Live Body Weight Changes and Physiological Performance of Barki Sheep Fed Salt Tolerant Fodder Crops under the Arid Conditions of Southern Sinai, Egypt

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Abstract: This experiment was conducted at Ras Sudr Research Station belonging to Desert Research Center to elucidate the effect of feeding a mixture of salt tolerant fodder crops (*Atriplex nummularia*, *Sorghum bicolor* and *Pearl millet*) on their physiological performance under arid and salinity conditions of Southern Sinai, Egypt. Eighteen Barki sheep, 3- 3.5 years old with an average body weight 28.50±1.02 kg were randomly divided into two equal groups (9 each). The first group (G1) was fed berseem hay and served as control. The second group (G2) was fed a mixture of *Atriplex nummularia*, *Sorghum bicolor* and *Pearl millet* at percentage of 50, 25 and 25%, respectively. Both groups were supplemented with concentrate feed mixture (CDM).The mean values of total proteins (TP), albumin (AL), glucose (GLU), cholesterol (CH), total lipids (TL), triiodothyronine (T_3), thyroxine (T_4), insulin, aldosterone (AL), alanine amino transferase (ALT), aspartate amino transferase (AST), alkaline phosphatase (ALP), urea, creatinine, sodium (Na) and potassium (K) were determined in plasma. The values of globulin (GL), albumin/ globulin (A/G) ratio, Na/ K ratio and Na index were calculated. Live body weight and average daily gain were recorded.

The results revealed that animals fed salt tolerant plants mixture had a comparable live body weight and average daily gain with the control group. On the other hand, feeding salt tolerant plants elevated ($P<0.05$) ALT and creatinine levels in addition to Na, K and aldosterone concentrations ($P<0.01$). However, salt tolerant plants mixture group had lower ($P< 0.01$) levels of GLU, CH, TL, insulin, ALP, thyroid hormones and urea than control group. Moreover, there were not significant differences between the two experimental groups of total proteins, albumin, globulin, A/G ratio and aspartate amino transferase (AST) values.

It could be concluded that feeding a mixture of salt tolerant plants (*Atriplex nummularia*, *Sorghum bicolor* and *Pearl millet*) without serious physiological hazards, would be an avenue to overcome the problem of feedstuff shortage prevailed under arid and salinity conditions of Sinai, Egypt.

[Shaker, Y.M. Live Body Weight Changes and Physiological Performance of Barki Sheep Fed Salt Tolerant Fodder Crops under the Arid Conditions of Southern Sinai, Egypt. J Am Sci 2014; 10(2s):78-88]. (ISSN: 1545- 1003). http://www.jofamericanscience.org. 11

Key words: Barki sheep, *Atriplex nummularia*, *Sorghum bicolor*, *Pearl millet*, plasma biochemical parameters, liver function, kidney function, electrolytes

1. Introduction

Many arid and semi-arid regions in the world particularly, in North Africa and the Near East regions, have soils and water resources that are too saline for most of the common conventional crop systems. Saline soils of various degrees occupy over 80 million ha in the Mediterranean basin (Anon., 2006). Halophytes and other salt-tolerant plants can constitute a major portion of the feeding program of livestock in the arid and semi-arid regions (Squires and Ayoub, 1994 and El Shaer, 2010).

Encouraging results have been found in some countries in the region with rehabilitation of potential halophytic species (Nemati, 1976 and El Shaer *et al*., 2005). Several studies recommended cultivating of salt and drought tolerant fodder shrubs (e.g. *Atriplex spp*.) and salt and drought tolerant grasses and legumes such as sorghum and *Pearl Millet* which might fill the gab in feed production in arid and saline areas (Hanafy *et al*., 2007 and El Shaer, 2010).

Atriplex nummularia has great potentialities since it is known to be tolerant to salinity and drought in addition to high content of crude protein, fiber and mineral contents (El Shaer, 2010 and Ben Salem *et al*., 2010). *Pearl millet* and sorghum are among the most potential salt-tolerant grass species as good quality fodders for small ruminants in Egypt and other countries in the Near East (Anon., 2009). Sorghum is becoming increasingly important fodder crop as it tolerates well low rainfall, high salinity and high temperatures (Al Khalasi *et al*., 2010).

However, high salt content of the salt tolerant plants is perhaps the major negative component. Furthermore, some anti-nutritive factors (ANFs) like lignin, oxalates and nitrates could restrict the utilization of some halophytes and salt-tolerant forages in livestock feeding mainly when they are used as sole diets. The presence of these compounds forms insoluble complexes with essential minerals, proteins and carbohydrates, lowering the nutritive value of the product (El Shaer, 2010). Therefore, appropriate mixing of these species, based on their complementary roles, could dilute the negative effects of these ANFs, thus improves animal performances (Masters *et al.*, 2001, Abd El-Rahman, 2003, ICBA, 2006, Anon., 2009 and El Shaer, 2010).

The insufficient information about the effect of feeding salt-tolerant plants on the physiological functions was the motive of this study to focus on liver and kidney functions and body weight changes in addition to the metabolic state of Barki sheep fed on a mixture of *Atriplex nummularia*, *Sorghum bicolor* and *Pearl millet*.

2. Materials and Methods

This study was carried out at South Sinai Station (Ras Sudr) which belongs to Desert Research Center, Ministry of Agriculture and Land Reclamation, South Sinai Governorate, Egypt. This study was conducted so as to monitor physiological and biochemical parameters changes of Barki sheep as a result of feeding a sun- dried chopped mixture of *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%) + *Pearl millet* (25%) for three months.

Eighteen Barki ewes, aged 3- 3.5 years old with an average body weight 28.50±1.02 kg, were divided into two equal groups. The first group (G1) was fed berseem hay (*Trifolium alexandrinum*, 4th cut) and served as control, while the second group (G2) was fed a mixture of *Atriplex nummularia*, *sorghum bicolor* and *pearl millet* at rate of 50, 25 and 25 %, respectively. Both groups were provided by concentrate feed mixture (CFM). All experimental animals were fed their nutrient requirements according to Kearl (1982). The chemical composition of *Atriplex nummularia, sorghum bicolor* and *pearl millet* and berseem hay (Table 1) was determined according to A.O.A.C. (1985).

Table (1): Chemical composition of feed mixture of the two experimental diets fed to Barki ewes (Dry matter basis)

	DM	OM	CP	CF	EE	NFE	Ash
Berseem hay	100.00	88.95	12.22	28.55	1.18	47.00	11.05
Atriplex nummularia	94.27	78.27	12.07	20.15	10.28	35.78	21.72
Sorghum bicolor	92.17	86.29	9.68	22.99	6.31	47.31	13.71
Pearl millet	91.93	83.81	9.18	21.40	8.25	44.98	16.19
Salt tolerant mixture*	92.59	83.41	10.91	19.72	13.68	39.10	16.59
Concentrate feed mixture	93.76	89.20	16.72	12.78	4.11	55.59	10.80

DM, dry matter CP, crude protein CF, crude fiber
EE, ether extract NFE, nitrogen free extract OM, organic matter
*, *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%) + *Pearl millet* (25%)

Fresh water was available twice daily over the experimental period. The experimental animals were housed in a semi-closed pen, roofed with and walled in four directions with concrete. All animals were weighed biweekly up to end of the experiment.

Just before offering ration and water, jugular blood samples were withdrawn into clean heparinized tubes and centrifuged for 30 minutes at a speed of 3000 r.p.m. for plasma separation.

Assay of total proteins (TP) and albumin (AL) was carried out according to Biuret method after Gornal *et al.* (1949) and Doumas *et al.* (1971), respectively. Values of globulin (GL) were 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 (TL), total cholesterol (CHO) and glucose (GLU) concentrations were determined according to Schmillet (1964), Roeschlau *et al.* (1974) and Tietz (1986), in order. Alanine (ALT) and aspartate (AST) amino transferases levels were analyzed according to Reitman and Frankel (1957), while alkaline phosphatase (ALP) was determined according to Belfield and Goldberg (1971). Plasma urea and creatinine concentrations as indicators for kidney function were determined using biodiagnostic kits according to Fawcett and Soctt (1960) and Schirmeister *et al.* (1964), respectively. Concentrations of sodium (Na) and potassium (K) were determined according to Trinder (1951) and Sunderman and Sunderman (1958), respectively.

Direct radioimmunoassay technique (RIA) was performed for plasma insulin, triiodothyronine (T_3), thyroxine (T_4) and aldosterone hormones using ready antibody coated tubes kits manufactured by Immunotech, Beckman Counter Company, France.

Experimental data were analyzed using General Linear Model Procedure (SAS, 2004).

3. Results and Discussion

Live body weight:

The results revealed that live body weight was not affected significantly by feeding salt tolerant fodder crops mixture (*Atripex halimus*, *Sorghum bicolor* and *Pearl millet*). The animals fed control diet (Control group) had insignificant higher final body weight and daily gain as compared to their counterparts of treatment (Table 2). These results underlined the potentiality of such salt tolerant fodder mixture to fulfill the animal requirements to maintain their body weight. In similar, working on Barki lambs, Shaker *et al.* (2008) reported that feeding mixture of atriplex and acacia resulted in non-significant differences in body weight with control group. Furthermore, Zarkawi *et al.* (2005) reported that Awassi ewes fed *Sesbania aculeate* which grown on salty soil and irrigated by saline water had comparable live body weight of ewes for control group. This slight reduction in daily gain of animals fed on *Atriplex nummularia*, *Sorghum bicolor* and *pearl millet* mixture might be attributed to the tannins content which was found to reduce the digestibility of protein and dry matter (Priolo *et al.*, 2000 and El-Shaer, 2010). A combination of reduced intake and low true digestibility of protein cause the negative effect of tannins on growth rate (Ben Salem *et al.*, 2010, El- Shaer *et al*., 2005 and El- Shaer 2010). These results were in agreement with those reported by Azamel (1997) and Nasr *et al.* (2002). Badawy *et al.* (2002) found that lambs fed fresh *Atriplex halimus* or *Acacia saligna* had lower average daily gain than the control group. Additionally, Shehata *et al.* (1988) reported that body weight gain was reduced in sheep and goats fed *Atriplex nummularia*.

Table (2): Live body weight of Barki sheep as affected by feeding salt tolerant fodder crops mixture

Item	G1	G2	± SE	Overall mean
Initial body weight ^{NS} **(kg)**	28.39	28.61	±1.49	28.50±1.02
Final body weight ^{NS} **(kg)**	36.31	35.83	±2.03	36.07±1.39
Body weight changes ^{NS} **(kg)**	7.92	7.22	±1.03	7.57±0.71
% of initial body weight ^{NS}	28.51	25.90	±3.11	26.71±2.14
Average daily gain ^{NS} **(gm)**	52.81	48.15	±10.49	50.48±8.91

NS, non-significant
G1, animals fed berseem hay + CFM (Control group)
G2, animals fed a mixture of *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%)+ *Pearl millet* (25%)+ CFM

Total proteins concentration:

Animals fed salt tolerant plants mixture of *Atriplex nummularia*, *Sorghum bicolor* and *Pearl millet* had insignificantly lower mean values of total proteins (4.80%), albumin (7.32%), globulin (2.17%) and albumin/ globulin ratio (19.94%) in comparison with control ones (Table 3). These results were in agreement with those reported by Askar (1998), Badawy *et al.* (2002), Abdel- Halim (2003) and Shaker *et al.* (2008). This decrease of TP, Al, Gl and A/G ratio values in treated animals (G2) might be attributed to the high content of tannins in such salt tolerant plants where tannins were reported to decrease the digestibility of crude protein (Muller *et al.*, 1989, Reed *et al.*, 1990 and Mahmoud, 2001). Coles (1986) found that poor absorption of dietary constituents from the intestinal tract leads to hypoproteinemia. On the other hand, higher salt intake might be another reason to introduce such decrement in TP, Al, Gl and A/G ratio levels (Weeth and Haverland, 1961 and Badawy, 1999). In accordance, Tata and Widnell (1966) observed a decrease in total protein concentration due to drinking saline water which might possibly reduce hepatic synthesis of RNA which in turn depressed the incorporation of amino acids for protein synthesis.

From another point of view, the slight decrease in total proteins fraction could be attributed to the lower crude protein recorded in ration of salt tolerant plants mixture (Table 1). Yousef and Zaki (2001) and Shahen *et al*. (2004) reported a positive correlation between dietary protein and plasma protein concentrations.

Table (3): The mean values of total proteins, albumin and globulin concentrations and albumin/ globulin ratio of Barki ewes as affected by feeding salt tolerant plants mixture

Item	G1	G2	± SE	Change	Overall
Total protein ^{NS} **(g/dl)**	5.90	5.63	± 0.370	- 0.27 (4.80%)	5.77± 0.264
Albumin ^{NS} **(g/dl)**	3.08	2.87	± 0.234	- 0.21 (7.32%)	2.98± 0.214
Globulin ^{NS} **(g/dl)**	2.82	2.76	± 0.306	- 0.06 (2.17%)	2.79± 0.198
A/ G ratio ^{NS}	1.48	1.24	± 0.303	- 0.21 (16.94%)	1.36± 0.242

NS, non-significant
G1, animals fed berseem hay + CFM (Control group)
G2, animals fed a mixture of *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%)+ *Pearl millet* (25%)+ CFM

Glucose concentration:

Feeding salt tolerant plants lowered ($P<0.01$) plasma glucose concentration by 17.88% which might be attributed to the tannins content in these plants. Tannins were reported to reduce digestibility of protein and carbohydrate by inhibiting digestive enzymes and/ or by altering permeability of the gut wall (Streeter *et al.*, 1993). Moreover, Ortiz *et al.* (1993) reported that tannins could adversely influence digestibility and absorption of nutrients such as proteins and amino acids, carbohydrates and lipids and also the activity of digestive enzymes.

On the other hand, high salt in these salt tolerant forages might reduce glucose concentration in group two (G2). This theory would be confirmed by results reported byAssad *et al.* (1997) when working on rams receiving saline water. In consistence, Kewan (2003) reported that the glucose level in camels fed acacia plus atriplex was lower than that of control groups.

Cholesterol concentration:

Animals fed salt tolerant plants mixture had lower (P<0.01) cholesterol concentration by 9.43% than the control ones (Table 4). Similar results were reported by Shaker *et al.* (2008) in Barki lambs and Fayed (2009) in Barki rams. This significant reduction in plasma cholesterol concentration could be due to the presence of tannins which interfere in lipids digestibility by complexing with fatty acids (Romero *et al.*, 2000), decreasing cholesterol absorption and increasing fat excretion (Bravo *et al.*, 1993). On the other hand, this decrease in cholesterol levels might be owing to saponins contents (Salem *et al.* 2004, El- Shaer *et al.*, 2005, Fayed *et al.*, 2010 and Ben Salem *et al.*, 2010). Saponins were found to lower serum cholesterol levels in animals (Matsuura, 2001). The hypocholesterolaemic action of saponins was previously reported (Francis *et al.*, 2002) through inhibiting the cholesterol absorption causing reduction in plasma high- density lipoprotein cholesterol fraction (Morehouse *et al.*, 1999) and/ or delaying the intestinal absorption of dietary fat by inhibiting pancreatic lipase activity (Han *et al.*, 2000). Finally, through low digestibility of fats in ruminants which is limilleted by the lack of emulsifying agents in the rumen (Cheeke, 1999).

Table (4): The mean values of glucose, cholesterol, total lipids, insulin and thyroid hormones concentrations of Barki ewes as affected by feeding salt tolerant plants mixture

Item		G1	G2	± SE	Change	Overall
Glucose**	**(mg/l)**	46.93a	39.81b	± 1.307	-7.12 (17.88%)	43.37±1.596
Cholesterol **	**(mg/dl)**	102.57a	93.73b	± 1.978	-8.84 (9.43%)	98.15±1.544
Total lipids **	**(g/l)**	3.03a	2.54b	± 0.068	-0.49 (19.29%)	2.78±0.106
Insulin **	**(µU/ml)**	12.56a	9.24b	±0.136	-3.32 (35.90%)	10.90±1.703
T3 **	**(pg/ml)**	5.05a	3.87b	±0.053	-1.18 (30.49%)	4.46±1.762
T4 **	**(ng/ml)**	11.99	8.18	±0.65	-3.81(46.57%)	10.09±1.445

**, p<0.01

In the same row, any two means in a certain item having different letters differ significantly.

G1, animals fed berseem hay + CFM (Control group)

G2, animals fed a mixture of *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%)+ *Pearl millet* (25%)+ CFM

Total lipids concentration:

Lipids virtually have an important role in all aspects of biological life, serving as hormones precursors, aiding in digestion, providing energy storage and metabolic fuel and acting as functional and structural components in biomembranes (Tietz, 1990).

Plasma total lipids (TL) levels had the same trend of glucose and cholesterol levels where treated group had lower (P<0.01) total lipids values than control by 19.29 % (Table 4). These lower values of TL could be due to the reported effects of tannins and saponins on fat metabolism (Cheeke, 1999, Han *et al.*, 2000, Salem *et al.* 2004, El- Shaer *et al.*, 2005 and Fayed *et al.*, 2010). Similar results were reported by Abdelhameed *et al.* (2004& 2006) who reported a significant decrease in total lipids and lipid fraction as a result of feeding on fresh saltbush forage plants. However, Shaker *et al.* (2008) demonstrated that feeding a mixture of atriplex and acacia led to a non-significant decrease in total lipids of Barki lambs.

Insulin concentration:

The present data revealed that insulin level decreased (P<0.01) in animals fed salt tolerant forages (G2) by 35.90% in comparison to their counterparts of control group (Table 4). Similar results were reported by Pearce *et al.* (2008) who reported that there was a significant effect of diet on plasma insulin concentration (P< 0.05) where animals fed saltbush diet had significantly lower plasma insulin concentration than sheep fed the control diet. In agreement, Digby *et al.* (2010 a&b) and Blache *et al*. (2007) suggested that decreasing in secretion of insulin could be in response to high salt which affect feed intake affecting the energy balance, defined as the difference between energy expenditure and the sum of energy intake and energy reserves, pushing towards a negative value. Moreover, in humans, plasma insulin decreased by up to 47% in response to an increase in salt intake, via saline infusion or consumption of salt in diet (Goodfriend *et al*., 1991).

Thyroid activity:

Thyroid hormones play a major effect on growth and development of animal. These hormones are in correlation with metabolism of protein, carbohydrate, fat (Zanouny *et al.*, 2013). In addition, normal function of the control nervous system is very dependent on normal output of T_4. Therefore, reduced thyroid secretion will ultimately results in reduced metabolism of such nutrients (Trenkle, 1978 and Hart *et al.*, 1981).

The obtained results of triiodothyronine (T_3) and thyroxine (T_4) hormones declared that the salt tolerant forages mixture group (G2) showed significant lower (P<0.01) mean values comparing to the control group by 30.49 and 46.57% for T_3 and T_4, respectively (Table 4). This decrement might be attributed to the high content of salt. Metwally (2001) reported that saline water treatment in camels decreased both of T_3 and T_4

suggesting that to the decreased of feed intake, so that the metabolism process decreased. In addition, Ayyat *et al.* (1991) and Ahmed (1996) reported that drinking saline water depressed T_3 and T_4 levels in rabbits.

Liver function:

Most plasma enzymes come from different tissues of animal. Its activity level had a relation with metabolism and functional status of certain organs. Body's ability to adjust and adapt depends on the function of tissues and organs largely (Shi-Gang *et al*., 2010). Concentrations of its enzymes alanine amino transferase (ALT), aspartate amino transferase (AST), alkaline phosphatase (ALP) and gamma glutamyl transferase (GGT) are those conventionally used for diagnosing hepatic damage. Transaminases are widely distributed in plasma, bile, cerebrospinal fluid and saliva but none is found in urine unless a kidney lesion is present (Norbert, 1987).

Alanine amino transferase is particularly useful in measuring hepatic necrosis and increased in serum when cellular degeneration or destruction occurs (Lessard *et al*., 1986).

The levels of alanine amino transferase (ALT) of salt tolerant forages mixture group exceeded (P< 0.05) their counterparts of control ration by 17.22% (Table 6) which might be attributed to the high tannins in these shrubs (Tripathy *et al*., 1984) or to the high content of salt as reported by Ibrahim (1995) in goats, Hussein (1987) in sheep, Ibrahim (2001) in camels and Ibrahim *et al*. (1991) in male buffalo- calves. Consistently, Shaker *et al*. (2008) found that the activity of ALT was higher (P<0.01) in animals fed fresh or silage form of atriplex and acacia mixture comparing to control group. Badawy *et al*. (2002) noticed that feeding lambs on fresh acacia increased significantly the level of ALT by 14.1 %.

Aspartate amino transferase (AST), which is present in extrahepatic tissues including myocardium and kidney, can be used as a good indicator of hepatic injury of sheep (Lessard *et al*., 1986). The mean values of AST exhibited similar trend as ALT where animals fed on the salt tolerant forages mixture (G2) got higher insignificant activity of AST (10.14%) than those recorded for the control group (Table 5). This slight elevation of AST activity could be due to high contents of tannins in these shrubs might be the main reason of AST elevation (Badawy *et al*., 2002 and Tripathy *et al*., 1984). In a harmony with the present results, Shaker *et al*. (2008) found a significant increase in activity of AST in lambs fed on fresh atriplex and acacia mixture as compared to their control group.

Table (5): The mean values of alanine amino transferase (ALT), aspartate amino transferase (AST), alkaline phosphatase (ALP), urea and creatinine concentrations of Barki ewes as affected by feeding salt tolerant plants mixture

Item		G1	G2	± SE	Change	Overall
ALT *	**(IU/l)**	23.69	27.77	± 1.24	+4.08 (17.22%)	25.73+1.126
AST NS	**(IU/l)**	26.04	28.68	± 3.355	+2.64 (10.14%)	27.36+2.581
ALP **	**(IU/l)**	166.89	151.81	± 1.856	-15.08 (9.93%)	159.25+3.940
Urea **	**(mg/dl)**	42.73	36.78	± 0.802	-5.95 (16.17%)	39.75+1.218
Creatinine *	**(mg/dl)**	1.06	1.40	± 0.093	+0.34 (32.07%)	1.22+0.073

*, P<0.05 **, p<0.01 NS, non significant

In the same row, any two means in a certain item having different letters differ significantly.

G1, animals fed berseem hay + CFM (Control group)

G2, animals fed a mixture of *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%)+ *Pearl millet* (25%)+ CFM

Silanikove *et al*. (1996) demonstrated that alkaline phosphatase is used to detect the bile obstruction (i.e. mild and progressive damage to the liver). The present results of alkaline phosphatase (ALP) activity demonstrated that animals fed salt tolerant forages mixture diet had lower (P< 0.01) values than those of control group (Table 5). This decline in alkaline phosphatase activity might be attributed to the existence of anti-nutritional factor in such salt tolerant plants. Tannins, which react with this enzyme, were reported to reduce its activity (Horigome *et al*., 1988 and Abde- Halim, 2003). In addition, excess of oxalate is an inhibitor for that liver enzyme (McComb *et al*., 1979). Abu- Zanat *et al*. (2003) reported that *Atriplex spp*. contain high concentrations of oxalate which can be toxic to livestock. In agreement, Shaker *et al*. (2008) reported that ALP levels decreased (P<0.01) in animals fed either fresh or silage forms of acacia and atriplex mixture.

Kidney function:

Urea and creatinine are the two main nitrogenous compounds eventually excreted by kidney. Accordingly, any change of their concentration would reflect impaired glomerular filtration and/ or insufficiency of renal tubules (Coffin, 1955, Miller, 1966 and Kaneko, 1989). Furthermore, urea is the major nitrogen- containing metabolic product of protein catabolism accounting for more than 75% of the non- protein nitrogen excreted. Also, production is also too dependent on several non- real variables such as a diet and hepatic synthesis.

The present results revealed that lower (P<0.01) mean concentration of urea was observed in animals fed salt tolerant forages mixture diet (G2) in comparison with control group (Table 5). These results were in agreement with those of Shaker *et al*. (2008) when Barki lambs fed atriplex and acacia mixture. This reduction in urea concentrations (16.17 %) could be owing to the presence of tannins, which reduce the ruminal proteins degradation (Mashudi *et al.*, 1997). In accordance, Waghorn *et al.* (1994), Patra *et al.* (2002) and Cook *et al*. (2008) reported that plasma urea nitrogen was lowered in sheep and goats fed legumes that high in tannins. Pearce *et al*. (2008) reported that treatment had a significant effect on plasma urea concentrations (P< 0.001) where sheep fed the control diet had significantly higher plasma urea concentrations than the saltbush group.

Azamel (1997) found that the blood urea was significantly lowered in two groups of growing lambs fed *Atriplex nummularia* in comparison with control groups. However, Badawy *et al.* (2002) found that animals fed fresh *Atriplex nummularia* had high urea values comparing with control group.

Feeding a mixture of *Atriplex nummularia*, Sorghum bicolor and *Pearl millet* forages (G2) increased (<0.05) the mean values of creatinine comparing to the control group (Table 5) in a reverse trend with that of urea results. Consisitenty, Badawy *et al.* (2002) and Shaker *et al*. (2008) found that animals fed fresh atriplex or acacia had higher mean values of creatinine than their counterparts fed on control ration. This increment in creatinine levels could be as a result of anti-nutritional factors and/ or high salt in such salt tolerant plants. Consistently, Zhu *et al.*, (1992) and Zhu and Filippich (1995) noticed that plasma creatinine was significantly increased in sheep dosed by 0.1 g tannic acid/ kg body weight intraperitoneally. Clark and Clark (1978) reported that feeding on *Atriplex species* caused destruction of renal nephrons since such plants contain high amounts of oxalates. Cheeke (1995) reported that the common effect of oxalate is to cause kidney damage owing to blocking of tubules by crystals of calcium oxalate. This does not necessarily cause death, but the kidney damage remains and subsequently ingestion of oxalate- containing plants may have fatal results.

On the other hand, high content of salt in such salt tolerant forages mixture might be the clue to understand the increment observed in creatinine level. Receiving salt load resulted in alteration in kidney function of cattle's (Nelson *et al.*, 1995 and Weeth and Lesperance, 1965). Hussein (1987) reported that drinking saline water caused highly significant increase in sheep plasma creatinine. Assad *et al.* (1989) noted a significant elevation of creatinine in serum of the ewes and their lambs received diluted sea water (1.3% TDS). Similarly, Abdel- Gawad (1993) demonstrated that drinking saline water by sheep, goats and camels increased plasma creatinine.

Blood electrolytes:

Minerals play an important role in the regulation of body fluids, acid base balance and metabolic processes (Milne, 1996).

The present findings of sodium (Na) level values demonstrated that animals fed salt tolerant forages (G2) had higher (P<0.01) value than control group (Table 7). The increase in sodium concentration might be due to atriplex which contains high content of sodium (6.45%) and chloride (7.03%) as reported by Mohamed (1996). Ben Salem *et al*. (2010) reported that most of the salt in oldman saltbush is sodium chloride and potassium chloride. Similar results were obtained by Rasool *et al.* (1996) in sheep. Badawy *et al.* (2002), Nasr *et al.* (2002) and Shaker *et al*. (2008) reported that serum Na^+ levels increased significantly in animals fed *atriplex*. Rasool *et al*. (1996) reported that there was significant (p< 0.01) increase in the sodium contents of blood serum at high levels of saltbush containing diet.

Table (6): The mean values of sodium, potassium, aldosterone concentrations, Na/ K and of Na index of Barki ewes as affected by feeding salt tolerant plants mixture

Item		G1	G2	± SE	Change	Overall
Na **	**(ppm)**	6150	7183	±36.955	+1033 (16.80%)	6666.67±117.286
K **	**(ppm)**	122.67	170.67	±2.298	+48 (39.13%)	146.66±6.253
Na/ K **		50.47	42.70	±1.137	-7.77 (18.20%)	46.57±1.246
Na/ Na+ K **		0.98	0.97	±0.0004	-0.01 (1.03%)	0.97±0.473
Aldosterone **	**(pg/ ml)**	614.58	800.39	±12.71	+185.81 (30.23%)	706.85±69.394

**, p<0.01

In the same row, any two means in a certain item having different letters differ significantly.

G1, animals fed on Berseem hay + CFM (Control group)

G2, animals fed on a mixture of *Atriplex nummularia* (50%)+ *Sorghum bicolor* (25%)+ *Pearl millet* (25%)+ CFM

Concerning of potassium concentration, animals fed salt tolerant forages mixture (G2) had higher (P<0.01) mean plasma potassium concentration value than the control group (Table 6). In agreement, Badawy *et al.* (2002) and Shaker *et al*. (2008) reported that animals fed on atriplex had higher K^+ concentration. This pattern of potassium was in complete harmony with that of sodium. Wegner and Schuh (1974) and Wichell (1976) noted a relationship between increasing Na^+ intake; which is already high in such salt tolerant forages, and high concentration of K^+ in plasma.

Rasool *et al*. (1996) reported a significant (P< 0.01) increase in the potassium contents in the blood from medium to very high levels of the saltbush in the diet Sodium and potassium are known to be found in high concentrations in halophytes and salt tolerant forages (NRC, 1975, Kearl, 1982 and El Shaer, 1981), however, excess intake of these electrolytes is accompanied by their excess excretion through the kidneys (Neathery, 1980).

The obtained results revealed that values of Na/K ratio and Na, K index values were lower (P<0.01) in treated group than control group (Table 6). In agreement, Shaker *et al*. (2008) reported that animals fed fresh form of atriplex and acacia mixture had insignificant Na/K ratio and Na, K index values. This reduction in Na/K ratio and Na, K index values might be attributed to the higher level of potassium in plasma (Table 6).

Aldosterone concentration:

Results of aldosterone level showed that animals fed salt tolerant forages mixture (G2) had higher (P<0.05) aldosterone level than that of control group (Table 6). This increment in aldosterone concentration might be attributed to the high content of salt in such desert shrubs. It is well known that aldosterone secretion increases hen blood potassium increased and this is evident in the present results (Table 6). In accordance, Shaker *et al*. (2008) reported that feeding atriplex and acacia mixture increased aldosterone concentration. Furthermore, Hamdi *et al.* (1982) clarified the association of aldosterone and $Na^+/ Na^+ + K^+$ index in the blood suggesting that it might be attributed to an increase in the aldosterone release in response to drinking the diluted sea water. In addition, Aboulnaga (1987) demonstrated that the aldosterone secretion and concentration of sodium and potassium in urine and blood plasma would be changed when the ratio of sodium and potassium intake was changed.

Conclusion

From aforementioned results, it could be concluded that introducing salt tolerant plants *Atriplex nummularia*, *sorghum bicolor* and *pearl millet* for sheep could be an attempt to reduce feed shortage for livestock in arid and saline conditions prevailed in Southern Sinai, Egypt and to increase the utilization of the available unpalatable salt tolerant plants as animals feeds specially for sheep and goats.

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Acknowledgment

The author would thank Prof. Dr. El-Shaer, the coordinator and Prof. Dr. Badawy, the key person of the regional project titled "Adaptation to climate changes in WANA marginal environments through sustainable crop and livestock diversification" which is funded by International Center for Biosaline Agricultural (ICBA), UAE for their finical support to achieve this work.

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