيناء

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إستخدام النباتات التى تتحمل الملوحة أصبح من الوسائل التطبيقية الملائمة لحل مشكلة نقص الأعلاف. تهدف هذه الدراسة الى التقييم الغذائى والاستساغة لثلاث محاصيل نجيلية (حشيشة السودان - الدخن اللؤلؤى - السورجم) منزرعة تحت مستويين من ملوحة مياة الري (مستوى ١ - ٤٠٠٠ جزء فى المليون مستوى ٢ ٧٠٠٠ جزء فى المليون أملاح كلية) عدد ١٨ من الكباش البرقى وزعت توزيعا عشوائى على عدد ٦ مجموعات (٣ كباش بكل مجموعة) حيث قدم للمجموعات الأولى والثانية والثالثة واحد من الأعلاف الثلاث المنزرعة تحت مستوي ملوحة ١ بينما قدم للمجموعات الرابعة والخامسة والسادسة واحد من الأعلاف الثلاث المنزرعة تحت مستوى ملوحة ٢ أجريت تجربة استساغة ثم أبعث بتجربة هضم لتقدير بعض القيم الغذائية .

أظهرت النتائج ان الأعلاف النجيلية الثلاث المنزرعة تحت مستويين ملوحة (٢٠١) وكانت مغذية للأغنام حيث كان محتواها من البروتين الخام كفاى مع محتوى منخفض من ADF - ADL . تأثر المأكول الاختيارى تأثيرا طفيفا بمستوي الملوحة . تباينت وتأثرت الى حد ما معاملات هضم كل العناصر الغذائية بمستوى ملوحة ماء الري . كانت معاملات هضم المادة الجافة- الألياف الخام- المستخلص الذائب الخالى من النترجين للأعلاف المنزرعة تحت مستوى ملوحة ١ مقارنة بمثيلاتها المنزرعة تحت مستوى ملوحة ٢ . تأثرت القيم الغذائية للأعلاف بمستوى الملوحة . أظهرت كل الأعلاف الثلاث المنزرعة تحت مستوى ملوحة ٢ ارتفاع محتواها من البروتين الخام المهضوم مقارنة بمثيلاتها المنزرعة تحت مستوى ملوحة ١ بغض النظر عن نوع النبات فقد احتجزت الحيوانات كمية نترجين ٣٨% أكثر عندما تغذت على الأعلاف الثلاث المنزرعة تحت مستوى ملوحة ٢ مقارنة بتلك التى تغذت على الأعلاف المنزرعة تحت مستوى ملوحة ١ . بصفة عامة احتجزت الأغنام كميات من عناصر النحاس - الزنك - الكوبلت عند تغذيتها على الأعلاف الثلاث المنزرعة تحت مستوى ملوحة ٢ وعلى العكس من ذلك يجب امداد الحيوانات بهذة العناصر عند تغذيتها على نفس الأعلاف الثلاث المنزرعة تحت مستوى ملوحة ١ . كانت كمية محصول العلف الناتجة من الأعلاف الثلاث تحت مستوى ملوحة ١ أكبر من الكمية الناتجة تحت مستوى ملوحة ٢ .

وتوصى الدراسة بإستخدام بعض النباتات التى تتحمل الملوحة (السورجم - الدخن - حشيشة السودان) المنزرعة فى بعض الاراضى الملحية التى تروى بمياه تصل نسبة الملوحة بها الى ٧٠٠٠ جزء فى المليون فى تغذية الاغنام حيث انها تحتوى على كميات كافية من البروتين الخام والمركبات الغذائية الكلية المهضومة اللازمة لتغطية احتياجات الحيوان بالاضافة الى إنتاج كسبات من المحصول الوفير وبخاصة السورجم المنزرع تحت مستوى ملوحة ٤٠٠٠ جزء فى المليون. ولهذا يمكن استخدام مثل هذه النباتات بنجاح وبأمان كمواد علفية عالية القيمة الغذائية لسد الفجوة الغذائية فى فصلى الصيف والخريف ولزيادة العائد الاقتصادى للاراضى الملحية (الهامشية) فى مصر.