Comparative nutritional studies of ewes and does fed salt tolerant plants under desert condition

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Abstract: The study was carried out at South Sinai Research Station, South Sinai Governorate, Egypt. Twenty eight pregnant Barki sheep and Shami goats were used to evaluate the effects of feeding cultivated salt-tolerant forages mixture, old man saltbush (*Atriplex nummularia* L.), Sorghum (*Sorghum bicolor* L.) and pear millet *(Pennisetum glaucum* L.) on feed intake, nutritive value, digestibility, nitrogen utilization, body weight changes, rumen and blood parameters. Animals were randomly assigned into two equal groups (14 animals each specie). Seven animals of each species were used as control and fed fresh alfalfa (*Medicago sativa* L.) with concentrate diet (mixture group). The other seven animals were fed mixture contained 50% *A. nummularia*, 25% *S. bicolor* and 25% *P. glaucumad libitum* with concentrate diet (mixture group). Data showed that values of dry roughage and total DMI (g/Kg$W^{0.75}$/d) were insignificant between both species and was higher for control group vs. mixture group. However, digestibility coefficients of CP and CF were higher for goats than sheep but were insignificantly differences in DM, OM and EE digestibility between both species. Also goats had higher in DCP% vs. sheep but were no significant differences in TDN, DCP intake (g/h/d) and TDN% among ewes and does. Nitrogen intake, excretion and balance (g/Kg$W^{0.75}$) were higher for control group vs. mixture group but was insignificantly differences between both species. Animals fed mixture group consumed water more than those fed a control group while urine, faces and total water execration were higher for same animals vs. control group. Sheep had higher ruminal TVFA's (m. equiv. /100 ml) than goats and was greater for control vs. mixture group but values of rumen ammonia (NH3-N mg/100 ml) were insignificantly between two species and treatments. However, significantly differences of NH3-N were detected in interaction between species and treatments. Animals fed Salt-tolerant plants mixture had higher values of body weight change (kg) and relative body weight (%) of mid pregnancy than those fed alfalfa. Values of glucose, total lipids and creatinine were significant in interaction between species and treatments. On the other hand, insignificant differences were observed in other blood parameters between species, treatments and interaction between species and treatments. Under arid and saline conditions in Sinai we could be recommended a mixture contained some cultivated salt-tolerant forages as a non-traditional feed resources which can improve small ruminants performance.

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1. Introduction

In Egypt, small ruminants are essential resources of cash revenue, savings nutrition (meat and milk), wool, compost and employment of many people particularly in populations with a low income and where poverty prevails. Improving the sustainability of animal production systems in Sinai by increasing the availableness of fodder resources through inducting of salt-tolerant fodder crops is considered one of the means to insure sustainable development of Bedouin communities in Sinai. Saline soils of various degrees occupy over 80 million ha. in the Mediterranean basin (Anon., 2006). Some studies recommended cultivating of salt-tolerant fodder shrubs (e.g. *A. nummularia* spp.) and salt tolerant grasses such as sorghum *(S. bicolor* L.*)* and pearl millet *(P. glaucum* L.*)* which might fill the gap in feed production in saline and dry areas (Hanafy *et al*., 2007 and El Shaer, 2010). Old man saltbush (*A. nummularia* L.) is a forage shrub originating in several marginal areas around the world as a vital source in the formulation of ruminant diets. This species recognized to be tolerant to salinity and drought as well as to high content of crude protein, fiber and minerals (El Shaer, 2010 and Ben Salem *et al*., 2010). High minerals concentrations can decrease food consumption, produce mineral imbalances and higher drinking water requirements (Norman *et al*., 2008 and Masters *et al*., 2005b). *P. glaucum* and *S. bicolor* are among the most likely salt-tolerant grass species as good quality fodders for small ruminants in Egypt and other countries in the Near East (Anon., 2009). Moreover, *S. bicolor* straw could be included part of roughage component in the small ruminant rations at different levels without any affecting of feed intake, digestibility and nitrogen balance (Venkateswarlu *et al*., 2014). Some anti-nutritional factors similar lignin oxalates and nitrates of salt-tolerant forages and halophytes could restrict in animals feeding mainly when they are used as sole diets. The presence of these compounds forms insoluble complexes with necessary minerals, proteins and carbohydrates, lowering the nutritive value of the product (El Shaer, 2010). Therefore, appropriate mixing of grass with shrubs has been assumed as an effective method of diluting the adverse effects of unlike secondary compounds especially, tannins (Bhat *et al*. 2013). Therefore, the target of this study was conducted to evaluate the effect of feeding cultivated salt-tolerant plants mixture of (*A. nummularia*, *S. bicolor* and *P. glaucum*) on nutritional performance of female Barki sheep and doe Shami goats under Southern Sinai conditions.

2. Materials and Methods

The current experiment was carried out at South Sinai research Station (Ras Sudr) which belongs to Desert Research Center, Ministry of Agriculture and Land Reclamation, South Sinai Governorate, Egypt. Three cultivated salt-tolerant plants mixture were collected from the Farm of South Sinai Research Station. This study was conducted so as to monitor nutritional parameters changes of ewe Barki sheep and doe Shami goats as a result of feeding a sun-dried chopped mixture at rate of 50, 25 and 25%, respectively.

Animals and Treatments

Twenty-eight pregnant Barki sheep and Shami goats were randomly assigned into two equal groups, fourteen Barki sheep an averaged (29.50±1.28 kg) body weight and fourteen Shami goats an averaged (25.62±1.33 kg) body weight. Seven animals of each species were used as control and fed fresh alfalfa (*Medicago sativa* L.) with concentrate feed mixture (control group). The other seven animals were fed mixture contained 50% *A. nummularia*, 25% *S. bicolor* and 25% *P. glaucumad libitum* with 40% of concentrate feed mixture (mixture group). Alfalfa and concentrate feed mixture were given to cover energy maintenance and production requirements of ewes and does according to the nutritional requirements of Kearl (1982**)**. The chemical composition of mixture of *A. nummularia*, *S. bicolor* and *P. glaucum* and fresh alfalfa (Table 1) was determined according to A.O.A.C. (2000).

Table 1: Composition of experimental feed consumed by ewes and does (as % of DM).

Item	DM	OM	CP	EE	CF	NFE	ASH
Alfalfa	92.77	85.18	15.54	2.53	22.63	44.48	14.82
Atriplex	91.59	78.27	12.35	1.36	20.15	44.41	21.73
Pearl millet	91.93	83.81	8.81	2.19	21.40	51.41	16.19
Sorghum	92.17	86.29	8.08	1.69	22.99	53.53	13.71
***Mixture**	92.59	83.41	9.37	1.78	19.72	52.54	16.59
CFM	93.75	89.20	14.72	3.15	12.27	59.06	10.80

**A. nummularia* (50%) + *S. bicolor* (25%)+*P. glaucum* (25%); dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF), nitrogen free extract (NFE); concentrate feed mixture (CFM).

Experimental procedures

Animals stayed in a semi-closed pen, roofed with and walled in four directions with concrete for 2-month period then moved to metabolic cages. Feed offered and refusals were daily collected and weighed for each group of animals to estimate the actual feed intake. The rations were adjusted every two weeks according to the changes of live body weight. Fresh water was available twice daily, at 08:00 and 14:00 h.

Weight changes

All animals were weighed biweekly up to end of the experiment and those were weighed in the morning before feeding. Body weight changes were calculated by subtracting the live body weight at the beginning of the experimental period from the live body weight at the end of the experimental period within each group.

Digestibility trails

Four animals from each group were randomly chosen and used in digestibility trial to determine digestibility, feeding value and N balance. Animals were housing in metabolic cages, weighted at the start and the end of the digestibility trial that lasted for 14 days (7 days as an adaptation period followed by 7 days as a collection period). During digestibility trial periods, feed amounts and residuals were daily weighed and recorded. Fecal output and urine were daily collected each from each animal and kept for later analysis. Ten percent of each fecal sample was taken and dried at 65ºc for a constant weight and ground to pass through a 1.0 mm mesh screen for chemical composition. At the end of the trial, samples of rumen liquid were taken place 3 hrs after feeding to estimate rumen ammonia and volatile fatty acids concentrations.

Analytical procedures

Dry matter (DM) content of feeds and feces determined by drying at 105ºC for 24 hours and organic matter (OM) by ashing at 550°C in a muffle furnace for 6 hours. Ether extract (EE) and crude protein (CP) were determined according to AOAC (2000). Ruminal fluid samples were analyzed for VFA (Warner 1964) and ammonia-N (AOAC 2000). Blood samples were analyzed for total proteins and albumin (Gornal *et al.* 1949 and Doumas *et al.* 1971 respectively), globulin was calculated by subtracting the value of albumin from the total protein whereas A/G ratio was calculated according to results of albumin and globulin, plasma total lipids, total cholesterol and glucose concentrations (Schmillet 1964, Roeschlau *et al.* 1974 and Tietz 1986 respectively), alanine (ALT) and aspartate (AST) amino transferases (Reitman and Frankel 1957), alkaline phosphatase (ALP) (Belfield and Goldberg 1971), plasma urea and creatinine concentrations as indicators for kidney function (Fawcett and Soctt 1960 and Schirmeister *et al.* 1964 respectively).

Statistical Analyses

Data were analyzed by using GLM procedure of the SAS statistical package (SAS, 2004) with a model consisting of species, Treatments and specie x Treatment. Means were presented in tables for animal speciesx Treatments regardless of the significance of the interaction effect. The least significant difference was used for comparing means. Differences between means with $P<0.05$ were accepted as statistically significant differences and those with $0.05<P<0.10$ were accepted as expressive tendencies to differences. Differences in mean values between treatments were compared by Duncan's multiple range test Duncan (1955).

4. Results and Discussion

Chemical composition

The nutritional compositions of *A. nummularia*, *S. bicolor*, *P. glaucum* and alfalfa are offered in Table 1. The concentrations of CP and ash content were generally higher values (12.35 and 21.73%, respectively) in *A. nummularia* than salt grass of *P. glaucum* and *S. bicolor* but the concentrations of CP and EE in alfalfa was higher than all salt-tolerant plants. The results are agreement with many investigators tested the saltbush as animal feed materials (Shawket *et al*, 2001; El -Shaer, 2006 and Fayed *et al*, 2010). *S. bicolor* recorded the highest values of OM, CF and NFE (86.29, 22.99 and53.53%, respectively) compared to other forage in this study. The high crude fiber of *S. bicolor* may be attributed to the high cell-wall constituents (Abdu, 1998). Salt-tolerant plants mixture in this study was higher in CP (9.37%) than the maintenance requirements for ruminants as recommended by (Norton, 2003) who determined that feeds contain less than 8% CP could not provide the ammonia levels required by rumen microbes for optimum activity.

Feed intake

Data of feed intake, digestibility and nutritive value by ewes and does are shown in Table 2. Values of dry roughage and total DMI (g/Kg $W^{0.75}$/d) were insignificant between both species and was higher ($P<0.01$) for control group vs. mixture group (73.83 vs. 35.16 and108.86 vs. 70.60 g/Kg $W^{0.75}$, respectively). Similar trend was observed with interaction among two species and treatments. In many ways, Authors related differences in DMI to breed and reporting that goats consumed more DMI vs. sheep (Gihad *et al*., 1980; Nefzaoui *et al*., 1993; Bartolome *et al*., 1998 and Rogosic *et al*., 2006). On the contrary, other reports observed that sheep had higher DMI than goats (Quick and Dehority, 1986; Aregheore, 1996; El Hag and A1 Shad 1998; Santra *et al*., 1998 and Salem *et al.* 2006), while others found that DMI of *A. nummularia* was higher for sheep vs. goats (Souza *et al*., 2004 and Alves *et al*., 2007). Moreover, similar DMI for both species were found by (Hadjipanayiotou, 1995 and Moujahed *et al*., 2005). In conclusion, Ngwa *et al*., 2000 and Lu *et al*., 2005 were discussed that The difference in DMI between two species may be due to the differences in anatomy and physiology characteristics of the digestive tract, and Abu-Zanat and Tabbaa 2006 reported that lower DMI of mixture group may be attributed to high salt content and anti-nutritional factors such as tannins in *A. nummularia* which contained 6.6% oxalates and 5.2% hydrolysable tannins as DM.

Digestibility coefficients

Crude protein (CP) and crude fiber (CF) digestibility were higher ($P<0.01$) for goats than sheep (80.59 vs. 73.32% and 53.10 vs. 45.52%, respectively) but was insignificantly differences in DM, OM and EE digestibility between both species. However, animals fed control group had higher ($P<0.01$) digestibility coefficients of DM, OM, CP, CF and NFE vs. those fed mixture group. A significant interaction was detected among two species and treatments (Table 2). These results are similar to other reports showed higher CF digestibility for goats than sheep (Alam *et al*, 1985; Leng, 1991; El Hag and A1 Shad 1998; Salem *et al*., 2006 and Agrawal1 *et al*., 2014). This may be related to larger populations of cellulolytic bacteria for goats vs. sheep (Gihad *et al*., 1980). Lower digestibility of salt-tolerant plants mixture vs. alfalfa may be due to added *A. nummularia* and the effect of salt content in the ruminal environment by rumen osmolality changes (Meneses *et al*., 2012 and Moreno *et al*., 2017). Thus leading to increase water intake, consequential influences on rumen physiology and metabolism of animals (Konig, 1993).

Nutritive values

Data of nutritive values by ewes and does indicated that control group recorded higher ($P<0.01$) TDN, DCP intake (g/h/d), TDN and DCP% vs. those fed mixture group. Also, goats was higher ($P<0.01$) in DCP% vs. sheep but was no significant differences in TDN, DCP intake (g/h/d) and TDN%. Significant increment of TDN in control group might be attributed to higher digestibility of OM, CP, CF and NFE than those of mixture group (Table 2). This concurs with earlier reports by (Al-Owaimer *et al.*, 2008 and Fayed *et al.*, 2010) they noticed that lambs fed alfalfa had higher TDN than those fed *Atriplex* species. Furthermore, TDN value for ration containing Atriplex was lower by 7.15% than that containing berseem hay (Ahmed *et al.*, 2001). In the current study, the elevation of DCP intake and DCP% in alfalfa may be due to higher CP content and rapid fermentation than that Salt-tolerant plants mixture (Table 1). Similar observations were reported by (Fayed *et al.*, 2010).

Table 2: Intake, digestibility and nutritive value of ewes and does as affected by feeding salt tolerant plants.

Item	Species		SEM	Treatments‡		SEM	Species* Treatments Sheep		Species* Treatments Goats		SEM	Significant		
	Sheep	Goats		C	M		C	M	C	M		Spec	Treat	S*T
Body weight, BW														
Kg $W^{0.75}$	14.62	12.84	0.50	13.87	13.59	0.64	14.94	14.30	12.80	12.88	0.72	ns	ns	ns
Feed intake														
Conc. intake, g/Kg $W^{0.75}$/d	34.92	35.56	0.87	35.03	35.44	0.93	34.89	34.94	35.17	35.94	1.26	ns	ns	ns
Roug. intake, g/Kg $W^{0.75}$/d	58.49	50.51	7.74	73.83^{a}	35.16^{b}	3.35	74.04^{a}	42.93^{b}	73.62^{a}	27.39^{c}	3.62	ns	***	*
TDM intake, g/Kg $W^{0.75}$/d	93.41	86.07	7.81	108.86^{a}	70.60^{b}	3.61	108.94^{a}	77.87^{b}	108.79^{a}	63.33^{c}	4.18	ns	***	*
Digestibility, %														
Dry matter	66.29	67.40	2.60	73.21^{a}	60.48^{b}	1.17	70.75^{b}	61.83^{c}	75.66^{a}	59.13^{c}	1.27	ns	***	**
Organic matter	68.32	67.98	2.43	74.10^{a}	62.20^{b}	0.98	73.19^{a}	63.44^{b}	75.00^{a}	60.95^{b}	1.26	ns	***	*
Crude protein	73.32^{b}	80.59^{a}	1.49	79.45^{a}	74.46^{b}	1.71	78.03^{a}	68.60^{b}	80.86^{a}	80.32^{a}	1.39	***	***	***
Crude fiber	45.52^{b}	53.10^{a}	4.94	61.61^{a}	37.01^{b}	2.28	55.42^{b}	35.61^{c}	67.79^{a}	38.40^{c}	2.39	***	***	**
Either extract	68.28	67.76	1.93	70.67^{a}	65.37^{b}	1.65	69.45^{ab}	67.11^{ab}	71.88^{a}	63.63^{b}	2.16	ns	*	*
Nitrogen free extract	74.65^{a}	69.49^{b}	2.27	77.57^{a}	66.57^{b}	1.31	78.90^{a}	70.40^{b}	76.23^{a}	62.74^{c}	1.27	***	***	**
Total digestible nutrients, TDN														
g/kg BW	23.57	23.34	2.03	30.36^{a}	16.56^{b}	1.23	29.05^{a}	18.09^{b}	31.66^{a}	15.02^{b}	1.41	ns	***	*
%	61.13	61.12	2.20	66.51^{a}	55.74^{b}	0.86	65.66^{a}	56.59^{b}	67.36^{a}	54.88^{b}	1.15	ns	***	*
Digestible crude protein, DCP														
g/kg BW	3.93	4.26	0.58	5.54^{a}	2.66^{b}	0.21	5.27^{a}	2.59^{b}	5.80^{a}	2.72^{b}	0.51	ns	***	*
%	10.01^{b}	11.17^{a}	0.61	12.14^{a}	9.04^{b}	0.28	11.92^{a}	8.09^{c}	12.35^{a}	9.98^{b}	0.24	***	***	**

C, animals fed on alfalfa + CFM (control group).
M, animals fed on *A. nummularia* (50%) +*S. bicolor* (25%) +*P. glaucum* (25%).
$^{a, b, c}$ Means without a common superscript letter in the row are differed (P < 0.05) between species, treatments, or their interactions.
ns = non-significant; t < 0.10; *P < 0.05; **P < 0.01; SEM = standard error of means.

Nitrogen utilization

Nitrogen intake, excretion, and balance are presented in Table 3. Data indicated that nitrogen intake, total N excretion and N balance (g/Kg$W^{0.75}$) were higher (P<0.01) for control group vs. mixture group (2.66 vs. 1.36, 1.03 vs. 0.44 and 1.08 vs. 0.56 g/Kg$W^{0.75}$, respectively). At similar trend was observed with interaction among two species and treatments. These differences may be due to high content of CP and digestibility in control group vs. mixture group. These results are similar to other reports that showed an increase total N excretion for animals fed alfalfa compared with those fed old man saltbush (Shawket *et al.,* 2005; Fayed *et al*., 2010 and Abdou *et al.,* 2011). However, it was insignificantly differences between both species in nitrogen intake, excretion and balance except feacal nitrogen excretion (g/Kg$W^{0.75}$) was higher (P<0.01) for sheep vs. goats (0.53 vs. 0.38, respectively).

Water utilization

Water utilization by ewes and does are illustrated in Table 4. Data was related to the metabolic body mass ($W^{0.82}$) indicate that animals fed mixture group consumed water more (P<0.01) than those fed a control group (214 vs. 88.65 ml/Kg $W^{0.82}$, respectively) while urine, feacal and total water execration were higher (P<0.01) for same animals vs. control group (99.65 vs. 60.11, 41.19 vs. 25.42 and 140.84 vs. 85.53 g/Kg $W^{0.82}$, respectively). This concurs with earlier reports showed higher water intake and excretion for animals fed *Atriplex* spp vs. control group (Shawket *et al.,* 2005; Allam *et al*. 2006; Hassan, 2009; Bhatti *et al*., 2009 and Ben Salem *et al*., 2010). On the other hand, water consumption and excretion were similar between both species. Similar results were reported by Gihad *et al.* (1989) who found that sheep and goats consumed relatively similar amounts of water intake but goats was excreted more feacal and urinary water than sheep. However, previous findings showed higher water intake for sheep vs. goats (Alam *et al*, 1985; Kandil and El Shaer, 1988; Gihad *et al*., 1989; Ferreira *et al*. 2002; Hadjigeorgiou *et al*. 2003 and Van, 2006).

Water balance was insignificantly higher for sheep vs. goats (141.46 vs. 128.22 ml/kg $W^{0.82}$, respectively) and was lower for animals fed mixture group vs. control group (Table 4).

Table 3: Nitrogen utilization of ewes and does as affected by feeding salt tolerant plants.

Item	Species		SEM	Treatments‡		SEM	Species* Treatment				SEM	Significant		
							Sheep		Goats					
	Sheep	Goats		C	M		C	M	C	M		Spec	Treat	S*T
BW, Kg $^{0.75}$	14.63	12.85	0.50	13.87	13.60	0.64	14.94	14.31	12.81	12.89	0.72	ns	ns	ns
Nitrogen intake														
g/Kg W $^{0.75}$	2.07	1.96	0.25	2.66^{a}	1.36^{b}	0.07	2.66^{a}	1.47^{b}	2.66^{a}	1.26^{b}	0.09	ns	***	*
Feacal nitrogen														
g/Kg W $^{0.75}$	0.53^{a}	0.38^{b}	0.04	0.55^{a}	0.36^{b}	0.03	0.59^{a}	0.46^{b}	0.51^{ab}	0.25^{c}	0.03	***	***	**
Urinary nitrogen														
g/Kg W $^{0.75}$	0.79	0.68	0.13	1.03^{a}	0.44^{b}	0.08	1.02^{a}	0.56^{b}	1.05^{a}	0.31^{b}	0.19	ns	***	*
Total nitrogen execration														
g/Kg W $^{0.75}$	1.32	1.06	0.17	1.58^{a}	0.80^{b}	0.10	1.61^{a}	1.02^{b}	1.56^{a}	0.56^{c}	0.19	ns	***	*
Nitrogen balance														
g/Kg W $^{0.75}$	0.75	0.90	0.12	1.08^{a}	0.56^{b}	0.09	1.05^{a}	0.45^{b}	1.10^{a}	0.70^{ab}	0.11	ns	***	*

C, animals fed on alfalfa + CFM (control group).
M, animals fed on *A. nummularia* (50%) + *S. bicolor* (25%) + *P. glaucum* (25%).
[a, b, c] Means without a common superscript letter in the row are differed (P < 0.05) between species, treatments, or their interactions.
ns = non-significant; t < 0.10; *P < 0.05; **P < 0.01; SEM = standard error of means.

Table 4: Water balance of ewes and does feeding salt tolerant plants during digestibility trial.

Item	Species		SEM	Treatments‡		SEM	Species* Treatments				SEM	Significant		
							Sheep		Goats					
	Sheep	Goats		C	M		C	M	C	M		Spec	Treat	S*T
Free drinking water														
ml/Kg W $^{0.82}$	150	153	24.87	88.65^{b}	214^{a}	8.18	79.42^{b}	220^{a}	97.87^{b}	208^{a}	11.67	ns	***	*
Combined water														
ml/Kg W $^{0.82}$	70.19	65.17	15.45	107.45^{a}	27.91^{b}	3.75	107^{a}	33.42^{b}	108^{a}	22.40^{b}	4.46	ns	***	*
Metabolic water*														
ml/Kg W $^{0.82}$	29.85	27.85	2.23	34.09^{a}	23.62^{b}	1.35	33.34^{a}	26.36^{b}	34.84^{a}	20.87^{c}	1.42	ns	***	*
Total water intake														
ml/Kg W $^{0.82}$	250.04	246.02	13.47	230.19^{b}	265.53^{a}	10.95	219.76	279.78	240.71	251.27	14.59	ns	*	ns
Urinary water														
ml/Kg W $^{0.82}$	71.74	88.02	10.34	60.11^{b}	99.65^{a}	8.37	61.83^{b}	81.66^{ab}	58.39^{b}	118^{a}	10.25	ns	**	*
Feacal water														
ml/Kg W $^{0.82}$	36.84	29.78	4.42	25.42^{b}	41.19^{a}	3.51	26.13^{b}	47.54^{a}	24.72^{b}	34.84^{ab}	4.41	ns	**	*
Total water execration														
ml/Kg W $^{0.82}$	108.58	117.80	13.32	85.53^{b}	140.84^{a}	9.20	87.96^{bc}	129.20^{ab}	83.11^{c}	152.84^{a}	12.28	ns	**	*
Water balance														
ml/Kg W $^{0.82}$	141.46	128.22	6.07	144.66	124.69	6.29	131.80	150.58	157.60	98.43	8.98	ns	ns	ns

C, animals fed on alfalfa + CFM (Control group).
M, animals fed on *A. nummularia* (50%) + *S. bicolor* (25%) + *P. glaucum* (25%).
*Metabolic water was calculated from TDN intake a yield of 0.6 g. water per g. (**Farid *et al.*, 1986**). Including insensible water loss.
[a, b, c] Means without a common superscript letter in the row are differed (P < 0.05) between species, treatments, or their interactions.
ns = non-significant; t < 0.10; *P < 0.05; **P < 0.01; SEM = standard error of means.

Ruminal parameters

Rumen ammonia (NH3-N mg/100 ml) and volatile fatty acids (VFA´s m. equiv. /100 ml) concentrations are presented in Table 5. Data showed insignificant values either for species or treatments while goats had high value of ammonia NH3-N vs. sheep (39.56 vs. 31.44 mg/100 ml respectively). However, values were significantly differences in interaction between two species and treatments. Similarly, the current ruminal NH3-N concentration was reported to be higher than the level required for maximum rumen microbial growth (Mehrez *et al.* 2001). The results obtained in this study agree with the findings by Domingue *et al.* (1991) and Carro *et al.* (2012) who reported that goats had higher value of ruminal NH3-N concentration vs. sheep. This may be attributed to goats had larger populations of cellulolytic bacteria than sheep as a result to greater rumen protein degradation and longer retention time of digest a in the rumen which could lead to a better fiber digestion and being better utilizers of poor roughages (Gihad *et al.*, 1980 and Domingue *et al.*, 1991). Moreover, Alam *et al.* (1985) concluded that ability of goats to maintain higher rumen NH3-N concentration with low N diets was associated with their lower water intake. Reduced rumen NH3-N concentrations of mixture group vs. control group could be attributed to decreased N intake and protein degradation (Ramos *et* *al*., 2009). Sheep had higher (P<0.01) ruminal TVFA's than goats (11.51 vs. 7.32 m. equiv. /100 ml, respectively) and was greater for control vs. mixture group. A significant interaction was observed between species and treatments (Table 5). This improved yield of rumen TVFA's concentrations may be due to the increases of OM digestibility in control vs. mixture group. The results were in agreement with Carro e*t al.* (2012) who observed that sheep were greater ruminal VFA concentrations compared with those found in goats for all diets. Lower values of rumen TVFA's concentrations of mixture group vs. control group may be due to anti-nutritional factors such as tannins in *A. nummularia* which caused to inhibit cellulolytic and protolytic enzymes and decrease the production of volatile fatty acids (Abu-Zanat *et al*., 2003b and Abu-Zanat and Tabbaa, 2006). Likewise, higher salt and lower energy contents of saltbush which decrease the production of TVFA's in the rumen (Shawket and Ahmed, 2009 and Aschenbach *et al*., 2011).

Table 5: Rumen ammonia and volatile fatty acids concentration of ewes and does feeding salt tolerant plants.

Item	Species		SEM	Treatments[ǂ]		SEM	Species* Treatment: Sheep		Goats		SEM	Significant		
	Sheep	Goats		C	M		C	M	C	M		Spec	Treat	S*T
NH_3-N, mg/100 ml	31.44	39.56	2.78	35.26	35.74	3.01	34.15[ab]	28.74[b]	36.37[ab]	42.75[a]	3.64	ns	ns	*
VFA´s, m. equiv. /100 ml	11.51[a]	7.32[b]	0.81	11.37[a]	7.46[b]	0.84	12.87[a]	10.15[b]	9.88[b]	4.77[c]	0.41	***	***	*

C, animals fed on alfalfa + CFM (control group).
M, animals fed on *A. nummularia* (50%) + S. *bicolor* (25%) + *P. glaucum* (25%).
[a, b] Means without a common superscript letter in the row are differed (P < 0.05) between species, treatments, or their interactions.
ns = non-significant; t < 0.10; *P < 0.05; **P < 0.01; SEM = standard error of means.

Live body weight changes

Body weight changes (BWC) by ewes and does are shown in Table 6. The results revealed that sheep had higher (P<0.05) values of body weight of mid pregnancy, end of pregnancy, Total BWC and highly significant (P<0.01) in BWC of mid pregnancy than goats (32.81 vs. 27.50, 36.56 vs. 31.43, 7.06 vs. 5.81 and 2.68 vs. 1.88kg, respectively). The same trend was observed with interaction among two species and treatments. The higher BW in sheep vs. goats could be due to changes in aggressive behaviors, genetic capacity or production systems (Van, 2006). Also, Konig (1993) showed that differences in BW of small ruminants fed diets containing levels of *Atriplex* spp were mostly due to an increase in total body water (average 22.3 g per day). However, animals fed Salt-tolerant plants mixture (mixture group) had higher (P<0.05) values of BWC of mid pregnancy (kg) and relative body weight of mid pregnancy (%) than those fed alfalfa (control group). Similarly, studying on Barki lambs, Shaker *et al.* (2014) reported that feeding mixture of *A. nummularia*, *S. bicolor* and *P. glaucum* was non-significant differences in BWC with control group. Furthermore, Abu-Zanat and Tabbaa (2006) reported that Awassi ewes receiving diets containing 50 and 100% saltbush had not significantly different of overall BW changes compared with control group. On the other hand, many authors found that BW gain was reduced in small ruminants fed *Atripex* spp. (Shehata *et al.* 1988 and Badawy *et al.* 2002).

Price cost of feed intake

Cost of daily feed (L.E.) of ewes and dose illustrated in Table 7. Data revealed that the lower feed cost along the feeding period was observed for animals fed mixture group vs. those fed control group in total feed cost, feed cost of kg total dry matter intake, TDN and DCP. At the same trend, feed cost of Kg $W^{0.75}$ (L.E.), relative cost of kg TDN and DCP% were low price of mixture group vs. control group and was similar between both species. Salt-tolerant plants mixture recorded a reductions in feed cost of Kg $W^{0.75}$ about 52% for sheep and 55% for goats compared with control group due to the low price of salt-tolerant plants mixture compared with alfalfa. The results are in agreement with those reported by Mousa and El-Shabrawy (2003) and Mehrez *et al.* (2011) they found that the feed cost was relatively lower than the control when sheep and goats fed rations contained 30-40% acacia.

Blood parameters

Blood parameters of sheep and goats are showed in Table 8. Data indicated that concentrations of glucose and total lipids were significant (P<0.05) for control vs. mixture group. However, animals fed mixture group had higher (P<0.01) ALP than control group while concentrations of creatinine was increased (P<0.01) for control group vs. mixture group. Also, values of glucose, total lipids and creatinine were significant (P<0.05) in interaction among two species and treatments. On the other hand, insignificant differences were observed in other blood parameters between species, treatments and interaction between species and treatments. In similar studies, Shaker (2014) who found that glucose and total lipids concentrations were significantly lowered in animals fed mixture group than the control group. Lower values of blood parameters among animals fed control group and those animals fed mixture group which might be attributed to high salt content (Salem *et al.* 2004, El- Shaer *et al.*, 2005 and Fayed *et al.*, 2010) and anti-nutritional factors such as tannins (Patra *et al*., 2002, Cook *et al*. 2008 and Ben Salem *et al*., 2010).

Table 6: Live body weight of pregnant ewes and does as affected by feeding salt tolerant plants.

Item	Species		SEM	Treatments[1]		SEM	Species* Treatments				SEM	Significant		
							Sheep		Goats					
	Sheep	Goats		C	M		C	M	C	M		Spec	Treat	S*T
N0. of animals	14	14		14	14		7	7	7	7				
Initial body weight (kg)	29.50	25.62	1.31	28.50	26.62	1.45	30.25	28.75	26.75	24.50	1.90	ns	ns	ns
Mid of pregnancy (kg)	32.18^{a}	27.50^{b}	1.28	30.50	29.18	1.53	32.50	31.87	28.50	26.50	1.90	*	ns	ns
End of pregnancy (kg)	36.56^{a}	31.43^{b}	1.33	34.81	33.18	1.61	37.25^{a}	35.87^{ab}	32.37^{ab}	30.50^{b}	1.97	*	ns	*
BWC of mid pregnancy (kg)	2.68^{a}	1.88^{b}	0.19	2.00^{b}	2.56^{a}	0.21	2.25^{b}	3.12^{a}	1.75^{b}	2.00^{b}	0.22	**	*	*
BWC of end pregnancy (kg)	4.38	3.93	0.24	4.31	4.00	0.26	4.75	4.00	3.87	4.00	0.32	ns	ns	ns
Total BWC (kg)	7.06^{a}	5.81^{b}	0.24	6.31	6.56	0.33	7.00^{a}	7.12^{a}	5.62^{b}	6.00^{ab}	0.34	*	ns	*
[2]RBW of mid pregnancy (%)	9.08	7.30	0.46	7.10^{b}	9.64^{a}	0.77	7.44^{b}	10.85^{a}	6.54^{b}	8.16^{ab}	1.03	ns	*	*
RBW of end pregnancy (%)	14.81	15.34	0.89	15.36	15.21	1.06	15.70	13.91	14.47	16.33	1.46	ns	ns	ns
Total RBW (%)	23.89	22.64	1.21	21.67	21.78	1.22	23.14	24.76	21.01	24.49	1.59	ns	ns	ns

[1]C, animals fed on alfalfa + CFM (Control group) M, animals fed on *A. nummularia* (50%) + *S. bicolor* (25%) + *P. glaucum* (25%)
BWC, body weight change; [2]RBW, relative body weight change = BWC (kg)/Initial BW (kg) × 100
[a, b]Means without a common superscript letter in the row are differed ($P < 0.05$) between species, treatments, or their interactions.
ns = non-significant; t < 0.10; *P < 0.05; **P < 0.01; SEM = standard error of means.

Table7: Price of feed intake by ewes and does during mid pregnancy period as affected by feeding salt tolerant plants.

Item	Sheep		Goats	
	Control group	Mixture group	Control group	Mixture group
Price of feed intake, h/d, L.E.				
Daily total feed cost	6.33	2.95	5.40	2.50
Feed cost of Kg total dray matter (L.E.)	3.91	2.65	3.92	3.10
Feed cost of Kg TDN (L.E.)	5.93	4.70	5.81	4.89
Feed cost of Kg DCP (L.E.)	32.67	28.06	31.76	26.30
Feed cost of Kg $W^{0.75}$ (L.E.)	0.42	0.20	0.42	0.19
Relative feed cost of Kg TDN (%) intake	100	0.79	100	0.84
Relative feed cost of Kg DCP (%)	100	0.86	100	0.83

The price of concentrate feed mixture, alfalfa and mixture of A. nummularia (50%) + S. bicolor (25%) + P. glaucum (25%) = 4800, 3500 and 900 L.E /ton, respectively.

Table 8: Mean values of Blood metabolites concentration of ewes and does as affected by feeding salt tolerant plants.

Item	Species		SEM	Treatments[1]		SEM	Species* Treatments				SEM	Significant		
							Sheep		Goats					
	Sheep	Goats		C	M		C	M	C	M		Spec	Treat	S*T
Total proteins	6.19	6.96	0.75	7.31	5.84	0.70	7.42	4.95	7.19	6.72	0.98	ns	ns	ns
Albumin	2.92	2.75	0.39	3.35	2.32	0.32	3.36	2.49	3.33	2.16	0.48	ns	ns	ns
Globulin	3.27	4.21	0.59	3.96	3.52	0.62	4.06	2.46	3.86	4.56	0.78	ns	ns	ns
A/G ratio	0.89	0.65	0.19	0.85	0.66	0.19	0.83	1.01	0.86	0.47	0.23	ns	ns	ns
Glucose	41.69	41.41	2.00	46.40^{a}	36.69^{b}	2.51	44.26^{ab}	39.12^{ab}	48.55^{a}	34.26^{b}	3.50	ns	*	*
Total lipids	2.84	2.86	0.18	3.11^{a}	2.58^{b}	0.15	3.03	2.65	3.20	2.51	0.21	ns	*	ns
Cholesterol	96.62	96.23	2.88	99.32	93.53	2.54	99.63	93.61	99.00	93.45	3.62	ns	ns	ns
ALT	24.78	27.90	1.58	24.94	27.74	1.63	23.40	26.15	26.47	29.32	1.52	ns	ns	ns
AST	21.06	21.00	3.23	19.38	22.68	3.18	18.48	23.64	20.28	21.72	4.89	ns	ns	ns
ALP	146.60	149.49	7.05	133.99^{b}	162.10^{a}	3.32	133.71^{b}	159.48^{a}	134.26^{b}	164.71^{a}	4.37	ns	***	*
Urea	39.32	42.81	2.58	43.64	38.48	2.05	41.03	37.60	46.25	39.36	2.86	ns	ns	ns
Creatinine	1.20	1.15	0.06	1.30^{a}	1.04^{b}	0.05	1.31^{a}	1.08^{ab}	1.29^{a}	1.00^{b}	0.06	ns	**	*

C, animals fed on alfalfa + CFM (Control group).
M, animals fed on *A. nummularia* (50%) + *S. bicolor* (25%) + *P. glaucum* (25%).
[a, b]Means without a common superscript letter in the row are differed ($P < 0.05$) between species, treatments, or their interactions.
ns = non-significant; t < 0.10; *P < 0.05; **P < 0.01; SEM = standard error of means.

Conclusion

It could be concluded that introducing salt tolerant plants *A. nummularia*, *S. bicolor* and *P. glaucum* for Barki sheep and doe Shami goats could be an attempt to reduce feed shortage and high prices for livestock in arid and saline conditions prevailed in Southern Sinai, Egypt and to increase the utilization of the available unpalatable salt tolerant plants without any adverse effect on performance of animals.

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