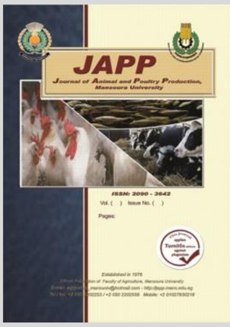
Journal of Animal and Poultry Production

Journal homepage: www.japp.mans.edu.eg
Available online at: www. jappmu.journals.ekb.eg

Oxidative Stress and Trace Elements Status in Different Reproductive Stages of Shami Goat Does Fed Salt-Tolerant Plants under Semi-Arid Conditions in Egypt

Hanan Z. Amer[1, 2*]; G. R. Donia[3] and N. H. Ibrahim[4]

[1]Animal and Poultry Physiology Department, Animal and Poultry Production Division, Desert Research Center, Egypt
[2] Department of Biology, Faculty of Science, Jazan University, Kingdom of Saudi Arabia
[3]Animal health department, Animal and Poultry Production Division, Desert Research Center, Egypt.
[4]Animal and Poultry Production Department, Faculty of Agriculture, Beni-Suef University, Egypt.



ABSTRACT

Objective of this study was to explore the impact of adding El-Mufeed liquid to salt tolerant plants in an attempt to reduce the oxidative stress of these plants by detecting changes in antioxidant indicators such as malondialdehyde (MDA), total antioxidant capacity (TAC), catalase (CAT), superoxide dismutase (SOD) and glutathione peroxidase (GPX) in Shami goats during pregnancy under South Sinai semi-arid conditions, Egypt. Two equal experimental groups (12 does each) were used. The first control group was fed wheat straw as the roughage portion of the diet, while the second group was fed salt tolerant plants mixed with El-Mufeed liquid. Blood samples were assembled from all experimental animals during dry, gestation and early lactation periods. Profile of MAD, TAC, CAT and trace elements (Cu, Se, Mn and Zn) were analyzed in plasma, while antioxidant SOD and GPX activities were measured in erythrocytes. Oxidative stress marker (MAD) was increased significantly with progress of gestation and lactation period and the vice versa was observed in TAC, CAT, SOD and GPX. It was observed that trace element and antioxidant enzymes had similar trend of changing with experimental period. Goats fed salt tolerant plants treated with El-Mufeed liquid did not differ greatly than control ones in their blood contents of antioxidant capacity (TAC) and antioxidant enzymes beside trace elements in spite of exposing to higher stress. Accordingly, it can be concluded that using El-Mufeed liquid to supply animals with trace minerals reduced oxidative effect of salt plants especially under stress of pregnancy.

Keywords: *Goat does, salt tolerant plants, pregnancy, oxidative stress, trace elements.*

INTRODUCTION

Lack of feed resources is one of the main constraints on animal production in arid and semi-arid areas of Egypt. Attention was therefore paid to the use of marginal resources, i.e. saline soils and groundwater, to produce unconventional pasture plants for animal feeding where traditional pasture cannot be cultivated. Native pastures (halophytes and other salt-tolerant plants) are the main sources of nutrition in the Egyptian deserts (Al-Shaer, 1996). The decrease and unpalatable plant species characterize about 70% of the total coverage. Some processing methods had been examined such as ensiling halophytic plants (Abou El Nasr *et al.*, 1996) or using some additives such as El-Mufeed liquid (Attia-Ismail *et al*., 1995) to improve the palatability and nutritional values of these unconventional plants.

In the past few years, the discovery of free radical destruction and the protection against it has turned out to be of great importance in animal production and reproduction studies where the lipid peroxide level and antioxidant state provide supplementary knowledge around the metabolic state of the animal rather than metabolic measurements alone (Castillo *et al*., 2003; Amer *et al*., 2014). Under healthy conditions, antioxidant enzymes and reactive oxygen species remain balanced, but this balance is disturbed in oxidative stress cases (Aurousseau et *al*., 2006). The reactive oxygen species containing hydrogen peroxide, superoxide radical and hydroxyl radical (Nazifi *et al*., 2010a) which are greatly toxic to cells and can highly interact with lively biomolecules such as proteins, lipids, nucleic acid, which leads to denaturation Protein, lipid peroxidation and DNA mutation (Esfandiari *et al*., 2007). This makes oxidative stress as one of the greatest usual mechanisms related with development of diseases variety (Berchieri-Ronchi *et al.*, 2015; Kandiel *et al.*, 2016).The ROS interact with lipids producing many intermediate compounds such as lipid peroxides, malondialdehyde (MDA) (Erisir *et al*., 2009), that extensively used for assessing oxidative stress (Lykkesfeldt and Svendsen 2007).

Total antioxidant capacity (TAC) defend cells from extra production of ROS (Bloomer and Fisher-Wellman 2008). The TAC includes endogenous compounds such as uric acid, superoxide dismutase (SOD), catalase (CAT), glutathione peroxidases (GPXs) and exogenous compounds (i.e. ascorbate, tocopherols, carotenoids, bioflavonoids) (Possamai *et al.*, 2007; Salar-Amoli *et al.*, 2009). The main function of SODs is the transfer of superoxide radical (O^{-2}) into hydrogen peroxide (H_2O_2). Catalase (CAT) detoxifies H_2O_2 and glutathione peroxidases (GPXs) removes H_2O_2 and lipid peroxides. Both CAT and GPXs belong to the secondary defense mechanism by conversion of H_2O_2 to H_2O (Garrel *et al.*,

* **Corresponding author.**
E-mail address: dr_hananzaher@yahoo.com
DOI: 10.21608/jappmu.2020.87134

2010). Estimating blood enzymatic antioxidants (CAT, GPXs and SODs) together with MDA levels may give valid information on oxidative stress level (Celi, *et al.*, 2010). However, under high oxidative stress the TAC components usually decrease (Halliwell, 2000).

Salinity of salt resistant plants, gestation and lactation are known to be stressful factors on organisms that accelerate the manufacture of ROS that cause oxidative stress (Górecka *et al*., 2002). Both fetus and dam are likely to knowledge oxidative stress, during gestation (Mutinati *et al*., 2013). At late gestation, negative energy balance might be the cause for the oxidative stress development, raised lipid peroxidation and decreased antioxidant activity (Rejitha and Karthiayini, 2014). Biomarkers of oxidative stress can be affected by plasma trace element concentrations and nutrition. There are very few reports describing the relationship between antioxidant enzymes and plasma profiles of trace elements as integral components in antioxidant system in goats fed salt tolerant plants.

This study was designed to complete the pervious study of Amer *et al.* (2014), which revealed oxidative stress effect of feeding pregnant Barki ewes with salt tolerant plants silage and recommended supplementing with trace elements in animals fed salt tolerant plants to improve the antioxidant capacity (as defense system) which enhances the growth performance and productivity of animal.

MATERIALS AND METHODS

This study was carried out at Ras Sudr Station (South Sinai) which belongs to Desert Researcher Centre, Agriculture Ministry, Egypt, during the period from September 2016 to February 2017.

Experimental animals:

At the beginning of the experiment, 32 dry Shami goat does were chosen during the breeding season with average body weight of 36±1.3 kg and 3-4 years old. All animals were housed in semi-open pens through the experimental periods. All does were divided into two similar groups (16 in each) according to the experimental diet. Does in the 1st group (T1) were fed wheat straw and concentrate feed mixture (CFM) and served as control, while those in the 2nd one (T2) were fed salt tolerant plants (50% Sorghum bicolor and 50% Pearl millet) treated with El-Mufeed liquid, as roughages and CFM. Goats were maintained on the treatments 20 days before recording data and mating season as initial period. Fresh tap water was available *ad lip* for all animals.

All experimental does were synchronized to estrus with two PGF2α injections given 11 day apart, then does in estrus post the 2nd PGF2α injection were naturally mated with proved fertile Shami bucks. The mated does were diagnosed for pregnancy on day 30 post-mating, and 12 pregnant does from each group were used as experimental animals at different reproductive stages.

Forage sampling:

The salt tolerant plants mixture (*Pearl millet* and *Sorghum bicolor*) was supplemented with El-Mufeed (About 250g of El-Mufeed was diluted with equal volume of water and sprayed on the amount of the salt tolerant plant mixture that offered daily to each animal just before morning feeding) to supply fermentable N, energy and minerals ensuring, thus, enhanced microbial growth in the rumen to increase feed intake, improve digestibility of rations and improve animals' performance. The components of El-Mufeed liquid used in the study were 93.66% cane-molasses, 1.20% urea, 1.39% mineral premix and 3.75% water. Mineral premix contained manganese sulphate monohydrate 8.55 g (2g Mn), copper sulphate anhydrous 1.05g (0.3g Cu), zinc sulphate monohydrate 0.52 g (0.14g Zn), sodium selenite anhydrous 0.03g (9.9mg Se) and sodium chloride as a carrier in amount making all premix up to 1.39 kg for 100 kg El-Mufeed liquid.

Wheat straw was obtained from the Nile Valley, while the salt tolerant plants (*Sorghum bicolor* and *Pearl millet*) were planted in the studied area and irrigated with saline water.

The trace elements in the both rations of the two groups in terms of copper (Cu), selenium (Se), manganese (Mn), and zinc (Zn) were established by spectroscopic methods. The trace elements concentrations (ppm) were 9.97 vs. 35.46 for copper (Cu); 42.16 vs. 165.3 for manganese (Mn); 920 vs. 1510 for selenium (Se) and 720 vs. 276 for zinc (Zn) in control and salt tolerant plants samples, respectively.

The chemical composition of different feed stuffs are shown in Table (1) and was measured according to A.O.A.C. (1985).

Table 1. Chemical composition (%) of experimental feeds (as % on DM basis)

Components	DM	OM	CP	EE	CF	NFE	Ash
Wheat-straw	93	75.00	3.6	1.2	30.9	39.3	25.00
Sorghum bicolor	92.17	86.29	9.68	6.31	22.99	47.31	13.71
Pearl millet	91.93	83.81	9.18	8.25	21.40	44.98	16.19
Salt tolerant mixture*	92.05	85.05	9.43	7.28	22.20	46.14	14.95
El-Mufeed liquid	68.11	83.00	10.00	1.06	1.36	70.58	17.00
Concentrate feed mixture	91.42	89.71	13.61	2.54	15.67	57.89	10.29

DM: dry matter, OM: organic matter, CP: Crude protein, EE: ether extract: CF: crude fiber, NFE: Nitrogen free extract

Blood samples and chemical analysis:

Blood samples (10 ml) were assembled into heparinized tubes from the jugular vein of does (n=12 in each group) at 8 a.m. during different physiological stages (dry, before mating; during pregnancy on days 30, 75, and 140 and on day 30 after parturition as early lactation period. Plasma was separated by cooling centrifugation at 4000 rpm for 20 min. Plasma was kept and kept at -80ºC. Micro elements (Cu, Mn, Zn and Se) concentrations in plasma were established using atomic absorption spectrophotometer (Pye Unicam SP9). Lipid peroxidation product as MDA was assessed according to Ohkawa *et al.* (1979) and stated as nmol/ ml, while TAC (mU/ L) and CAT (U/ L) were determined by chromatography techniques allowing to the method of Koracevic *et al.* (2001) and Aebi (1984). Superoxide dismutase (SOD) and glutathione peroxidase (GPX) were determined in red blood cells according to the method of Nishikimi *et al.*

(1972) and Paglia and Valentine (1967), respectively. Kits were purchased from Bio-diagnostic Co., (Cairo, Egypt). All other chemicals were of the highest commercially graded available.

Statistical analysis

A factorial design (2 experimental diets x 5 reproductive stages) of analysis of variance (ANOVA) was statistically used to determine the influence of diet, reproductive stage and their interaction on the studied parameters. All measurements were analyzed by generalized linear model by statistical software Minitab 12.1 (SAS, 2004). The significant differences among means of reproductive stages were determined by Multiple rang test of Duncan. Results were presented as Mean ± SEM.

RESULTS AND DISCUSSION

Oxidative stress and antioxidant status:

Plasma concentration of malondialdehyde (MDA), as a marker of the oxidative stress, was affected significantly by reproductive stage ($P<0.01$) and the experimental diet ($P<0.01$), but the interaction effect was not significant. Level of MDA increased ($P<0.05$) by advancing pregnancy stage up to mid-pregnancy, then it showed insignificant changes up to early lactation. Level of MDA was significantly ($P<0.01$) higher in does fed mixture of salt tolerant (T2) than in those fed wheat-straw (T1). The insignificant effect of interaction between the diet and reproductive stage reflected the maximum level of MDA (1.32 nmol/ml) at late pregnancy in Shami goats fed salt tolerant plants compared with controls fed wheat straw (1.04 nmol/ml). The trend of increase in MAD level with the progress of gestation and during lactation was associated with a trend of declined levels of total antioxidant capacity (TAC) and antioxidant enzymes (CAT, SOD and GPXs, Table 2).

According to the current results of MDA, several authors (Patil *et al*., 2007; Amer *et al*., 2014; Nawito *et al*., 2016; Abd El Hameed *et al.*, 2018) reported that MAD increased by progressing the normal pregnancy. In this respect, Casanueva and Viteri (2003) showed that the oxidative stress moved to the peak at the second half of gestation and it may cause the fetus death in the absence of antioxidant. Morris *et al.* (1998) reported high circulating levels of lipid peroxides in normal pregnancy. Toescu *et al.* (2002) recorded that late pregnancy was attended by formation of oxidizable particles with increasing oxidative damage. As well, Dimri *et al.* (2010) indicated that heavy pregnant ruminants lean to have raised lipo-peroxidative processes because of enhanced free oxygen radical's production and thus have a low status of antioxidative. They concluded that the vulnerability of cells to oxidative stress is a function of the overall balance between the degree oxidative stress and the antioxidant defense capability.

Likewise, Górecka *et al*.(2002), Patil *et al.* (2007), Idonije*et al*. (2011) and Rizzo *et al.*(2012) explained that gestation and lactation are reflected as stressful periods complemented by great metabolic need and increased tissue oxygen requirements leading to the production of ROS and rise of oxidative stress markers. This could be clarified by the fact that eighty percent of sheep fetal development occurs in the last two months of pregnancy so the ewes reveal a significant improvement in metabolism during this period (Cristian and Jauhianinen, 2001), accompanied by enhance in fatty acid intake from the mother's fat store and production of hydrogen peroxide which is increased through the sharp decomposition of fat and the mobilization of fatty acids from body deposits throughout gestation (Öztabak *et al*., 2005 and Rezapour and Roudbaneh, 2011). This also happens during lactation to withstand the lactogenesis (Adela *et al*., 2006). These processes increase oxygen requirement and circulating lipids, resulting in increased MAD level (Gür *et al.* (2011).

Finally, Ognik *et al.* (2015) reported that several metabolic pathways during pregnancy are dislocated, resulting in greater consumption of energy substrates, oxygen, and high metabolic placental demands, with resultant increasing ROS and oxidative stress.

The increase in maternal lipids profile during gestation varies with trimesters. In early pregnancy, there is improved accumulation of body fat associated with both hyperphagia and increased fat formation, while in late pregnancy, there is accelerated breakdown of fat deposits that play an important role in fetal development (Herrera, 2002). Increased lipid levels in pregnancy may increase the susceptibility of multiple polyunsaturated fatty acids to peroxidation damage by free radicals that may lead to higher MDA production (Ciragil *et al*., 2005).

Additionally, the increase in placental progesterone is associated with an increase in circulating lipids and MDA (Erisir *et al*., 2009). In this way, Mohebbi-Fani *et al.* (2012) recorded that MDA generation occurred during the genesis of the steroid. The high MDA concentrations found in the placentomes reinforce the hypothesis that pregnancy is characterized by oxidative stress (Myatt, 2006), due to the high placental metabolism and steroid development.

The results of this study indicated that pregnancy caused major changes in the antioxidant protective mechanisms in goat blood. There was a adverse association between antioxidant enzyme activities and lipid peroxide or MDA content. Oxidative stress affects continuous increase in the concentration of lipid peroxide products and decline in the level of enzymatic antioxidants (Sharma *et al*., 2011).

GPX and SOD activities have been found to be decreased during the second trimester of gestation in humans (Qanungo and Mukherjea, 2000). In accordance, Erisir *et al*. (2009) found that erythrocyte activity of CAT decreased significantly during gestation in Awassi ewes. Also, Öztabak *et al*. (2005) showed that plasma CAT activity was lower in pregnant Chios ewes during late pregnancy than in the non-pregnant ewes.

Although does in T2 exposed to additional oxidative stress (pregnancy and salt tolerant plant intake), they had nearly the same levels of antioxidant enzymes throughout the experimental period. Moreover, TAC in treated goats increased than that in control ones (0.99 vs. 0.93 mU/L) at the end of experimental period, which resulted in significant interaction between the experimental diet and reproductive stage. This may due to the role of El-Mufeed liquid in progressing digestibility and providing trace minerals.

Table 2. Level of plasma malondialdehyde (MDA), total antioxidant capacity and antioxidant enzymes of pregnant Shami goats as affected by the experimental diet and reproductive stage.

Item	Experimental diet (ED)	Reproductive stage (RS) Dry	Early pregnancy	Mid pregnancy	Late pregnancy	Early Lactation	Overall mean	±SEM ED	RS	ED X RS
MDA (nmol/ml)	T1	0.92	0.97	1.08	1.04	1.01	1.01	0.03 **	0.04 **	0.06 NS
	T2	1.04	0.96	1.21	1.32	1.25	1.15			
Overall mean		0.96^{B}	0.97^{B}	1.14^{A}	1.18^{A}	1.13^{A}				
TAC (mU/L)	T1	1.34	1.25	1.15	0.95	0.93	1.12	0.02 *	0.03 **	0.05 *
	T2	1.29	1.03	1.03	0.91	0.99	1.05			
Overall mean		1.31^{A}	1.14^{B}	1.09^{B}	0.96^{C}	0.93^{C}				
CAT (U/L)	T1	149.22	123.02	98.89	64.87	50.96	97.39	2.25 NS	3.57 **	5.05 NS
	T2	154.36	126.77	85.81	51.21	38.16	91.26			
Overall mean		151.79^{A}	124.90^{B}	92.35^{C}	58.04^{D}	44.56^{E}				
SOD (U/L)	T1	253.91	217.61	205.73	160.12	122.54	191.98	3.81 NS	6.02 **	8.52 NS
	T2	247.80	208.30	190.63	135.06	138.76	184.11			
Overall mean		250.86^{A}	212.96^{B}	198.18^{B}	147.59^{C}	130.64^{C}				
GPX (mU/L)	T1	272.35	317.74	168.60	194.53	142.66	221.77	5.94 NS	9.40 **	13.29 NS
	T2	304.77	311.25	155.63	201.02	136.17	219.18			
Overall mean		288.56^{A}	314.50^{A}	162.11^{C}	197.78^{B}	139.42^{C}				

[A, B,C and D] : Means with different letters in the same row are significantly different at P<0.05, TAC: total antioxidant capacity; CAT: catalase; SOD: superoxide dismutase; GPX: glutathione peroxidase, T1: Diet white straw; T2: Diet with salt tolerant plants treated with El-Mufeed liquid, *: P<0.05; **: P<0.01; NS: non-significant

Very few studies describe the effect of salinity on antioxidant enzymes. The results of our study revealed increased (P<0.05) overall mean of MAD level associated with significant (P<0.05) decrease in animals fed salt tolerant plants when compared with those fed control diet (white straw). These results agreed with Amer *et al.* (2014). Moreover, Mohammed *et al.* (2019) revealed that drinking well water (5000 ppm &10000 ppm) induced significant increase of oxidative stress markers (MDA) and decrease in the values of antioxidants parameters. The negative influences of salt on cell membranes are the results of the accumulation of toxic ions and ROS (Cicerali, 2004). Evidence reminds that cell membranes are the primary sites of salinity infection because ROS can interact with multiple polyunsaturated fatty acids and disrupt cell structure and function and cause peroxidation of essential membrane lipids or organelles within cells, which leads to leakage of cellular contents, rapid dehydration and cell death. Accordingly, lipid peroxide is an indication of oxidative stress in cells and tissues (Esfandiari *et al*., 2007).

Plasma trace elements:

Results of trace elements (Table 3) showed that only plasma Zn content was (P<0.01) affected by the experimental diet. Overall mean of Zn content was higher (P<0.05) in goats fed salt tolerant plants than in control goats (8.82 vs. 6.26 ppm).

Reproductive stage significantly affected all trace elements (Table 3). Trace element contents, including Cu, Mn and SE significantly (P<0.05) decreased by advancing reproductive stage, being the lowest at lactation. However, Zn showed the highest value at early lactation and the lowest value in dry stage. The insignificant interaction on Cu content reflected similar trend of reduction by advancing the reproductive stage in goats fed salt tolerant plants and wheat straw. On the other hand, the significant interaction on other elements reflected in higher Mn and Se in control goats than treated ones during dry stage, but Zinc was higher in control goats at early lactation. An opposite trend was observed for these elements during the other stages.

Metabolism of minerals plays important role in regulating physiological functions during pregnancy and lactation in small ruminants, as these physiological statuses constitute metabolic stress related with changes in the minerals profile (Ceylan *et al*., 2009; Elnageeb and Adelatif, 2010). The concentration of minerals in the blood varies as a result of interactions between its body stores, the transfer of nutrients to the fetus, and the start of milk synthesis (Kincaid, 2008). Gestation provides significant pressure to micro mineral balance in mammals (Mills and Davies, 1979). The level of copper in tissues and body fluids depends on diet, age, health and gender (Ashton, 1970). In this context, Elnageeb and Adelatif (2010) explained that the low level of copper during lactation could be related the animal's response to the fetus' needs by increasing the filling of stored copper for the development of the nervous system.

The observed decrease in levels of Cu, Mn and Se by advancing reproductive stage was in similar patterns with the behavior of antioxidant enzymes (Table 2). This may suggest that MDA level and activity of antioxidant enzymes can be influenced by nutrition and plasma trace element concentrations. Many results ensured this relationship. In calves, Humphries *et al*. (1983) found that dietary Cu deficiency led to a sharp decrease in plasma concentration of Cu and red blood cells activity of SOD. Likewise, Nazifi *et al.* (2010b) recorded a positive correlation between the plasma concentration of Cu and SOD activity of red blood cells because Cu, Zn and Mg are the major components of SOD that plays a vital role as an antioxidant to protect against oxidative stress (Nazifi *et al*., 2010b).

In accordance with the present results, El-Tohamy *et al.* (1986) found no difference due to pregnancy in Mn unlike other trace elements.

The need for zinc in most animals depends on its effect on enzymes and proteins and their activities associated with vitamin A synthesis, carbon dioxide transport (CO_2), free radical destruction, collagen fiber degradation, stabilization of red blood cell membrane, essential fatty acids metabolism, synthesis protein and nucleic acid metabolism, among others (Powell, 2000; McCall *et al.*, 2000; Stefanidou *et al.*, 2006). Unexpectedly, the zinc concentrations in plasma goat plasma fed salinity-tolerant plants exceeded those of the control group (8.82 vs. 6.26 ppm, Table 3) although the low levels of Zn intake (720 vs. 276 in control and salt tolerant plants samples, respectively). It may be that that animals fed salt tolerant plants treated with El-Mufeed liquid were more efficient at benefiting from lower zinc intake. Elnageeb and Abdelatif (2010) suggested that combining reduced nutritional status and pregnancy in unfinished ewes might increase the efficiency of zinc intake. The largest part of the total body zinc is found in the bones and competes with copper for absorption from the intestine (Kargin *et al.*, 2004). The high level of zinc in the mid and late pregnancy could be attributed to the increased rate of zinc collection in the fetus. Williams *et al.* (1972) recorded that the developing fetus accumulates 1 to 2 mg of zinc a day and that pregnant ewes increase the demand for zinc at the end of pregnancy.

Awadeh *et al.* (1998) and Trávníček *et al.* (2008) demonstrated a high correlation between the whole blood selenium content and Glutathione peroxidase (GSH-Px) activity in ewe blood, where about11.8% of total selenium in the in this compound is related. GSH-Px activity can be considered a good indicator and diagnostic tool to determine the state of selenium in sheep (Pavlata *et al.*, 2012) and thus in assessing the state of antioxidants (Adela *et al.*, 2006).

Table 3. Trace elements concentrations of Shami goats as affected by the experimental diet and reproductive stage.

Mineral	Experimental Diet (ED)	Reproductive stage (RS)					Overall mean	±SEM		
		Dry	Early pregnancy	Mid pregnancy	Late pregnancy	Lactation		ED	RS	ED X RS
Cu, ppm	T1	1.11	0.89	0.75	0.99	0.38	0.82	0.03 NS	0.05 **	0.07 NS
	T2	1.12	0.99	0.75	0.99	0.63	0.89			
Overall mean		1.11^{A}	0.94^{B}	0.75^{C}	0.99^{AB}	0.50^{D}				
Mn, ppm	T1	0.481	0.288^{d}	0.187	0.215	0.149	0.26	0.02 NS	0.04 **	0.05 **
	T2	0.147	0.375	0.533	0.430	0.101	0.31			
Overall mean		0.314^{A}	0.331^{A}	0.360^{A}	0.322^{A}	0.125^{B}				
Zn, ppm	T1	4.03	2.33	2.24	6.78	15.97	6.26	0.41 **	0.64 **	0.91 **
	T2	5.17^{e}	9.56	12.12	14.65	2.62	8.82			
Overall mean		4.60^{C}	5.94^{BC}	7.18^{B}	10.71^{A}	9.29^{A}				
Se, ppm	T1	0.253	0.251	0.265	0.295	0.191	0.251	0.002 NS	0.003 **	0.004 **
	T2	0.237	0.254	0.280	0.293	0205	0.254			
Overall mean		**0.245^{C}**	**0.253^{C}**	**0.272^{B}**	**0.294^{A}**	**0.198^{D}**				

A, B and C : Means with different letters in the same row are significantly different at P<0.05, TAC: total antioxidant capacity; CAT: catalase; SOD: superoxide dismutase; GPX: glutathione peroxidase, T1: Diet white straw; T2: Diet with salt tolerant plants treated with El-Mufeed liquid, *: P<0.05; **: P<0.01; NS: non-significant

CONCLUSION

We can conclude that El-Mufeed liquid supply animals with trace minerals to be closed to control group and goats fed with salt tolerant plants treated with El-Mufeed liquid adapted with salinity and adverse effects of these plants and antioxidant defense mechanisms limit oxidative damage and finally ensure good health in spite of adverse effect of pregnancy. So, we recommended supplying animals fed salt plants with El-Mufeed liquid to reduce the harmful effects of salt plants and improve the antioxidant capacity which consequently enhances growth performance and animal productivity

Competing interests

The authors state that they do not have conflict of interest regarding research, authorship, and/or publications of this article. The authors declare that they have no competing interests.

ACKNOWLEDGMENT

This study is a part of the regional project titled “Adaptation to climate changes in WANA marginal environments through sustainable crop and livestock diversification” funded by International Center for Bio-saline Agricultural (ICBA), UAE.

REFERENCES

A.O.A.C. (1985). Official Methods of Analysis. Association of Official Analytical Chemistry. Washington, D. C., USA.

Abd El Hameed, A. R.; Mahmoud, K. G. M.; Nawito, M. F.; Sosa, A. S. A and.Ezzo, O. H. (2018): Progesterone concentration, oxidants and antioxidants indices in singleton and multiple bearings ewes and does. Bioscience Research, 15(4):3881- 3887.

Abou El- Nasr, H. M., Kandil, H. M., El-Kerdawy, D. A., Khamis, H. S. and El-Shaer, H. M., (1996): Value of processed under arid condition of Egypt. Small Ruminant Res. 24: 15-20.

Adela, P.; Zinveliu, D.; Pop, R. A.; Andrei, S. and Kiss, E. (2006): Antioxidant status in dairy cows during lactation. Buletin USAMV-CN., 130 – 135.

Aebi, H. (1984). Catalase *in vitro*. Methods Enzymol., 105: 121 – 126.

Akinola, F. F.; Oguntibeju, O. O. and Alabi, O. O. (2010): Effects of severe malnutrition on oxidative stress in Wistar rats. Scientific Research and Essays, 5(10), pp. 1145 – 1149.

Amer, Z. H.; Ibrahim, N. H.; Donia, G. R; Younis, F. E. and Shaker, Y. M. (2014): Scrutinizing of Trace Elements and Antioxidant Enzymes Changes in Barki Ewes Fed Salt-Tolerant Plants under South Sinai Conditions. J. Am. Sci.; 10 (2): 241- 249.

Ashton, W. M. (1970). Trace elements in enzyme systems with special reference to deficiency of copper and cobalt in some animal diseases. Outlook Agricul., 6: 95- 101.

Attia-Ismail, S.A.; A.A.M. Fahmy and R.T. Fouad, 1994. Improving nutritional value of some roughage with mufeed liquid supplement. Egy. J. Anim. Prod., 31:161-174.

Aurousseau, B.; Dominique, G. and Durand, D. (2006): Gestation linked radical ROS fluxes and vitamins and trace element deficiencies in the rudiment. Reproduction Nutrition Development, 46: 601- 620.

Awadeh, F. T.; Kincaid, R. L. and Johnson, K. A. (1998): Effect of level and source of dietary selenium on concentrations of thyroid hormones and immunoglobulins in beef cows and calves. J. Anim. Sci., 76: 1204 – 1215.

Berchieri-Ronchi, C. B.;Presti, P.T.; Ferreira, A. A.; Correa, C. R.; Salvadori, D. M.; Damasceno, D . C. and Yeum K. J. (2015): Effects of oxidative stress during human and animal reproductions. International Journal of Nutrology, 8: 6 - 11.

Bloomer, R. J. and Fisher–Wellman K. H. (2008): Blood Oxidative Stress Biomarkers: Influence of Sex, Training Status, and Dietary Intake. Gender Medicine, 5: 218–228.

Casanueva, E. and Viteri, F. E. (2003): Iron and Oxidative Stress in Pregnancy. The Journal of Nutrition ; 133: (5), 700S – 1708S.

Castillo, C.; Hernández, J.; López-Alonso, M.; Miranda, M. and Benedito, J. L. (2003): Values of plasma lipid hydroperoxides and total antioxidant status in healthy dairy cows: preliminary observations. Arch. Tierz., 46: 227 – 233.

Castillo, C.; Hernzndez, J.; Bravo, A.; Lopez-Alonso, M.; Pereira, V. and Benedito, J. L. (2005): Oxidative status during late pregnancy and early lactation in dairy cows. The Veterinary Journal, 169: 286 –292.

Celi, P.; Di Trana, A. and Claps, S. (2010): Effects of plan of nutrition on oxidative stress in goats during the peripartum period. Vet. J., 184: 95 - 99.

Ceylan, E.; Tarritanir, P. and Dede, D. (2009): Changes in some macro-minerals and biochemical parameters in female healthy Siirt Hair goats before and after parturition. J. Animal and Veterinary Advances, 8 (3): 530 – 533.

Cicerali, I. N. (2004): Effect of salt stress on antioxidant defence systems of sensitive and resistant cultivars of lentil (*Lens culinaris M*.). M.Sc. thesis, submitted to the Graduate School of Natural and Applied Science of Middle East Technical University, Turkey.

Ciragil, P.; Kurutus, E. B.; Gul, M.; Kilinc, M.; Aral, M. andGuven, A. (2005): The effects of oxidative stress in urinary tract infections during pregnancy. Mediators of Inflammation. 5: 309 – 311.

Cristian, R. S. and Jauhianinen, L. (2001): Comparison of hay and silage for pregnant and lactating finish langrage ewes. Small Rum. Res., 39: 47 – 57.

Dimri, U.; Ranjan, R.; Sharma, M. C. and Varshney, V. P. (2010): Effect of vitamin E and selenium supplementation on oxidative stress indices and cortisol level in blood in water buffaloes during pregnancy and early postpartum period. Trop. Anim. Health Prod., 42: 405 – 410.

Elnageeb, M. E. and Adelatif, A. M. (2010): The minerals profile in desert ewes (Ovisaries): Effects of pregnancy, lactation and dietary supplementation. American-Eurasian J. Agric. Environ. Sci., 7 (1): 18 – 30.

El-Shaer, H. M. (1996): Rangelands as feed resources in the Egyptian desert: Management and Improvement Proc. of the Inter. Conf. on Desert Development in the Arab Gulf Countries, State of Kuwait, 23 - 26.

El-Tohamy, M. M.; Salama, A. and Youssef, A. E. M. (1986): Blood constituents in relation to the reproductive state in she-camel (*Camelus dromedarius*) Beitrage fur Trop. Landwitschaft und Vet. Med., 24, 425-430.

Erisir, M.; Benzer, F. andKandemir, F. M. (2009): Changes in the rate of lipid peroxidation in plasma and selected blood antioxidants before and during pregnancy in ewes. Acta Vet. Brno., 78: 237–242.

Esfandiari, E.; Shekari, F.; Shekari, F. and Esfandiari, M. (2007): The effect of salt stress on antioxidant enzymes' activity and lipid peroxidation on the wheat seedling. Not. Bot. Hort. Agrobot. Cluj., 35 (1): 49 – 56.

Garrel, C.; Fowler, P. A. and Al-Gubory, K. H. (2010): Developmental changes in antioxidant enzymatic defences against oxidative stress in sheep placentomes. Journal of Endocrinology, 205: 107–116.

Gitto, G.; Reiter, R.J.; Karbownik, M.; Tan, D.X.; Gitto, P.; Barberi, S. and Barberi, I. (2002): Causes of oxidative stress in the pre and perinatal period. Biol. Neonate, 81: 146 – 157.

Górecka, R., Kleczkowski, M., Kluciński, W., Kasztelan, R. and Sitarska, E. (2002): Changes in antioxidant components in blood of mares during pregnancy and after foaling. Bull.Vet. Inst. Pulawy, 46: 301-305.

Grotto, D.; Maria, L .S.; Valentini, J.; Paniz, C.; Schmitt, G.; Garcia, S.C.; Pomblum, V. J.; Rocha, J. B. T. and Farina, M. (2009): Importance of the lipid peroxidation biomarkers and methodological aspects for malondialdehyde quantification. Quim. Nova; 32: (1) 169- 74.

Gür, S.; Turk, G.; Demirci, E.; Yuce, A.; Sonmez, M.; Özer, S. and Aksu, E. H. (2011): Effect of pregnancy and foetal number on diameter of corpus luteum, maternal progesterone concentration and oxidant/antioxidant balance in ewes. Reprod. Domest. Anim .; 46: 289-95

Halliwell, B. (2000): Why and how should we measure oxidative DNA damage in nutritional studies? How far have we come? Am. J. Clin. Nutr., 72: 1082 – 1087.

Herrera, E. (2002): Lipid metabolism in pregnancy and its consequences in the fetus and newborn. Endocrine, 19: 43 – 55.

Humphries, W. R.;Philippo,M.; Young, B. W. and Bremner,I.(1983): The influence of dietary iron and molybdenum on copper metabolism in calves. British J Nutr., 49: 77 – 86.

Idonije, O.B.; Festus, O.; Okhiai, O. and Akpamu, U. (2011): A comparative study of the status of oxidative stress in pregnant Nigerian women. Research Journal of Obstrics and Gynecology, 4 (1): 28 – 36.

Kandiel, Mohamed. M.M., Heba M. El - Khaiat and Mahmoud, K. Gh. M. (2016): Changes in some hematobiochemical and hormonal profile in Barki sheep with various reproductive statuses. Small Ruminant Research, 136: 87 - 95

Kargin, F.; Seyrek, K.; Bulduk, A. and Aypak, S. (2004): Determination of the levels of zinc, copper, calcium, phosphorus and magnesium of Chios ewes in the AydÝn Region. Turk. J. Vet. Anim. Sci., 28, pp. 609- 612.

Kearl, I. C. (1982). Nutrients requirements in developing countries. Utah Agric. Exp. Stat., Utah State University, Logan, USA.

Khan M. A and Gul, B. (2002): Salt tolerant plants of coastal sabkhas of Pakistan. In H. Barth and B. Boer [eds.], Sabkha ecosystems: the Arabian Peninsula and adjacent countries, vol. 1, 123–140. Kluwer, Dordrecht, Netherlands.

Kincaid, R. (2008): Changes in the concentration of minerals in blood of peripartum cows. Mid-South Ruminant Nutrition Conference. 1- 8.

Koracevic, D.; Koracevic, G.; Djordjevic, V.; Andrejevic, S. and Cosic, V. (2001): Method for the measurement of antioxidant activity in human fluids. J. Clin. Pathol., 54: 356 – 361.

Lykkesfeldt J. and Svendsen O. (2007): Oxidants and antioxidants in disease: oxidative stress in farm animals. The Veterinary Journal, 173: (3) 502-11.

McCall, K. A.; Huang, C. and Fierke, C. A. (2000). Function and mechanism of zinc metalloenzymes. The Journal of Nutrition. 130:1437-1446.

McDowell, L. R. (2003): Minerals in Animal and Human Nutrition, Second Edition. Elsevier Science B. V., Amsterdam, The Netherlands.

Mills, C. F. and Davies, N. T. (1979): Perinatal changes in the absorption of trace elements. CIBA Foundation Series 70: 247-265.

Minatel, L. and Carfagnini, J. C. (2000): Copper deficiency and immune response in ruminants. Nutrition Research. 20:1519-1529.

Mistry, H. D. and Williams, P. J. (2011): Review Article: The importance of antioxidant micronutrients in pregnancy. Oxidative Medicine and Cellular Longevity, 1 – 12.

Mohammed, R. S.; Donia, G. R.; Tahoun, E. A. and El Ebissy, E. A. (2019): Oxidative Stress and Histopathological Alternations in Sheep as A Result of Drinking Saline Water Under the Arid Conditions of Southern Sinai, Egypt. Alexandria Journal of Veterinary Sciences, 61 (1):54 – 66.

Mohebbi-Fani, M., Mirzaei, A., Nazifi, S. and Shabbooie, Z. (2012) Changes of vitamins A, E, and C and lipid peroxidation status of breeding and pregnant sheep during dry seasons on medium-to-low quality forages. Trop. Anim. Health Prod., 44: 259-265.

Morris, J. M.; Gopaul, N. K.; Eachresen, M. J.; Knight, M.; Linton, E. A.; Dhur, S.; Anggard, E. E and Redman, C. W. (1998): Circulating markers of oxidative stress are raised in normal pregnancy and pre-eclampsia. British Journal of Obstetrics and Gyneacology, 105: 1195-1199.

Mutinati, M., Piccinno, M., Roncetti, M., Campanile, D., Rizzo, A. and Sciorsci, R.L. (2013) Oxidative stress during pregnancy in the sheep. Review article. Reprod. Domest. Anim., 48: 353-357.

Myatt, L. (2006): Placental adaptive responses and fetal programming. J. Physiol., 572: 25-30.

Myatt, L. (2010): Review: reactive oxygen and nitrogen species and functional adaptation of the placenta. Placenta, 31: Supplement, S66- S69.

Nawito, M. F.; Abd El Hameed, A. R.; Sosa, A. S. A. and Mahmoud, K. G. M. (2016): Impact of pregnancy and nutrition on oxidant⁄antioxidant balance in sheep and goats reared in South Sinai, Egypt, Veterinary World, 9(8): 801-805.

Nazifi, S.; Ghafari, N.; Farshneshani, F.; Rahsepar, M. and Razavi, S. M. (2010a): Reference values of oxidative stress parameters in adult Iranian fat-tailed sheep. Pakistan Vet. J., 30(1): 13 – 16.

Nazifi, S.; Shahriari, A. and Nazemian, N. (2010b): Relationships between thyroid hormones, serum trace elements and erythrocyte antioxidant enzymes in goats. Pak. Vet. J., 30 (3): 135 – 138.

Nishikimi, M.; Rao, N. A. and Yagi, K. (1972): The occurrence of superoxide anion in the reaction of reduced phenazine methosulfate and molecular oxygen. Biochemical and Biophysical Research Communications, 46 (2):849 – 854.

Nozik, G. E.; Suliman, H. and Piantadosi, C. (2005): Extracellular superoxide dismutase. Int. J. Biochem. 37(2): 2466-2471.

Ognik, K.; Patkowski, k.; Gruszecki, T. and Kostro, K. (2015): Redox status in the blood of ewes in the perinatal period and during lactation. Bull Vet InstPulawy, 59:557 - 61.

Ohkawa, H.; Ohishi, W. and Yagi, K. (1979): Assay for lipid peroxides in animal tissues by thiobarbituric acid reaction. Anal. Biochem.; 95: 351–358.

Öztabak, K.; Civelek, S.; Özpinar, A.; Burçak, G. and Esen, F. (2005): The effects of energy restricted diet on the activities of plasma Cu-Zn SOD, GSH-Px, CAT and TBARS concentrations in late pregnant ewes. Turk. J. Vet. Anim. Sci., 29: 1067-1071.

Paglia, D. E. and Valentine, W. N. (1967): Studies on the quantitative and qualitative characterization of erythrocyte glutathione peroxidase. J. Lab. Clin. Med., 70: 158 – 169.

Patil, S. B.; Kodiwadmath, M. W. and Kodliwadmath, S. M. (2007): Study of oxidative stress and enzymatic antioxidants in normal pregnancy. Indian J. Clin. Biochem., 22: 135 – 137.

Pavlata, L.; Misurova, L.; Pechova, A.; Husakova, T. and Dvorak, R. (2012): Direct and indirect assessment of selenium status in sheep – a comparison. VeterinarniMedicina, 57 (5): 219 – 223.

Possamai, F.P.; Fortunato, J.J.; Feier, G.; Agostinho, F.R.; Quevedo, J.; Wilhelm, F. D. and Dal-Pizzol, F. (2007): Oxidative stress after acute and sub-chronic malathion intoxication in Wistar rats. Environmental Toxicology ad Pharmacology, 23: 198–204.

Powell, S. R. (2000):The antioxidant properties of zinc. The Journal of Nutrition. 130:1447-1454.

Qanungo,S. and Mukherjea, M. (2000): Ontogenic profile of some antioxidants and lipid peroxidation in human placental and fetal tissues. Mol. Cell Biochem., 215: 11 – 19.

Rejitha, J. and Karthiayini, K. (2014) Effect of ascorbic acid supplementation on haemato-biochemical and oxidative stress parameters of crossbred Malabari does during peripartum period. Int. J. Sci. Technol., 2(6): 202-205.

Rezapour, A. and Roudbaneh, M. T. (2011): Effect of food restriction on oxidative stress indices in Ghezel ewes. Journal of Animal and Veterinary Advances, 10 (8): 980 – 986

Rizzo, A.; Roscino, M.; Binetti, F. and Sciorsci, R, (2012): Roles of reactive oxygen species in female reproduction. Reproduction in Domestic Animals, 47 (2) 344-52.

Salar-Amoli, J.;Hejazy, M. andEsfahani, T. A. (2009): Comparison between some oxidative Stress Biomarkersvalues in serum and plasma of clinically healthy adultcamels (*Camelus dromedarius*) in Iran.Vet Res Commun., 33:849–854.

SAS Institute (2004): Statistical Analysis System, STAT/ user’s guide, Release 9.1, SAS Institute, Cary NC. USA.

Sharma, N.; Singh,N. K.; Singh, O. P.;Pandey, V. and Verma, P. K. (2011): Oxidative Stress and Antioxidant Status during Transition Period in Dairy Cows. Asian-Aust. J. Anim. Sci., 24(4): 479 – 484.

Sies, H. (1991): Role of reactive oxygen species in biological processes. KlinWochenschr, 69 (21- 23): 965 - 8.

Squires, V.R. and Ayoub, A.T., (1994): Halophytes as a Resource for Livestock and for Rehabilitation of Degraded Lands. Kluwer Academic Publisher, Dordrecht Boston, London, 315.

Stefanidou, M.; Maravelias, C.; Dona, A. and Spiliopoulou, C. (2006): Zinc: a multipurpose trace element. Archives of Toxicology. 80: 1- 9.

Toescu, V.; Nuttall, S. L.; Martin, U.; Kendall, M. J. and Dunne, F. (2002): Oxidative stress and normal pregnancy. Clin. Endocrinol., 57: 609 – 613.

Trávníček, J.; Racek, J.; Trefil, L.; Rodinová, H.; Kroupová, V.; Illek, J.; Doucha, J. and Písek, L. (2008): Activity of glutathione peroxidase (GSH-Px) in the blood of ewes and their lambs receiving the selenium-enriched unicellular alga Chlorella. Czech J. Anim. Sci., 53, (7): 292 – 298.

Underwood, E. J. and Suttle, N. F. (2003): Los mineralesen la nutrición del ganado, TerceraEdición. Editorial Acribia, Zaragoza, España.

Vannucchi, C.I.; Jordao, A. A. and Vannucchi, H. (2007): Antioxidant compounds and oxidative stres s in female dogs during pregnancy. Res Vet Sci., 83 (2): 188- 193.

Williams, J. W.; Beutler, E.; Reselev, A. J. and Rundels, R. W. (1972):Haematology. Mc Grawhill. New York, London, pp: 100- 124.

Williams, J. W.; Beutler, E.; Reselev, A. J. and Rundels, R. W. (1972):Haematology. Mc Grawhill. New York, London, pp: 100- 124.

الإجهاد التأكسدي وحالة العناصر النادرة في المراحل التناسلية المختلفة لإناث الماعز الشامي المغذاه على النباتات المتحملة للملوحة تحت الظروف شبه الجافة في مصر

حنان زاهر عامر[١،٢]، جهاد رشاد دنيا [٣]و ناجي حامد متولي ابراهيم[٤]

[١]قسم فسيولوجيا الحيوان والدواجن، شعبة الانتاج الحيواني والدواجن، مركز بحوث الصحراء، المطرية، القاهرة، مصر

[٢]قسم البيولوجي، كلية العلوم، جامعة جازان، المملكة العربية السعودية.

[٣]قسم صحة الحيوان والدواجن، شعبة الانتاج الحيواني والدواجن، مركز بحوث الصحراء، المطرية، القاهرة، مصر

[٤]قسم الإنتاج الحيواني والدواجن- كلية الزراعة، جامعة بني سويف، مصر

أجريت هذه الدراسة بهدف استكشاف تأثير إضافة سائل المفيد إلى النباتات التي تتحمل الملوحة في محاولة للحد من الإجهاد التأكسدي لهذه النباتات من خلال الكشف عن التغيرات في مؤشرات مضادات الأكسدة مثل المالونداليديهيد (MDA) والسعة الكلية لمضادات الأكسدة (TAC) والكاتاليز (CAT) والسوبر أكسيد ديسترايز(SOD) والجلاثيون بيروكسيديز(GPX) خلال المراحل الفسيولوجية المختلفة في الماعز الشامي التي تتغذى على نباتات تتحمل الملوحة تحت الظروف شبه الجافة في جنوب سيناء ، مصر. تم استخدام مجموعتين تجريبيتين متساويتين (١٢ عنزة لكل منهما)، تم تغذية المجموعة الضابطة الأولى بتبن القمح باعتباره الجزء الخشن من النظام الغذائي ، بينما تم تغذية المجموعة الثانية بالنباتات المتحملة للملوحة الممزوجة بسائل المفيد. تم جمع عينات الدم من جميع حيوانات التجربة خلال فترة الحمل والجفاف والرضاعة المبكرة. تم تحليل كل من MAD، TAC، CAT والعناصر النادرة مثل النحاس والزنك والمنجنيز والسيلنيوم في البلازما، في حين تم قياس أنشطة SOD و GPX المضادة للأكسدة في كريات الدم الحمراء. أوضحت النتائج زيادة قيم MAD في الماعز من المجموعتين مع التقدم في الحمل والحليب. في الوقت نفسه انخفضت مستويات الإنزيمات المضادة للأكسدة CAT، SOD، GPX، TAC في بلازما حيوانات المجموعتين أثناء الحمل والحليب المبكرة. ولوحظ أن العناصر النادرة والإنزيمات المضادة للأكسدة لديها اتجاه مماثل للتغيير طول الفترة التجريبية. لم تختلف الماعز المغذاه على النباتات المقاومة للملوحة المعالجة بسائل المفيد اختلافا كبيرا عن ماعز المجموعة الضابطة في محتويات الدم من قدرة مضادات الأكسدة (TAC) والإنزيمات المضادة للأكسدة بجانب العناصر النادرة على الرغم من التعرض لضغط أعلى. وفقا لذلك، يمكن استنتاج أن استخدام سائل المفيد لتزويد الحيوانات بالمعادن النادرة قلل من التأثير التأكسدي للنباتات الملحية خاصة تحت ضغط الحمل.

الكلمات الدالة: اناث الماعز- النباتات المتحملة للملوحة ، الحمل ، الإجهاد التأكسدي، العناصر النادرة