J. Animal and Poultry Prod., Mansoura Univ., Vol.9 (2): 67 - 75, 2018

Some Minerals Profile in Blood and Milk of Barki Ewes Fed Salt Tolerant Plants in Egyptian North Western Coast

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ABSTRACT

This study aimed at exploring the effect of complete replacement of berseem hay (control) in the diet by leaves and stems of salt tolerant plants (*Acacia nilotica*, *Atriplex nummularia* and *Cassava manihot esculenta*) on some minerals profile in blood and milk of Barki ewes under the conditions of Egyptian north western coast. Forty mature healthy Barki ewes at late pregnancy, 3-4 years old with an average live body weight 51.5 ± 0.46 kg were randomly divided into 4 similar groups (10 ewes each). The first group was fed the control diet which consisted of 40% concentrate feed mixture plus 60% berseem hay (BH), while in the 2^{nd}, 3^{rd} and 4^{th} groups, BH as percentage was replaced by *Acacia*, *Atriplex* and *Cassava* respectively. All animals were kept under the same managerial conditions. The experiment was lasted 4 weeks befor parturition and along the lactation period for nearly two months. From each group, 5 ewes were chosen randomly every week to obtain milk samples. The same procedure was carried out but biweekly for blood sampling. Chemical analysis was performed for estimating some macro and micro-mineral concentrations in blood and milk.Feeding salt tolerant plants resulted in increasing the blood concentrations of Ca, P, Fe and Mn. However, the level of blood Cu decreased by feeding these plants. Feeding *Acacia* resulted in the highest level of Zn. Each of Ca/P ratio and blood levels of Na, K and Mg were not affected. The highest overall means for the macro-elements were found in milk of ewes fed *Atriplex*. In addition, those ewes showed the highest level of Mg in their milk. Feeding *Acacia* resulted in the highest level of Cu, while nourishing *Cassava* developed the highest level of Zn. Nevertheless, no serious changes were found in concentration of macro and micro-elements either in blood or milk of ewes fed these slat tolerant plants. Accordingly, it can be concluded that it safe to replace hay with one of these plants in feeding lactating Barki ewes.

Keywords: Barki ewes , salt tolerant plants, blood milk minerals.

INTRODUCTION

Livestock are the main source of income for people in North Western Coastal regions in Egypt. Barki sheep are well adapted to such areas when compared to other sheep breeds. Besides overgrazing, the natural rangelands were deteriorated resulting in severe animal feed shortages, especially in the dry seasons (El-Shaer, 2004). Under these challenging conditions, untraditional feed resources such as tanniniferous plants shrubs and other salt-tolerant plants can offer practical alternatives in marginal areas as stated by El-Shaer and Gihad (1994) and Squires and Ayoub (1994). These inedible plant types represent roughly about 70% of the total green coverage in this area of Egypt (El-Shaer *et al.*, 1997). Salt tolerant plants are characterized by moderate digestible crude protein, low digestible ether extract and soluble carbohydrates, but high oxalate and mineral concentrations, principally Na, K, Cl and Ca. (El-Shaer and Gihad, 1994 and Ben Salem *et al.*, 2002). However, feeding Salt Tolerant plants for a long duration exhibited changes in the body fluids, haemogram and histopathology of different organs, which did not return back to normal conditions after exclusion of the plants from the diet (Ibrahim, 2001).

Haenlein (2001) explained that milk yield and milk composition of ruminants vary by system of feeding, breed, parity, season, managerial practices, environmental circumstances, lactation stage and health state of the Mammary gland. Sheep milk contains high total solids and major nutrient contents. He added that many changes in sheep milk composition occurred during the late stage of lactation because towards the end of lactation the fat, protein, total solids and minerals contents increased, while the lactose content decreased.

Sheep milk has around 0.9% total minerals or ash compared to 0.7% in cow milk (Young and Haenlein, 2006). They showed that calcium, phosphorus, magnesium, zinc, iron and copper contents are higher in sheep than in cow milk, while the reverse seems to be the case on average for potassium, sodium and manganese. However, changes could occur due to feeding differences and months of the year. The minor and trace minerals are of nutritional and possible health interest but their levels in sheep milk have not received much study.

Macro and micro-elements are essential to maintain the optimum and living status in domestic animals by playing a critical role in the physiological processes related to health, growth and reproduction and the adequate function of the immune and endocrine systems (Arthington, 2005; Andrieu, 2008 and Soetan *et al.*, 2010) as they are important for functioning of a number of enzymes and proteins within the body (Close, 1998; Boland, 2003 and Gressley, 2009). Accordingly, trace elements contribute to general health by building body defense mechanisms and improving metabolism and hence deficiency can predispose to disease. Effect of trace elements on growth and milk production has been widely studied (Kinal *et al.*, 2005; Atyabi *et al.*, 2006; Griffiths *et al.*, 2007; Siciliano-Jones *et al.*, 2008 and Hackbart *et al.*, 2010). Kinal *et al.*, (2007) reported significantly increased milk production following trace mineral supplementation. Zinc is an essential trace element involved in the catalytic, structural and regulatory processes of keratinization and in general protein metabolism (Paulrud, 2005), consequently, teat canal keratin production is dependent on zinc status (Paulrud, 2005). Like zinc, both copper and manganese are important for keratin formation (Tomlinson *et al.*, 2004) that provides udder immunity. Growth is affected by the roles of copper (Gengelbach and Spears (1998), manganese (Hansen *et al.,* 2006), cobalt (Schwarz *et al.*, 2000) and zinc (Gressley, 2009). Vongsamphanh and Wanapat (2004) found that feeding of high levels of *Cassava* hay and dried *Cassava* root increased the milk yield, but decreased the feed conversion ratio. However, they succeeded to decrease feed cost.

Blood levels of calcium, phosphorus and magnesium in small ruminants in prepartum and lactation period reflect their metabolism or supply of these substances through feed and their utilization by all tissues particularly mammary glands (Djokovic *et al.*, 2014). Administration of iron provided an increase in hematological parameters and a better growth in calves (Lindt and Blum 1993; Mohri *et al.*, 2004; Heidarpour Bami *et al.*, 2008).

This study aimed at exploring the effect of complete replacement of berseem hay (control) in the diet by leaves and stems of salt tolerant plants (*Acacia nilotica* or *Atriplex nummularia* or *Cassava manihot esculenta*) on some minerals profile in blood and milk of Barki ewes in Egyptian north western coast.

MATERIALS AND METHODS

This study was carried out at Borg El-Arab Experimental station, Alexandria Governorate, belonging to the Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, whereas the fodder trees of *Acacia nilotica*, *Atriplex nummularia* and *Cassava manihot esculenta* were harvested along the sub-roads of the North Western Coast of Egypt near the Mediterranean Sea, west of Alexandria city, latitudes 21° and 31° North and longitudes 25° and 35° East.

Animals and experimental managements:

Forty mature healthy Barki ewes at late pregnancy (last third), aged 3-4 years with average live body weight 51.5±0.46 kg were used in this study. The animals were randomly divided into 4 similar groups (10 ewes each) according to their live body weight (LBW) and age. All animals were kept in a semi-open shaded yard and kept under the same managerial conditions during the experimental periods.

Animals of the first group were fed the control diet consisted of 40% concentrate feed mixture (CFM), plus 60% berseem hay (BH), while in the 2nd, 3rd and 4th groups, BH had been replaced by edible parts leaves and stems of *Acacia*, *Atriplex* and *Cassava*, respectively. The CFM consisted of 25% un-decorticated cotton meal, 43% yellow corn, 25% wheat bran, 3.5% molasses, 2% limestone, 1% common salt and 0.5% minerals mixture.

Animals were fed diets to cover their nutrient allowances corresponding to the physiological and productive stage according to NRC (1985). Ewes were adapted to their diets for 4 weeks as preliminary period, and then fed experimental rations 4 weeks before parturition and continued to weaning their lambs (suckling period, 8 weeks). All animals were fed daily at 9 a.m. and 4 p.m., fresh water was available all times. Chemical composition on DM% (DM, OM, CP, EE, NFE and Ash), and some Macro (Ca, P, Na and K) and Micro (Fe, Mn, Mg, Zn and Cu) minerals g/kg of feed stuffs were analyzed according to A.O.A.C. (1995) and illustrated in Table (1).

Table 1. Chemical composition on DM% basis and minerals content (g/kg) of feed ingredients.

Item	Experimental Feed Stuff				
	CFM	**Hay**	***Acacia***	***Atriplex***	***Cassava***
Chemical Composition (on DM% basis)					
DM	91.20	95.12	71.62	45.32	44.39
OM	93.09	89.59	81.88	73.92	88.26
CP	15.70	10.64	10.03	12.19	22.94
CF	14.23	38.54	16.54	25.12	28.05
EE	3.13	1.03	1.74	1.72	2.92
NFE	60.84	39.38	53.57	34.89	34.35
Ash	6.10	10.41	18.12	26.08	11.74
Mineral content (g/kg)					
Ca	6.654	8.564	48.654	2.529	21.302
P	2.005	3.395	2.744	1.0318	2.654
Na	10.523	19.210	8.339	0.0904	1.813
K	8.004	10.889	3.881	14.542	14.695
Fe	0.354	0.471	0.203	0.215	0.184
Mn	0.021	0.031	0.033	0.011	0.180
Mg	0.168	0.114	0.727	0.158	0.620
Zn	0.019	0.030	0.297	0.0231	0.108
Cu	0.002	0.003	0.004	0.003	0.004

Samples collection and experimental measurements:

Blood samples were collected biweekly during experimental periods from the jugular vein of 5 ewes from each group, randomly chosen every time, into clean test tubes with anticoagulant. Blood samples were centrifuged at 3000 rpm for 20 minutes to obtain plasma and frozen at -20 °C for late biochemical assay. Plasma concentrations of some macro (Ca, P, Na and K) and micro-minerals (Fe, Mn, Mg, Zn and Cu) were estimated calorimetrically using commercial chemical reagent kits (Bio-diagnostic product Kit, Egypt).

From each experimental group, 5 ewes were randomly selected each week for milk sampling. Milk samples were representing morning and evening milking.

Milk samples (approximately 100 ml for each) were collected from the 2nd up to 7th wk. of the suckling period.

Milk samples were directly analyzed for Macro (Ca, P, Na and K) and Micro (Fe, Mn, Mg, Zn and Cu) minerals according to the methods described by A.O.A.C. (1995) using flames, atomic absorption spectrophotometer (Perkin Elmer model 460).

Statistical analysis:

Changes in mineral concentrations in ewes' blood and milk were statistically analyzed using General Linear Model's procedures of SAS GLM (SAS, 2004), the model includes the effect of treatments (variables), sampling time (times) and their interaction beside the effect of repeated measurements. Means were compared via the LSMEANS/PDIFF of the same procedure. Values were considered significant at $P \leq 0.05$. Means were tested using Duncan's multiple Range test procedure (1955).

RESULTS AND DISCUSSION

Impact of feeding salt tolerant plants on blood minerals status:

A- Macro-elements:

Table (2) demonstrated the results of feeding STP on macro-elements concentrations in the blood of Barki ewes. As compared with control ewes that fed BH, plasma level of P increased significantly in all groups fed salt tolerant plants while plasma Ca increased significantly in ewes fed *Cassava*. However, the ratio Ca/P did not affected. In accordance, EL-Bassiony (2013) found an increase in blood P in kids of Shami goats fed STP mixture compared with those fed BH. Also, Alazzeh and Abu-Zanat (2004) found that lactating ewes fed saltbush showed an increase in the blood serum concentration of P. However, EL-Hawy (2013) found that blood P decreased in Shami does fed STP mixture.

Feeding these salt tolerant plants resulted in insignificant increase in blood Na levels, with the highest average was in ewes fed *Atriplex* and *Acacia*. However, K levels did not affected by feeding these plants. Nasr *et al.* (2002) and EL-Bassiony (2013) reported that blood sodium (Na) increased by feeding STP mixture, and interpreted this due to high content of Na in *Atriplex*.

In early lactation the Ca and P regulatory mechanisms are adapted to markedly increased Ca and P demands occurred by the mammary glands. Mobilization of Ca from bone and absorption from the blood and gastrointestinal tract increases to enable the animal to synthesis milk ingredients (Liesegang *et al.,* 2007). Shawket *et al.* (2015) stated that the milk production of ewes fed fresh *Atriplex* and *Acacia* showed better persistency and lactation presumed to least 16 weeks. They also showed that both Na and K concentrations in the blood of ewes fed fresh *Atriplex* and *Acacia* were higher by 1.6 and 1.3 times than those fed control diets.

The levels of plasma Ca increased from pre- to post-partum stage, while, the levels of P decreased except for ewes fed *Cassava*. However, plasma Ca and P in all groups increased appreciably at the end of lactation stage. Likewise, the levels of plasma Na and K reached the highest levels at the end of lactation stage.

Table 2. Impact of feeding salt tolerant plants on blood plasma macro-element concentrations of Barki ewes in different physiological periods. (Means ± SE)

Item	Sampling time	Experimental group			
		Hay	*Acacia*	*Atriplex*	*Cassava*
Ca, mg/dl	Pre-parturition	8.616±0.361^{c}	9.792±0.194^{b}	9.882±0.157^{b}	10.694±0.569^{a}
	At lambing	10.866± 0.232^{a}	10.756± 0.181^{a}	10.606± 0.319^{a}	9.795± 0.180^{b}
	At weaning	11.190± 0.303	11.426± 0.234	11.076± 0.215	11.804± 0.250
	Overall mean ± SE	10.224±0.271^{b}	10.658±0.169^{ab}	10.521±0.162^{ab}	10.764±0.258^{a}
P, mg/dl	Pre-parturition	5.310±0.365^{a}	4.259±0.195^{bc}	4.613±0.152^{b}	3.931±0.362^{c}
	At lambing	3.494± 0.243	3.194± 0.143	3.236± 0.266	3.641± 0.114
	At weaning	6.058± 0.137^{c}	9.933± 0.064^{a}	9.799±0.097^{a}	8.401± 0.143^{b}
	Overall mean ± SE	4.954±0.247^{b}	5.7950±0.555^{a}	5.883±0.535^{a}	5.324±0.425^{ab}
Ca/P ratio	Pre-parturition	1.722±0.182^{c}	2.334±0.100^{b}	2.167±0.090b^{c}	2.894±0.284^{a}
	At lambing	3.358±0.260^{b}	3.672±0.193^{ab}	3.879±0.369^{a}	2.788±0.091^{c}
	At weaning	1.856±0.065^{a}	1.148±0.023^{b}	1.133±0.018^{b}	1.408±0.034^{ab}
	Overall mean ± SE	2.312±0.172	2.385±0.204	2.393±0.243	2.363±0.158
Na, mmol/l	Pre-parturition	143.69±6.385	152.65±10.011	152.88±7.868	138.66±5.757
	At lambing	140.02±2.509	138.10±4.043	145.14±3.673	140.66±6.546
	At weaning	151.21±4.035^{b}	170.97±8.334^{a}	156.93±3.692^{ab}	158.88±7.381^{ab}
	Overall mean ± SE	144.97±2.736	153.91±5.674	151.65±3.064	146.07±3.730
K, mmol/l	Pre-parturition	3.47±0.215	3.65±0.346	3.73±0.269	3.15±0.279
	At lambing	3.46±0.101	2.99±0.221	2.95±0.162	3.15±0.211
	At weaning	3.54±0.143^{b}	4.28±0.255^{a}	3.93±0.070^{ab}	3.96±0.112^{ab}
	Overall mean ± SE	3.49±0.087	3.64±0.0.198	3.53±0.144	3.42±0.147

a, b and c, Means within the same row with different superscript are significantly different (P<0.05).

B- Micro-elements:

Table (3) demonstrated the results of feeding STP on Micro-element concentrations in the blood of Barki ewes. Plasma level of Zn increased significantly by feeding *Acacia*. Plasma level of Mg was not affected by feeding salt tolerant plants. Feeding STP while led to significant increase in plasma Fe and Mn, led to significant decrease in plasma Cu. Masters *et al.* (2007) had warned about the risk of Cu deficiencies in sheep that fed saltbush due to the high salt content of these plants. Copper absorption is affected by the physiological stage of the animal, dietary level of copper (Jenkins and Hidiriglou, 1989) and interactions with phytate, ascorbic acid, fibre, tannin etc. which appear to complex with copper (Cousins, 1985) and other trace elements. A deficiency of copper results in glucose intolerance, decreased insulin response, and increased glucose response.

It is associated with hypercholesterolemia and atherosclerosis. Copper possesses an insulin-like activity and promotes lipogenesis (Kazi, *et al.,* 2008) and (Ekmekcioglu *et al*., 2001). In general, copper plasma level may be considered as a good reflection of Cu intake in ruminants; normal levels lie between 0.070 – 0.120 mg/ dl (Tarour, 1975; Faye and Grillet 1984; Faye *et al*., 1990). Accordingly, the recent changes in ewes plasma Cu were within the normal range.

For the effect of physiological status, plasma levels of Zn (µg/dl) decreased from pre to post-partum in all groups then increased at the end of lactation reaching its highest level especially in plasma of ewes fed *Atriplex* and *Cassava*.

Plasma Mg (ml/dl) increased from pre to post weaning in ewes fed *Cassava*, but in the other groups it showed a decrease from pre to post-partum then increased again to its high level.

In all groups, plasma Fe (mg/dl) increased after parturition reaching its high level at the end of lactation.

The changes from pre to post-partum in plasma Cu (mg/dl) showed that it increased in ewes fed BH (control) and those fed *Atriplex*, while decreased in ewes fed *Acacia*, but did not change in ewes fed *Cassava*. In all groups plasma Cu reached its highest level at the end of lactation. Plasma Mn (µmol/l) increased in all groups reaching its highest levels at the end of lactation.

Both Cu and Zn work together to support the metabolism and activate the enzyme cupper-zinc superoxide dismutase, which act as an antioxidant protect the cell from harmful reactive species. Since the cells constantly produce new reactive oxygen species, they depend on antioxidants to continually neutralize the components and prevent cell damage and the cells can continue to function properly. On the other hand, Zn is an integral component of a large number of metallo-enzymes with important metabolic functions ranging from control of gene expression to metabolism of protein, fat and carbohydrate (Neldner, 1991).

The lower concentration of Ca, Zn, Mg and Cu in the blood of ewes fed salt tolerant plants was mainly due to their content of secondary metabolites such as oxalic acid in *Atriplex* and condensed tannins in *Acacia* as stated by (James, 1977) and (Cheeke, 1995) who stated that oxalic acid binds with Ca and Mg forming insoluble salts and non-digestible components. Also, McDowell (1992) reported that oxalic acid and tannic acid as chelating agents interferes with Zn absorption. Furthermore, an imbalanced Ca/P ratio were found in ewes fed salt bush diets as a result of binding Ca with oxalate which could be improved by adding good quality Ca and P sources to the ewes diets during lactation period (Alazzeh and Abu-Zanat, 2004).

Table 3. Impact of feeding salt tolerant plants on blood plasma micro-element concentrations of Barki ewes in different physiological periods. (Means ± SE)

Item	Sampling time	Experimental group			
		Hay	*Acacia*	*Atriplex*	*Cassava*
Fe, mg/dl	Pre-parturition	85.300±3.577^{c}	96.940±1.925^{b}	97.831±1.551^{b}	105.870±5.635^{a}
	At lambing	107.576±2.297^{a}	106.490±1.790^{a}	105.000±3.155^{a}	96.972±1.783^{b}
	At weaning	110.783±2.995	113.119±2.322	109.655±2.133	116.858±2.470
	Overall mean ± SE	101.220±2.686^{b}	105.516±1.670^{ab}	104.162±1.600^{ab}	106.567±2.552^{a}
Mn, µmol/L	Pre-parturition	3.290±0.138^{b}	3.738±0.075^{ab}	3.774±0.060^{ab}	4.084±0.217^{a}
	At lambing	3.582±0.366^{b}	4.141±0.051^{a}	3.926±0.168^{ab}	3.650±0.101^{ab}
	At weaning	3.893±0.403^{b}	4.299±0.121^{ab}	4.229±0.082^{ab}	4.509±0.095^{a}
	Overall mean ± SE	3.589±0.186^{b}	4.059±0.065^{a}	3.976±0.072^{a}	4.081±0.105^{a}
Mg, mg/dl	Pre-parturition	1.40±0.087	1.50±0.123	1.54±0.078	1.32±0.095
	At lambing	1.37±0.042^{ab}	1.15±0.055^{b}	1.17±0.063^{ab}	1.39±0.087^{a}
	At weaning	1.47±0.092^{b}	1.72±0.101^{a}	1.55±0.033^{ab}	1.38±0.047^{b}
	Overall mean ± SE	1.41±0.043	1.45±0.078	1.42±0.054	1.36±0.044
Zn, µg/dl	Pre-parturition	114.41±2.770	118.34±7.152	109.74±4.712	110.27±4.854
	At lambing	80.12±3.787^{b}	105.51±1.947^{a}	86.18±2.214^{b}	83.03±2.815^{b}
	At weaning	113.99±3.605	108.24±2.112	113.41±1.8384	114.12±2.212
	Overall mean ± SE	102.84±4.314^{b}	110.69±2.760^{a}	103.11±3.399^{b}	102.47±3.851^{b}
Cu, mg/dl	Pre-parturition	0.240±0.023^{a}	0.204±0.018^{ab}	0.160.±0.015^{c}	0.187±0.004b^{c}
	At lambing	0.260±0.020^{a}	0.172±0.007^{b}	0.187±0.010^{b}	0.184±0.009^{b}
	At weaning	0.285±0.020^{a}	0.234±0.011^{b}	0.215±0.006^{b}	0.235±0.010^{b}
	Overall mean ± SE	0.262±0.012^{a}	0.203±0.008^{b}	0.187±0.007^{b}	0.202±0.006^{b}

a, b and c, Means within the same row with different superscript are significantly differ (P<0.05).

On the other hand, the high level of Ca in salt tolerant plants basal diets may be negatively affecting Zn availability and excessive dietary Ca is known to negatively affect concentration of Zn in animal body tissues (Alfaro *et al.,* 1988 and McDowell, 1992). Also, the decrease availability of Zn may due to the higher level of Mg and K in the diets of salt tolerant plants (McDowell, 1992). The higher content of Se in *Atriplex* and *Acacia* than berseem hay may responsible of the significantly higher Se in the blood of ewes fed these plants compared with control diets.

The previous works exhibited conflict results. EL-Hawy (2013) found that Shami does fed STP mixture had higher blood values for Mg and Ca. EL-Hassanein *et al.* (2002) demonstrated that levels of Ca did not show significant differences in animals fed halophytes in fresh or silage forms and their control group which fed BH. Donia, *et al.* (2014) found that Shami goats fed STP mixture showed higher values of Zn, than their counterparts of the control group.

So, feeding ruminants on mixed saltbushes is desirable (Gihad and El-Shaer, 1994; Hassan *et al.,* 2015 and Shawket *et al.,* 2015) because of combination of such shrubs lead to enhance their palatability, consumption and actually nutrients utilization.

Based on the present results it could be concluded that, the impact of using salt tolerant plants on blood minerals varied according to the animal physiological status (late pregnancy and lactation period).

Impact of feeding salt tolerant plants on milk mineral status:

A- Macro-elements:

Table (4) summarized the effects of feeding salt tolerant plants (STP) on macro-minerals concentration in milk of Barki ewes. In general, feeding STP increased the overall means of Ca, P, Na and K concentrations in ewe milk compared with group fed control diet. Overall means of these minerals were the highest ($P<0.05$) in milk of ewes fed *Atriplex* that were 2.673, 0.869, 0.550 and 2.145 mg/l, respectively. Bayoumi *et al.* (1990); Rincon *et al.* (1994) and Hassan (2009) cleared that the halophytes contain high levels of Na, K and Ca, and this was reflected on animals' milk mineral profile.

Table 4. Impact of feeding salt tolerant plants on milk Macro-elements concentrations of Barki ewes. (Means ± SE)

Item	Suckling Wk.	Experimental group			
		Hay	*Acacia*	*Atriplex*	*Cassava*
Ca, mg/dl	2nd wk.	0.453±0.027^{c}	1.600±0.165^{b}	2.623±0.044^{a}	0.603±0.045^{c}
	3rd wk.	0.513±0.059^{c}	1.730±0.132^{b}	2.623±0.039^{a}	0.650±0.076^{c}
	4th wk.	0.467±0.048^{c}	1.830±0.115^{b}	2.587±0.066^{a}	0.617±0.045^{c}
	5th wk.	0.337±0.023^{d}	1.877±0.107^{b}	2.680±0.087^{a}	0.760±0.076^{c}
	6th wk.	0.337±0.044^{d}	1.897±0.216^{b}	2.780±0.070^{a}	0.773±0.082^{c}
	7th wk.	0.317±0.020^{d}	1.940±0.124^{b}	2.743±0.084^{a}	0.863±0.071^{c}
	Overall mean ± SE	0.404±0.023^{d}	1.812±0.058^{b}	2.673±0.029^{a}	0.711±0.033^{c}
P, mg/dl	2nd wk.	0.270±0.051^{b}	0.357±0.035^{b}	0.713±0.049^{a}	0.503±0.141^{ab}
	3rd wk.	0.277±0.041^{c}	0.430±0.017^{b}	0.773±0.086^{a}	0.497±0.058^{b}
	4th wk.	0.300±0.045^{c}	0.597±0.032^{b}	0.823±0.084^{a}	0.590±0.059^{b}
	5th wk.	0.347±0.060^{b}	0.713±0.023^{a}	0.877±0.041^{a}	0.707±0.077^{a}
	6th wk.	0.423±0.055^{c}	0.813±0.058^{b}	0.973±0.073^{a}	0.833±0.048^{b}
	7th wk.	0.453±0.020^{c}	0.897±0.044^{b}	1.053±0.035^{a}	0.900±0.040^{b}
	Overall mean ± SE	0.345±0.024^{c}	0.634±0.049^{b}	0.869±0.036^{a}	0.672±0.046^{b}
Na, m mol/l	2nd wk.	0.333±0.109^{b}	0.360±0.065^{b}	0.450±0.075^{a}	0.340±0.075^{b}
	3rd wk.	0.360±0.068^{b}	0.400±0.081^{b}	0.480±0.072^{a}	0.380±0.023^{b}
	4th wk.	0.440±0.098	0.460±0.092	0.510±0.069	0.460±0.092
	5th wk.	0.510±0.040	0.550±0.093	0.580±0.064	0.547±0.079
	6th wk.	0.560±0.035	0.590±0.081	0.630±0.075	0.590±0.104
	7th wk.	0.600±0.081	0.630±0.082	0.650±0.142	0.620±0.058
	Overall mean ± SE	0.467±0.036^{b}	0.498±0.040^{ab}	0.550±0.035^{a}	0.489±0.038^{ab}
K, m mol/l	2nd wk.	1. 770±0.075^{b}	1.820±0.066^{b}	1.900±0.139^{a}	1.927±0.045^{a}
	3rd wk.	1.820±0.087^{b}	1.843±0.059^{b}	1.950±0.176^{a}	1.960±0.017^{a}
	4th wk.	1.900±0.040	1.940±0.157	1.970±0.035	1.990±0.205
	5th wk.	1.950±0.285	1.980±0.081	2.020±0.202	2.040±0.023
	6th wk.	1.990±0.0225^{c}	2.010±0.126^{c}	2.900±0.208^{a}	2.110±0.029^{b}
	7th wk.	2.020±0.310^{b}	2.100±0.023^{ab}	2.130±0.180^{a}	2.150±0.132^{a}
	Overall mean ± SE	1.908±0.072^{b}	1.949±0.040^{b}	2.145±0.102^{a}	2.029±0.042^{ab}

a, b, c and d, Means within the same row with different superscript are significantly different ($P<0.05$).

The present results are in agreement with those obtained by EL-Saadany *et al.* (2016) who recorded that Barki ewes fed *Atriplex* had the higher milk and blood mineral concentrations especially calcium and phosphorus. Likewise, Chadwick *et al.* (2009) reported that ewes grazing saltbush had higher total mineral content in their milk than pasture-fed ewes, with higher concentrations of K and P elements. Milk of camels fed *Atriplex* diet had higher ($P<0.05$) concentrations of Na, K and Ca than that those fed berseem hay diet (Shawket *et al.*, 2010). In contrast, Abbeddou *et al.* (2011) concluded that feeding ewes on *Atriplex* leaves did not increase either milk sodium or potassium.

In the present study, providing lambs with milk rich in Ca, P, Na and K was of great benefits. Calcium plays a very important role in structural and physiological functions such as maximizing production, minimizing health problems, allowing the muscle contraction and normal insulin production (Goff, 1999). Providing adequate Ca and P could avoid occurrence of milk fever and decline in smooth muscle contraction, suppression of dry matter intake, increase in body fat mobilization in the form of non-esterified fatty acids (Martinez *et al.,* 2014), reduction of neutrophil function (Martinez *et al.,* 2012, 2014). Phosphorous is essential for bone and teeth formation, and involve in many metabolic reactions and energy transfer within the body, efficient use of feed and normal growth (Cromwell, 1997). Sodium is important for maintaining osmotic balance, in cellular uptake of glucose and in amino acid transport (NRC, 1985). Salt deficiencies can affect the efficiency of digestion (Thiangtum *et al.,* 2011). The K requirement increases in diets with higher Na and Cl levels. In ruminants, K is essential for rumen microorganisms and feed intake (DeGaris and Lean, 2008). All macro-elements increased with advancing lactation period reaching the highest concentration in milk at seven weeks. Lactation curve of ewes is characterized by fast reaching beak followed by gradual decline. Accordingly, milk is concentrated at mid and late lactation.

B-Micro-elements:

Feeding STP did not affect the milk concentration of Mn and Zn (Table 5). However, feeding these plants resulted in significant decrease in Fe of milk especially in ewes fed *Acacia* (1.271 mg/l). Also, a significant decrease was observed in milk Cu in ewes fed *Atriplex* and *Cassava*.

Table 5. Impact of feeding salt tolerant plants on milk micro-elements concentrations of Barki ewes. (Means ± SE)

Item	Suckling Wk.	Experimental group			
		Hay	*Acacia*	*Atriplex*	*Cassava*
Fe mg/l	2^{nd} wk.	$2.670±0.058^a$	$0.840±0.078^d$	$1.083±0.148^b$	$0.970±0.070^c$
	3^{rd} wk.	$2.270±0.133^a$	$1.028±0.096^c$	$1.310±0.203^b$	$1.340±0.118^b$
	4^{th} wk.	$2.533±0.048^a$	$1.550±0.128^b$	$1.653±0.056^b$	$1.750±0.091^b$
	5^{th} wk.	$1.880±0.339^a$	$1.210±0.031^d$	$1.573±0.134^c$	$1.717±0.015^b$
	6^{th} wk.	$1.803±0.075^a$	$1.357±0.214^b$	$1.813±0.051^a$	$1.787±0.113^a$
	7^{th} wk.	1.603±0.093	1.643±0.152	1.777±0.109	1.623±0.128
	Overall mean ± SE	$2.127±0.110^a$	$1.271±0.081^c$	$1.535±0.077^b$	$1.531±0.078^b$
Mn mg/l	2^{nd} wk.	$0.042±0.018^b$	$0.045±0.014^a$	$0.015±0.001^d$	$0.022±0.006^c$
	3^{rd} wk.	$0.041±0.012^a$	$0.040±0.012^a$	$0.025±0.005^c$	$0.032±0.010^b$
	4^{th} wk.	0.056±0.011	0.054±0.006	0.078±0.008	0.057±0.003
	5^{th} wk.	0.038±0.003	0.042±0.005	0.038±0.004	0.041±0.002
	6^{th} wk.	$0.042±0.010^{ab}$	$0.026±0.008^c$	$0.030±0.014^{bc}$	$0.047±0.005^a$
	7^{th} wk.	0.046±0.007	0.031±0.011	0.032±0.006	0.048±0.004
	Overall mean ± SE	0.044±0.006	0.039±0.004	0.036±0.005	0.041±0.003
Mg mg/l	2^{nd} wk.	$0.087±0.062^c$	$0.170±0.060^b$	$0.250±0.006^a$	$0.110±0.095^c$
	3^{rd} wk.	$0.110±0.095^c$	$0.180±0.056^b$	$0.280±0.012^a$	$0.110±0.046^c$
	4^{th} wk.	$0.120±0.067^b$	$0.190±0.115^b$	$0.310±0.017^a$	$0.140±0.067^b$
	5^{th} wk.	$0.150±0.026^b$	$0.200±0.165^b$	$0.330±0.012^a$	$0.170±0.051^b$
	6^{th} wk.	$0.180±0.092^b$	$0.220±0.075^b$	$0.330±0.017^a$	$0.200±0.068^b$
	7^{th} wk.	$0.193±0.070^b$	$0.200±0.124^b$	$0.340±0.012^a$	$0.210±0.114^b$
	Overall mean ± SE	$0.140±0.027^b$	$0.193±0.037^b$	$0.307±0.043^a$	$0.157±0.028^b$
Zn mg/l	2^{nd} wk.	$1.390±0.121^c$	$2.520±0.061^a$	$1.253±0.114^d$	$1.574±0.177^b$
	3^{rd} wk.	$1.382±0.095^{bc}$	$1.726±0.008^a$	$1.240±0.109^c$	$1.521±0.176^b$
	4^{th} wk.	$1.900±0.132^a$	$1.437±0.041^{bc}$	$1.328±0.067^c$	$1.617±0.029^b$
	5^{th} wk.	$1.268±0.086^b$	$0.931±0.056^c$	$1.227±0.061^b$	$1.463±0.020^a$
	6^{th} wk.	$1.457±0.087^a$	$0.849±0.042^b$	$1.502±0.015^a$	$1.627±0.177^a$
	7^{th} wk.	$1.677±0.054^a$	$1.213±0.058^b$	$1.783±0.108^a$	$1.667±0.097^a$
	Overall mean ± SE	1.512±0.062	1.446±0.138	1.389±0.057	1.578±0.048
Cu mg/l	2^{nd} wk.	$0.007±0.005^b$	$0.082±0.016^a$	$0.006±0.005^b$	$0.007±0.006^b$
	3^{rd} wk.	$0.031±0.008^b$	$0.065±0.018^a$	$0.012±0.001^d$	$0.017±0.007^c$
	4^{th} wk.	0.059±0.008	0.045±0.004	0.043±0.006	0.057±0.018
	5^{th} wk.	$0.058±0.015^a$	$0.049±0.018^a$	$0.017±0.009^c$	$0.029±0.010^b$
	6^{th} wk.	$0.060±0.006^a$	$0.042±0.012^a$	$0.015±0.003^b$	$0.036±0.006^{ab}$
	7^{th} wk.	$0.061±0.009^a$	$0.034±0.003^b$	$0.022±0.013^b$	$0.039±0.010^b$
	Overall mean ± SE	$0.046±0.006^a$	$0.053±0.008^a$	$0.019±0.004^b$	$0.031±0.005^b$

a, b, c and d, Means within the same row with different superscript are significantly different (P<0.05).

In the same trend, Chadwick *et al.* (2009) reported that ewes grazing on saltbush had a higher total mineral content in their milk than pasture-fed ewes, with higher concentrations of Na, K and P and lower concentrations of Fe.

The Fe decrease in milk might adversely affect lambs since iron is essential for formation of haemoglobin and myoglobin, beside cytochromes, catalases and peroxidases enzymes. In addition, the low Cu intake by suckling lambs might adversely affect glucose and fat metabolism according to Kazi, *et al.* (2008) and Ekmekcioglu *et al.* (2001). However, these two elements increased in milk with advancing lactation (Table 5), hence the risk of their deficiency might disappear gradually. It is very important to investigate the mineral status of lambs suckling milk from dams fed salt tolerant plants.

For the effect of physiological status, while Fe concentration in milk of ewes fed STP increased with advancing lactation, it decreased in ewes fed BH. From Table (1), Fe concentration in BH was higher, nearly double, than that exist in all STP. Levels of Mg increased in all groups with advancing lactation in spite of the great variation in its concentration in experimental feed ingredients. In the case of Mn level in milk, it was not changed in all groups except in milk of ewes fed *Cassava* whereas it increased at late lactation. It worthily to notice that, *Cassava* had the highest level of Mg (Table 1). The levels of Zn and Cu increased in milk with advancing lactation in ewes of all groups but decreased in milk of those fed *Acacia*. This plant has very higher concentration of Zn, but has similar level of Cu when compared to the other feed ingredients (Table 1).

It can be concluded that the milk concentration of micro-elements was affected by both their levels in feed ingredient and decreasing milk amount at last stage of lactation.

CONCLUSION

According to the present results of minerals profile in blood and milk, it could be concluded that, feeding salt tolerant plants, *Acacia nilotica, Atriplex nummularia* and *Cassava manihot esculenta* as alternatives to berseem hay did not cause any sever changes in studied macro and micro-minerals in both blood and milk of lactating Barki ewes except for Cu that must be provided to ewes to keep their normal metabolice and hormonal functions.

More studies are required for the effect of feeding these salt tolerant plants. Feeding ruminants on mixed saltbushes is desirable because of combination of such shrubs lead to enhance their palatability, consumption and actually nutrients utilization.

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مظاهر بعض العناصر المعدنية في دم و حليب النعاج البرقي المغذاة على النباتات المتحملة للملوحة في الساحل الشمالي الغربي من مصر

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تهدف الدراسة الى اظهار تأثير الاستبدال الكامل لدريس البرسيم في العليقة بأوراق وسيقان بعض النباتات المتحملة للملوحة و هي الأكاسيا (أكاسيا نيلويتكا) والأتربلكس (الأتربلكس نوموولاريا) والكاسافا (الكاسافا مانيهوت اسكولنتا) على مظاهر بعض العناصر المعدنيه في دم ولبن النعاج البرقي تحت ظروف الساحل الشمالى الغربى المصرى. تم تقسيم أربعون نعجة برقى ناضجه في الثلث الأخير من الحمل تتراوح أعمارها بين ٣-٤ سنوات ومتوسط وزن حي ٥١,٥ ±٠,٤٧ كجم عشوائيا الى أربع مجموعات متماثله ١٠ في كل منها. غذيت المجموعة الأولى على العليقة الضابطة والمحتوية على ٤٠% مخلوط علف مركز +٦٠% دريس برسيم بينما في المجموعات الثانية والثالثة والرابعة تم استبدال دريس البرسيم بالأكاسيا و الأتربلكس والكسافا بالترتيب. كانت كل الحيوانات تحت ظروف رعاية موحده . امتدت التجربة مده ٤ أسبوع قبل الولادة واستمرت طوال فترة الرضاعة (حوالى شهرين). تم أخذ عينات لبن كل أسبوع وعينات دم كل أسبوعين من ٥ نعاج مختارة عشوائيا من كل مجموعة لعمل التحاليل الكيميائية اللازمة لتقييم بعض تركيزات المعادن الكبرى والصغرى في الدم واللبن.أظهرت التغذية على النباتات المقاومة للملوحة زيادة في تركيزات الكالسيوم والفوسفور و المنجنيز والحديد. أدت التغذية علي الاكاسيا الي ارتفاع مستوي الزنك . بينما انخفض مستوى النحاس وذلك عند التغذية على نفس النباتات. كما لم تتأثر نسبة الكالسيوم/الفوسفور وكذلك مستويات الصوديوم والبوتاسيوم والمغنيسيوم في دم النعاج. أعطت مجموعة النعاج المغذاة على الأتربلكس أعلى قيم للعناصر الكبرى في الحليب بالإضافة الى أعلى مستوى للمغنيسيوم في حليبها. كما أدت التغذية على الأكاسيا إلى إرتفاع مستوى النحاس بينما أدت التغذية على الكسافا إلى ارتفاع مستوي الزنك في الحليب. ومع ذلك لم يكن هناك تغيرات مؤثره فى تركيز العناصر الكبرى والصغرى فى أى من دم أو لبن النعاج المغذاه على النباتات المتحمله للملوحه. ووفقا لذلك يمكن التوصيه بأنه يمكن استبدال الدريس بأحد هذة النباتات المتحمله للملوحه بأمان فى تغذيه النعاج البرقى الحلابه.