SOME PHYSIOLOGICAL RESPONSES OF SHAMI GOATS TO FEEDING SALT TOLERANT FODDER CROPS DURING PREGNANCY UNDER SOUTH SINAI CONDITIONS

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SUMMARY

To study the effect of feeding salt tolerant fodder crops during pregnancy under south Sinai conditions (Ras Sudr station) on some physiological responses of Shami goats, fourteen Shami doe goats aged 2.5- 3.0 years old with averaged 25.07± 2.44 kg body weight were used and randomly divided into two equal groups (7 animals each) as follow: The first group (G1) fed berseem hay as control, while the second one (G2) fed a mixture of *Atriplex nummularia* (50%) + *Sorghum bicolor* (25%) + *Pearl millet* (25%). Both groups were supplemented with concentrate feed mixture (CDM). Live body weight changes and daily gain were recorded biweekly. Blood samples were collected from the all animals during dry, gestation (early, mid and late) for the determination of the biochemical parameters, electrolytes and hormones. The results revealed that live body weight and weight gain of control and the treated groups of doe goats were similar. Treated goats had slightly insignificant lower concentrations of TP, AL, GL, A/G ratio, and cholesterol with significant effect of pregnancy on total proteins profile. The mean values of TP, AL and GL significantly decreased (P<0.05) with advancing gestation periods. Glucose and aldosterone concentrations in treated pregnant goats showed significant (P<0.01) decrease as compared to the control animals. The significant interaction between treatment and physiological stage for ALT, ALP enzyme and insulin concentrations was for the reverse effect of each source of variance. While ALT, ALP enzyme and insulin increased by feeding salt tolerant plants but they were decreased by advancing pregnancy stages. Feeding a mixture of salt tolerant plants significantly decreased (P<0.01) the concentrations of urea and creatinine in comparison with control diet with insignificant increased throughout the gestation periods. The concentration of Na was affected significantly (P<0.01) by treatment and physiological status where it showed significant increase in the treated animals during different pregnancy stages. Potassium concentration was increased significantly from dry to reach peak during mid-gestation then declined again during late gestation compared to control animals. These results might indicate that salt tolerant plants could be a feasible solution to minimize the problem of animal feed shortage under arid conditions of Southern Sinai without sever physiological problems. These problems might be amplified due to the stress of pregnancy.

Keywords: *Shami doe goats; salt tolerant plants, Atriplex nummularia, Sorghum bicolor, Pearl millet; pregnancy; physiological parameters; Sinai.*

INTRODUCTION

Animal production in the Egyptian deserts is mainly based on natural vegetation as animal feeds. Small ruminants are the most dominant livestock in Sinai desert. They play an important role in the social life and economic status of Bedouins. Shami goats, in particular, are characterized by their high milk production and faster growth rate in addition to their large size relative to Baladi goats (Zarkawi and Soukouti, 2004). Feeding Shami does during physiological stresses; gestation and lactation; seemed to be a great challenge to spread such breed in desert areas whenever grazing is the only feed source (Badawy and Youssef, 2008). Shortage of feeds and water are the main limiting factors for sufficient animal production under the arid conditions of South Sinai in Egypt (Abdul-Aziz *et al*., 2001) and is considered the main constraint to improve livestock productivity. Dry regions in Egypt suffer from a chronic shortage of fodder crops production due to several environmental factors, particularly salinity stress in soils and ground water. Bedouins spend a considerable amount of money to buy and transport other feed ingredients from the Nile valley region, which puts an additional burden on the economic situation of Bedouins and have an impact on the feed gab in the Nile valley areas (Alsheikh *et al*., 2012). The rangelands of Sinai are an open shrub vegetation, most likely salt and/or drought tolerant plant; therefore, intensive efforts have been directed to use these plants as animal feed resources (El Shaer, 2006).

Feeding halophytes is a feasible solution to minimize the problem of animal feed shortage in desert areas. Therefore, proper range management and utilization of halophytes as an animal feed should have the priority of the development plan (Abd El-Rahman *et al.*, 2008). Halophytes have the advantage of tolerating high salt levels in the saline lands, have economic potentialities in the arid and semi-arid areas (El Shaer, 2000) and provide a valuable reserve feed for grazing animals particularly under drought conditions or fill regular gaps in feed supply caused by seasonal conditions (ICBA, 2006).The most available halophytic species are atriplex, which could be planted in such areas. This plant can be utilized as a main or secondary source of feed in periods when the availability of conventional forage is low (Alicata *et al.*, 2002). In addition, feeding *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).

Salinity of salt tolerant plants and pregnancy are known to be stress factors on animal (Amer *et al*., 2014) and during pregnancy, maternal tissues are involved in providing energy for reproduction processes, which may affect blood serum chemistry values (Yokus *et al*., 2006) and the effect of the feeding salt tolerant fodder crops on the physiology of pregnant Shami goats is not fully understood. Most researches focused only on the effect of feeding salt tolerant fodder crops on non-pregnant animals and the others focused on the effect of physiological status on biochemical parameters but little studies was conducted the interaction between feeding salt tolerant fodder crops and physiological stages. Therefore, the present study was designed to gain detailed information on the changes in some physiological and biochemical parameters in doe Shami goats during pregnancy due to the impact of feeding salt tolerant fodder crops under South Sinai conditions.

MATERIALS AND METHODS

This study was conducted at South Sinai Station (Ras Sudr) which belongs to Desert Researcher Center, Ministry of Agriculture and Land Reclamation, Egypt, in order to monitor the effect of feeding a sun-dried chopped mixture of salt tolerant fodder crops on some physiological and biochemical parameters of Shami goats during different gestation stages. Fourteen Shami doe goats aged 2.5- 3.0 years old with averaged 25.07± 2.44 kg body weight were randomly divided into two equal groups (7 animals each). The first group (G1) fed berseem hay (*Trifolium alexandrinum*, 4^{th}cut) and was used as control, while the second group (G2) fed a mixture of *Atriplex nummularia* (50%) plus *Sorghum bicolor* (25%) and *Pearl millet* (25%). The chemical composition of *Atriplex nummularia*, *sorghum bicolor* and *Pearl millet* and berseem hay was determined according to A.O.A.C. (1985).

The experimental animals were housed indoors inside separate semi-closed pens and were weighed biweekly up to end of the experiment. Drinking clean fresh water was made available twice a day over the experimental period. Both groups were provided by concentrate feed mixture (CFM). All experimental animals were fed their nutrient requirements according to Kearl (1982).

Jugular blood samples were collected into heparinized tube (10 ml) from all experimental animals in early morning just before offering ration and water during dry and different gestation periods. Heparinized blood samples were centrifuged at 3000 rpm for 30 min. Pipetting off plasma was carried out without disturbing the white buffy layer. Plasma samples were separated, labeled and stored in Eppendorf vials at -80^{o}C for pending analysis of the investigated biochemical parameters. Colorimetric determination of total proteins (TP) and albumin (AL) in plasma were carried out by a test kits supplied by Egyptian-American Company for Laboratory Services according to method described by Gornall *et al.* (1949) and Doumas *et al.* (1971), respectively. Values of globulin (Gl) and A/G ratio were calculated. Glucose concentration was analyzed according to Tietz (1986). Assay of liver functions was monitored by colorimetric determination of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities according to the method of Reitman and Frankel (1957). Total cholesterol (CHO) and alkaline phosphatase concentration (ALP) was determined according to Roeschlau *et al.* (1974); Belfield and Goldberg (1971) respectively. Indicators for kidney functions were determined using biodiagnostic kits according to Fawcett and Soctt (1960) and Schirmeister *et al.* (1964) for colorimetric determination of plasma urea and kinetic determination of creatinine concentrations, respectively. Blood 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 and aldosterone hormones using ready antibody coated tubes kits manufactured by Immunotech, Beckman Counter Company, France. Data were analyzed using General Linear Model Procedure (SAS, 2004) for repeated measurements.

RESULTS and DISCUSSION

Chemical composition of feed stuffs:

Considerable variations were observed among the chemical composition of *Atriplex nummularia, sorghum bicolor* and *Pearl millet* when compared to berseem hay. The results presented in Table (1) showed that dry matter (DM), crude fiber (CF) and nitrogen free extract (NFE) contents were higher in Berseem hay (100, 28.55 and 47 respectively) than in the salt tolerant plants mixture (92.59, 19.72 and 39.10 respectively). The mixture had higher ash and ether extract (EE) contents than Berseem hay since *Atriplex nummularia* is rich in ash fiber and EE (21.72 and 10.28, respectively.). *Sorghum bicolor* and *Pearl millet* contained lower crude protein (CP) (averaged 9%) compared to *Atriplex nummularia* (12.07%), therefore CP in the mixture forage was decreased to 10.91%. However, it seems fair enough that CP of the mixture could cover the nitrogen requirements of grazing animals (El Shaer, 2003). These data agreed with those of Abdou *et al.* (2011). Also Fayed *et al.* (2010) reported that Berseem hay and *Atriplex nummularia* had similar CP concentrations (averaged 12%). However, the CP of salt tolerant plant might be lower than those reported by other workers (Aganga *et al.*, 2003) that could be attributed to different factors such as climate and stage of growth.

Table (1): Chemical composition (%) of the individual feed stuffs and the mixture diet (on 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
CFM	93.76	89.20	16.72	12.78	4.11	55.59	10.80

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

Live body weight changes:

The results presented in Table (2) revealed that live body weight and body gain of control (fed berseem hay + CFM) and experimental (fed salt tolerant fodder crops mixture+ CFM) groups of Damascus doe goats were similar. These results also suggested that control diet of Damascus does can be replaced with salt tolerant fodder crops mixture (*Atriplex nummularia*, *Sorghum bicolor* and *Pearl millet*) without any adverse effects on live weights of the goats. This resulted in a significant financial benefit in feed costs and was possible because of the higher crude protein concentration in the atriplex. The results of study were in line with the findings of Shaker *et al.* (2008, 2014) and Shaker (2014) who reported that feeding Barki lambs with mixture of salt tolerant fodder crops mixture resulted in non-significant differences in body weight with control group. These indicated the potentiality of such salt tolerant fodder mixture to fulfill the animal requirements to maintain their body weight. However, the presence of CFM is very important to achieve benefits from salt tolerant fodders. In this concern, Ben Salem *et al.* (2002) reported that supplementing cactus based diets with *Atriplex nummularia* foliage improved the feeding value of these diets and improved sheep growth. Goats find it difficult, physiologically, to cope with ingesting large amounts of salt, resulting in decreased feed intake. Consequently, they struggle to maintain weight when grazing saltbush without supplementation mainly because of its high salt content (Masters *et al.*, 2005; Chadwick, 2009). Moreover, it was assumed that the insignificant body weight gain due to feeding saltbushes alone might be related to increased body water retention and accumulation of sodium (Nawaz *et al.,* 1994; Masters *et al.*, 2005).

Table (2): Live body weight of Shami doe goats as affected by feeding salt tolerant fodder crops mixture

Item	G1	G2	± SE
Initial body weight (IBW)(kg)	25.07[a]	25.00[a]	± 2.44
Final body weight (FBW)(kg)	30.43[a]	31.00[a]	± 2.48
Bodyweight changes (BWC)(kg)	5.36[a]	6.00[a]	± 0.39
Average daily gain (ADG)(gm)	35.71[a]	40.00[a]	± 2.65

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
Within each raw, means superscript with the same letter are not significantly different (P≤ 0.01)

Blood metabolites:

Blood metabolic profile (BMP) is a set of diagnostic procedures that are based on determining the various indicators in the blood of animals (Van Saun, 2000). Nutritional status and animal health can be assessed using BMP (Herdt *et al.*, 2000). The most important factors affecting the concentration of blood metabolic indicators are nutrition and physiological status (Antunovic *et al.*, 2002; Roubies *et al.*, 2006).

Total proteins profile:

Table (3) shows the average values of total proteins profile of goat fed salt tolerant plants mixture during different physiological states. Goats fed salt tolerant shrubs mixture had slightly insignificant lower concentrations of total proteins (TP), albumin (AL), globulin (GL) and albumin/ globulin ratio (A/G ratio) as compared with control group. These results are in accordance with those obtained by Shaker *et al.* (2008, 2014) and Shaker (2014). Taking the chemical composition of feed mixture into consideration (Table 1), the slight decrease in total proteins fraction could be attributed to the lower crude protein recorded in ration of salt tolerant plants mixture. Shahen *et al.* (2004) found a positive correlation between dietary protein and plasma protein concentrations. From another point of view, the insignificant 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). Moreover, Coles (1986) found that poor absorption of dietary constituents from the intestinal tract leads to hypoproteinemia. At the same time, higher salt intake might be another reason (Weeth and Haverland, 1961). 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.

Analyzing the data revealed the significant effect of pregnancy on total proteins profile. According to the physiological status, the mean values of TP, AL and GL decreased significantly ($P<0.05$) with advancing gestation period where the lowest concentrations were observed in late gestation period. Karapehlivan *et al.* (2007) stated that TP is one of the important blood indicators for metabolic activity in pregnant animals. Balikci *et al.* (2007) and Gürgöze *et al.* (2009) reported a decrease in TP on day 120 to 150 of gestation in ewes compared to other stages of gestation. In accordance, El-Sherif and Assad (2001) and Taghipour *et al.* (2010) reported that TP gradually decreased during pre-partum period and reached the lowest level at parturition and then slowly increased afterward. This decrease might be due to the preparation of reproductive system during pregnancy (growth of uterus) which requires large quantity of protein (Vihan and Rai, 1983). During pregnancy, the rise in the mother’s basal metabolic rate and the increase in nutrient requirement of placenta and fetus growth are involved in energy and protein consumption, consequently, dam blood serum chemistry values were decreased (Safsaf *et al.*, 2012). Relative to protein metabolism, the decline in serum protein is associated to the fact that the fetus synthesizes its proteins from the amino acids provided by the mother and growth of fetus enhances exponentially reaching maximum levels during late pregnancy, particularly in the muscles (Jainudeen and Hafez, 1994; Antunovic *et al*. 2002).

The level of albumin reflects the storage capacity of the total protein (Louacini *et al.*, 2012) and it is a very important source of amino acids for the necessities of the fetus and the mother (Jainudeen and Hafez, 1989). According to Piccione *et al.* (2009) and Kaneko *et al.* (2008), the noticeable progressive decrease of albumin during the second half of pregnancy is due to the increase of nutrient transfer toward the mammary gland and growing fetus. Similar decreasing trend were also recorded for globulin (Antunovic *et al.*, 2011; Bamerny, 2013) which might be due a rapid extraction of immunoglobulin (Ig) from the plasma during the last few months of pregnancy when a colostrum is being formed in the mammary gland as a preparatory step for the bulk secretion of Ig into colostrum after lambing (El-Sherif and Assad, 2001; Karapehlivan *et al.*, 2007; Kaneko *et al.*, 2008). Globulin can be also used for the formation of milk protein (casein) as suggested by Sharma *et al*. (2015) which might explain the decreased level of total protein reported in the current study.

Some energy metabolism indicators:

A: Plasma Glucose:

The obtained results in Table (4) demonstrated that animals fed salt tolerant plants mixture showed a significant (P<0.01) decrease in glucose concentration as compared to the control animals. Similar results were reported by Shaker *et al.* (2008, 2014) and Shaker (2014) who attributed the reduction in glucose concentration to the high content of tannins in these salt tolerant plants. Tannins were reported to adversely influence digestibility and absorption of nutrients such as proteins and amino acids, carbohydrates and lipids and also the activity of digestive enzymes (Ortiz *et al.*, 1993) through inhibiting digestive enzymes and/or by altering permeability of the gut wall (Streeter *et al.*, 1993). High salt content in the salt tolerant plants mixture used in this experiment might be another reason for such reduction in glucose concentration. Assad and El-Sherif (2002) studied the effect of saline water on sheep and they found an incidence of energy expenditure by sheep for coping with saline load, which exerted a stress on the liver function. It could be concluded that due to the lower values of glucose in blood of doe goats fed salt tolerant plants mixture they must be supplied by energy-rich diets.

Table (3): Total proteins profile of Shami doe goats as affected by feeding salt tolerant fodder crops mixture

Item	Treatment	Pregnancy stages				Overall	± SE		
		Dry	Early	Mid	Late		T	S	TxS
Total proteins (g/l)	G1	7.25^{a}	8.13^{a}	7.19^{a}	5.81^{ab}	7.10^{A}	0.39^{NS}	0.56^{*}	0.79^{*}
	G2	5.98^{ab}	8.26^{a}	6.72^{ab}	4.14^{b}	6.28^{A}			
	Overall	6.61^{AB}	8.19^{A}	6.95^{A}	4.97^{B}				
Albumin (g/l)	G1	2.64^{ab}	3.37^{a}	3.33^{a}	2.90^{ab}	3.06^{A}	0.16^{NS}	0.22^{*}	0.32^{*}
	G2	3.34^{a}	3.39^{a}	2.15^{b}	1.92^{b}	2.70^{A}			
	Overall	2.99^{AB}	3.38^{A}	2.74^{AB}	2.41^{B}				
Globulin (g/l)	G1	4.61	4.76	3.86	2.91	4.04^{A}	0.30^{NS}	0.43^{*}	0.61^{NS}
	G2	2.64	4.87	4.57	2.22	3.57^{A}			
	Overall	3.62^{AB}	4.81^{A}	4.21^{A}	2.56^{B}				
A/G ratio	G1	0.61^{ab}	0.87^{ab}	1.09^{ab}	1.04^{ab}	0.91^{A}	0.09^{NS}	0.13^{NS}	0.18^{*}
	G2	1.35^{a}	0.71^{ab}	0.47^{b}	0.90^{ab}	0.85^{A}			
	Overall	0.98^{A}	0.79^{A}	0.78^{A}	0.97^{A}				

*T= treatment; S= pregnancy stage; G1= animals fed berseem hay; G2= animals fed salt tolerant fodder mixture, * = P<0.05; NS= not significant; a, b= values in the same rows within the same parameter with the same superscript are not differ significantly; A, B= values in the same column with the same superscript are not differ significantly*

Statistical analysis (Table 4) revealed that glucose level was not affected by pregnancy stage. Moreover, there were no differences in glucose level between dry and pregnant doe goats. The significant decrease in insulin (Table 4) during pregnancy seemed to play a role in keeping glucose levels. The low observed glucose levels in mid pregnancy might be associated with fetus development and mobilization of maternal glucose to fetal blood circulation as illustrated by Jacob and Vadodaria (2001). On the other hand, the significant interaction between treatment and physiological stage was due to the lower level of plasma glucose in animals of G2 than those of G1 all over the experimental period by 14.58 mg/dl in average, while was only 11.75 mg/dl at early stage but reached 15.83mg/dl at late stage. Glucose was stated to be needed in higher levels during pregnancy due to high consumption by fetus and milk formation (Firat and Ozpinar, 2002; Ramin *et al.*, 2007). The present results emphasize that the fodder mixture did not cover the high need of energy, which necessitate supplementation with energy-rich diet especially at mid and late pregnancy. On contrary, some authors reported different findings of blood glucose level. Al-Dewachi (1999) reported high blood glucose levels in pregnant ewes.

B: Insulin

Metabolic hormones such as insulin play an important role in animal metabolism. Insulin is a 5.8-kDa protein synthesized in the pancreatic β-cells and secreted in response to plasma glucose level (Magistrelli *et al.*, 2008). Insulin has an important role in glucose transport and modulates peripheral satiety signals and directly targets the central nervous system to inhibit food intake (Gale *et al.*, 2004). Also, insulin has an important role in lipid metabolism, stimulating lipogenesis and inhibiting lipolysis (Ban-Tokuda *et al.*, 2008). The present data revealed that insulin level was significantly increased (P<0.01) in animals fed salt tolerant forages (G2) in comparison to their counterparts of control group (Table 4). In this context, *Atriplex farinose* was reported to exert hypoglycemic activity through insulin release stimulatory effect (Soliman and Donia, 2015). The maximum reduction in glucose levels was observed in rats receiving 400 mg/kg of *Atriplex farinose* extract. This supported by the present data of the reduced glucose concentration in animals fed salt tolerant plants mixture. The most reasonable explanation to rising insulin in G2 was given by Ogihara *et al.* (2001) and Donovan *et al.* (1993) that high-salt diets might be a factor in promoting insulin resistance as a normal physiological response to dietary salt loading. It has been reported that insulin resistance is coupled with increased insulin secretion, due to homeostatic mechanisms compensating the insensitivity (Isganaitis and Lusting, 2005), thus resulting in higher concentrations of insulin.

Taking the physiological status into consideration, the levels of insulin during gestation periods were significantly lower than that of dry period (Table 4). The lowest value was observed in mid gestation period. This result was in accordance with those reported by Antunovic *et al.* (2011), who suggested that the physiological status had significant effect on the serum concentration of insulin. Digby *et al.* (2008) found that high salt feeding during pregnancy is associated with changes in the circulating concentrations of insulin in the pregnant ewe. Changes in biochemical indicators and the concentration of insulin pointed at the energy deficit of ewes in pregnancy. Therefore, Antunovic *et al.* (2011) recommended the importance of measuring blood metabolic profile and insulin hormone to assess the nutritional and health status of pregnant and lactating ewes. The significant interaction between treatment and physiological stage for insulin level was for the reverse effect of each source of variance. While insulin increased by feeding salt tolerant plants, it decreased by advancing pregnancy stage. The fall in insulin level is associated with a concomitant decrease in the insulin receptors of the adipocytes which is responsible for fat mobilization during mid pregnancy (Vernon *et al.*, 1981). As reported earlier by Khan and Ludri (2002) and Mondal *et al.* (2014), the decline in plasma insulin concentration around parturition could facilitate the mobilization of nutrients from fat depot for milk synthesis. The decrease in insulin levels during mid pregnancy may be attributed to sharp increase in non-esterified fatty acid (NEFA) concentrations and decrease in glucose concentrations (Bauman and Currie, 1980).

C: Cholesterol

Animals fed salt tolerant plants mixture had insignificant lower cholesterol concentration as compared with the control ones (Table 4). Similar results were reported by Shaker *et al.* (2008) in Barki lambs and Fayed (2009) in Barki rams. This insignificant decrease in cholesterol levels might be owing to saponins contents (Fayed *et al.*, 2010; Ben Salem *et al.*, 2010). This is consistent with those reported by Potter *et al.* (1993) who found that saponins from different sources causing lower serum cholesterol levels in a variety of animals. The explanation was given by Han *et al.* (2000) and Francis *et al.* (2002) that several dietary saponins have a hypocholesterolaemic action through inhibiting the cholesterol absorption causing reduction in plasma high-density lipoprotein cholesterol fraction and/or delaying the intestinal absorption of dietary fat by inhibiting pancreatic lipase activity. On the other hand, the anti-nutritional factors were found to affect lipids profile indirectly where tannins play a considerable role in lipids digestibility by complexing with fatty acids (Romero *et al.*, 2000) causing a decrease in cholesterol absorption and increase in fat excretion (Bravo *et al.*, 1993). Similarly, Ayyat *et al.* (1991) noted a decrease in cholesterol level as a result of high salt intake. These authors suggested that protein and fat metabolism were negatively affected as a result of drinking saline water.

Cholesterol level showed insignificant gradual increase from dry period to late gestation (Table 4). Being a metabolic parameter, cholesterol is used to detect health problems that might be encountered during pregnancy and to assess the nutritional status of animals (Firat and Ozpinar, 1996). Insignificant increased cholesterol level in blood of different animal species during gestation period especially at late stage had been detected by Waziri *et al.* (2010) and Antunovic *et al.* (2011). In sheep, during late pregnancy, blood serum lipids profile was found to be characterized by increased concentration of total cholesterol, triglycerides and lipoproteins (Schlumbohm *et al.,* 1997) due to an increased mobilization of fatty acids from adipose tissue making available new sources for foetal growth. It was suggested that if ewes do not receive at least half of the required energy during late pregnancy, fat depots are mobilized in large quantities (Firat and Ozpinar, 2002). Variation in blood cholesterol content has been observed during oestrus and pregnancy, as precursor of the steroid hormones (Iriadam, 2007) and this increase might be due to estrogen stimulation during the pregnancy (Kaushik and Bugalia, 1999).

Furthermore, Khatun *et al.* (2011) reported that with the advancement of pregnancy, serum cholesterol level showed a decreasing trend. Taghipour *et al.* (2010) reported that serum cholesterol and triglyceride concentrations gradually decreased during pregnancy and reached low levels after lambing. Several studies have demonstrated the impact of factors such as breed (Abdelrahmen and Aljumaah, 2012), season (Antunovic *et al.*, 2002), feed, age and experimental conditions on the changes in blood biochemical parameters (Boudebza *et al.*, 2014). All these factors could explain the differences observed between our results and those reported by other authors.

Liver enzymes (AST, ALT and ALP):

Feeding salt tolerant plants mixture resulted in a significant (P<0.01) increase in both ALT and ALP enzymes but insignificant increase in AST enzyme activity (Table 4). These results were in harmony with those of Shaker (2014) on sheep and Shaker *et al.* (2014) and Donia *et al.* (2014) on goats. They found that the activities of liver enzymes were higher (P<0.01) in animals fed salt tolerant plants comparing to control group. This increment of liver enzyme activities might be attributed to high tannins content in these salt tolerant plants mixture (Tripathy *et al.*, 1984) or to high content of salt as reported by Hussein (1987) on sheep and Ibrahim (1995) on goats. Similarly, Assad and El-Sherif (2002) in their study on sheep, found that ALT and AST activities were increased significantly as a result of drinking saline water.

The effects of pregnancy on liver enzyme (AST and ALT) showed fluctuation in their mean values (Table 4). The data showed insignificant decreased in AST while the decrease in ALT was significant (P<0.05) and the lowest values was recorded during mid-gestation period. The mean values of ALP showed the same trend of ALT enzyme where values of ALP showed significant (P<0.01) decrease in mid and late gestation periods and the lowest values was recorded during mid-gestation. The significant interaction between treatment and physiological stage for ALP was for the reverse effect of each source of variance. While ALP increased by feeding salt tolerant plants, it decreased by advancing pregnancy stage.

Metabolic profiles have been used to predict prepartum and postpartum metabolic problems and for the diagnosis of metabolic disorders and the assessment of the nutritional status of animals. The study of biochemical profiles in maternal serum is a tool for pregnancy diagnosis and certain changes in values of liver function tests occur during normal pregnancy and serum liver function tests are essential in the management of liver diseases during pregnancy (Gürgöze *et al.*, 2009). The subnormal or elevated enzyme level in serum is one of the important tools to assess liver functioning and healthy state of pregnancy (Khatun *et al.*, 2011). It has been reported that the transaminase enzymes play a significant role in the normal continuation of gestation (Hafez *et al.*, 1983). Serum ALT activity showed a tendency to decrease in late gestation in the Angora cat in the study of Simsek *et al.* (2015), it was ascertained that serum ALT activity had decreased on day 55 of gestation, in comparison to the value measured on day 15 of gestation. In the present study, it is worth to mention that the insignificant differences observed for AST among experimental stages and the significant decreased of ALT and ALP recorded during mid and late pregnancy of Shami goats might indicate that animals were in good health and didn't suffer from pregnancy toxaemia. Major adaptations in maternal physiology and metabolism are required for successful pregnancy outcome. As gestation progresses, reference ranges for the concentration of many biochemical parameters change significantly from those found in the non-pregnant state (Lockitch, 1997).

Data available for the impact of gestation on ALT and AST activity are unclear and are somewhat controversial (Gürgöze *et al.*, 2009). In a few studies, a decrease in AST and ALT activities has been reported by Manish-Mahawar *et al.* (2004). Also, In agreement, Khatun *et al.* (2011) reported that serum AST and ALT levels decreased significantly with advancing pregnancy. While some researchers determined adverse results, El-Sherif and Assad (2001) reported that during pregnancy AST and ALT in pregnant Barki ewes started to increase significantly reaching maximum values at parturition.

Kidney function indicators:

A: Urea and Creatinine

Urea and creatinine are the two main nitrogenous compounds eventually excreted by kidney and their level in serum is known to reflect the state of glomerular filtration rate and kidney function (Kaneko, 1989). Accordingly, any change of their concentration means impaired glomerular filtration and/or insufficiency of renal tubules (Kaneko, 1989).

The present results (Table 5) revealed that urea and creatinine behaved the same trend. Feeding a mixture of salt tolerant plants significantly decreased (P<0.01) the concentrations of urea and creatinine in comparison with control diet. This reduction could be owing to the presence of tannins, which reduce the ruminal proteins degradation (Mashudi *et al.*, 1997). Moreover, 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. These results were in agreement with those of Shaker *et al.* (2014) and Donia *et al.* (2014) on goats. Conversely, some studies showed no adverse effect of salt plant on kidney function. Al-Khalasi *et al.* (2010) reported that there were no significant differences in blood urea of Omani sheep fed salt-tolerant sorghum forage or Rhodes grass and El-Bassiony (2013) reported that feeding salt tolerant plants did not have any adverse effects on BUN concentration. In the current study, urea and creatinine concentrations were increased insignificantly throughout the gestation period (Table 5). Similar results for urea and creatinine were reported by Donia *et al.* (2014) on goats and by Saeed *et al.* (2009) on pregnant camels. However, these indices might vary depending on factors such as sex, age, weather, stress, season and physical exercise (Kaneko *et al.*, 2008). Mufti *et al.* (2000) reported that as the gestation age advanced, marked changes occur in urea and creatinine in amniotic and maternal serum in ewes. The increased level of urea during pregnancy might be related to either nutritional management or high protein metabolism (Gürgöze *et al.*, 2009).The high requirement for energy by pregnant sheep during their second half of pregnancy led to an increase in urea level (Piccione *et al.*, 2009). These results coincided with the decreased protein concentration in the current study.

Table (4): Energy metabolism blood indicators and liver enzymes of Shami doe goats as affected by feeding salt tolerant fodder crops mixture and stage of pregnancy

Item	Treatment	Pregnancy stage				Overall	± SE		
		Dry	Early	Mid	Late		T	S	TxS
Glucose (mg/l)	G1	53.25^{a}	49.39^{ab}	48.55^{ab}	53.37^{a}	51.14^{A}	2.69**	3.80^{NS}	5.37*
	G2	36.80^{ab}	37.64^{ab}	34.26^{b}	37.54^{ab}	36.56^{B}			
	Overall	45.03	43.52	41.41	45.46				
Insulin (µU/ml)	G1	22.76^{b}	3.46^{ed}	0.77^{f}	2.49^{e}	7.37^{B}	0.18**	0.26**	0.37**
	G2	25.52^{a}	2.86^{ed}	4.23^{d}	5.81^{c}	9.61^{A}			
	Overall	24.14^{A}	3.16^{C}	2.50^{D}	4.15^{B}				
CHO (mg/dl)	G1	96.43	97.12	99.00	103.47	99.01^{A}	2.34^{NS}	3.32^{NS}	4.69^{NS}
	G2	92.32	92.47	93.45	96.32	93.64^{A}			
	Overall	94.37	94.79	96.22	99.90				
AST (IU/l)	G1	21.48	24.60	20.28	23.40	22.44^{A}	1.43^{NS}	2.03^{NS}	2.87^{NS}
	G2	26.76	24.12	21.72	31.32	25.98^{A}			
	Overall	24.12	24.36	21.00	27.36				
ALT (IU/l)	G1	29.66	29.20	26.47	29.83	28.79^{B}	0.86**	1.21*	1.72^{NS}
	G2	36.44	35.30	29.32S	31.21	33.07^{A}			
	Overall	33.05^{A}	32.25^{A}	27.89^{B}	30.52^{AB}				
ALP (IU/l)	G1	189.15^{b}	187.14^{b}	134.26^{e}	151.24^{d}	165.45^{B}	2.82**	3.99**	5.65**
	G2	209.65^{a}	213.62^{a}	164.71^{cd}	177.14^{bc}	191.28^{A}			
	Overall	199.40^{A}	200.38^{A}	149.48^{C}	164.19^{B}				

*T= treatment; S= pregnancy stage; G1= animals fed berseem hay; G2= animals fed salt tolerant fodder mixture, * = P<0.05; ** = P<0.01; NS= not significant; a, b= values in the same rows within the same parameter with the same superscript are not differ significantly; A,B= values in the same column with the same superscript are not differ significantly*

The obtained data revealed insignificant increased mean values of creatinine in pregnant goats to reach its peak during late pregnancy (Table 5). In agreement, Khatun *et al.* (2011) reported that creatinine showed in general an increasing trend in ewe's serum during different stages of pregnancy. Abu El-Ella and Kommonna (2013) on Damascus goats and Abdel-Hafez (2002) on sheep reported that serum creatinine concentration was increased gradually with advancing pregnancy. The increment in creatinine during this period might be owing to foetus development (Korshom *et al.*, 1993). Moreover, Piccione *et al.* (2009) reported that the creatinine level was affected by the physiological phase and showed the higher levels during the late pregnancy and early lactation. It is recognized that during the late gestation, the mother, for the foetal maternal circulation, undergo the load of organic waste of the fetus (Ferrell, 1991). So, the increase in serum creatinine levels could be attributed to the development of the foetal musculature, which is well documented in sheep and ewes too (Roubies *et al.*, 2006).

B: Sodium and Potassium

Minerals occur in body fluids and tissues as electrolytes, concerned with the maintenance of osmotic pressure, acid-base balance, membrane permeability and tissue irritability (Underwood and Suttle, 1999). In the current study, plasma sodium (Na) values were higher (P<0.01) in animals fed salt tolerant forages (G2) than in those fed traditional diet (Table 5). Similar results were obtained by Nasr *et al.* (2002); Shaker *et al.* (2008) and Shaker (2014) who reported that serum Na^+ levels was increased significantly in animals fed salt tolerant plant. This increase might be due to high content of sodium (6.45%) and chloride (7.03%) in atriplex as reported by Mohamed (1996). Wichell (1976) noted a relationship between plasma Na^+ and its intake; which is already high in such forages. The current results also indicate that the concentration of Na was affected significantly (P<0.01) by physiological status where it increased gradually from dry to mid-gestation period and then a slight regression was observed at late pregnancy specially in animals of G2 (Table 5). Pregnancy constituted metabolic stress, associated with alterations in the minerals profile dependent on the reproductive status of small ruminants. Metabolism of mineral elements plays a significant role in the regulation of physiological functions of pregnancy. The concentration of minerals varies in blood of animals as a result of changes in the concentration of nutrients in the diet and interactions between those nutrients, transfer of nutrients to the fetus, initiation of milk synthesis, changes in hormone levels and body weight loss (Kincaid, 2008).

Table (5): Changes in kidney function indicators of Shami doe goats as affected by feeding salt tolerant fodder crops mixture during pregnancy

Item	Tr.	Dry	Pregnancy periods			Overall	±SE		
			Early	Mid	Late		T	S	TxS
Urea (mg/dl)	G1	42.57^{abc}	43.27^{abc}	46.24^{ab}	47.04^{a}	44.78^{A}	1.58^{**}	2.24^{NS}	3.17^{*}
	G2	37.27^{bc}	35.51^{c}	39.36^{abc}	38.36^{abc}	37.63^{B}			
	Overall	39.92	39.39	42.80	42.70				
Creat. (mg/dl)	G1	1.14^{ab}	1.21^{ab}	1.29^{a}	1.31^{a}	1.24^{A}	0.04^{**}	0.06^{NS}	0.08^{*}
	G2	0.88^{c}	0.97^{bc}	1.00^{bc}	1.07^{abc}	0.98^{B}			
	Overall	1.01	1.09	1.14	1.19				
Na (ppm)	G1	3500^{f}	6400^{c}	$6500b^{c}$	6800^{a}	5800^{B}	14.43^{**}	20.41^{**}	28.86^{**}
	G2	3900^{e}	6600^{b}	6800^{a}	6200^{d}	5875^{A}			
	Overall	3700^{C}	6500^{B}	6650^{A}	6500^{B}				
K (ppm)	G1	160^{bc}	170^{b}	159.66^{bc}	150^{cd}	159.92	2.27^{NS}	3.22^{**}	4.55^{**}
	G2	141^{d}	170^{b}	196^{a}	150.66^{cd}	164.41			
	Overall	150.5^{B}	170^{A}	177.83^{A}	150.3^{B}				
Aldo. (pg/ ml)	G1	924.42^{a}	296.79^{c}	370.39^{c}	539.16^{b}	532.69^{A}	7.93^{**}	11.21^{**}	15.86^{**}
	G2	860.46^{a}	92.37^{d}	55.55^{d}	709.30^{b}	429.42^{B}			
	Overall	892.4^{A}	194.6^{D}	213.0^{C}	624.2^{B}				

*T= treatment; S= pregnancy stage; G1= animals fed berseem hay; G2= animals fed salt tolerant fodder mixture, * = P<0.05; ** = P<0.01; NS= not significant; a, b= values in the same rows within the same parameter with the same superscript are not differ significantly; A,B= values in the same column with the same superscript are not differ significantly*

In the present study, the pattern of changes in Na might be due to the increase in salt demand for pregnancy and lactation. For goats, the Na requirements increased from 0.015 g/day for dry animals to 0.034 g/day on 105-133 days of pregnancy (NRC, 2007). When sodium losses and sodium requirements for growth, pregnancy, lactation and work exceed intake, sodium deficiency can occur (Michell, 1985). This reduction may partly be related to the increase in foetal demands (Elnageeb and Abdelatif, 2010) or is most likely a consequence of loss of Na element in colostrum and milk. In mammals, the aqueous phase of colostrum contains high concentrations of the main ions (Na and Cl) (Ruchebusch *et al.*, 1991). These results agreed with some studies which reported the decreased value of Na concentration mostly in parturition (Azab and Abdel-Maksoud, 1999; Ahmed *et al.*, 2000; Donia *et al.*, 2014).

The present results revealed that animals fed salt tolerant plants mixture had insignificant increase in plasma K values than their counterparts fed traditional diet (Table 5). In agreement, Shaker *et al*, (2008) reported that animals fed on atriplex had higher K^+ concentration. According to physiological status, the mean values of potassium (K^+) concentration was increased significantly from dry to reach peak during mid-gestation then declined again during late gestation compared to control diet (Table 5). Moreover, K^+ concentrations in animals fed salt tolerant plants behaved the same trend of Na during gestation periods. To similar results had come by Azab and Abdel-Maksoud (1999), who reported that concentration of K^+ was decreased during late pregnancy. Kulcu and Yur (2003) reported that there were significant differences between dry and pregnancy periods for serum K^+ concentration in sheep. These differences could be associated with increased requirements for intensive growth of fetus in high pregnancy due to increased synthesis of milk in lactation (Antunovic *et al.*, 2011). Elnageeb and Abdelatif (2010) reported that K^+ level was decreased significantly ($P< 0.05$) during late gestation.

C: Aldosterone

The pregnant goats fed salt tolerant forages (G2) had significant lower ($P<0.01$) value of aldosterone than pregnant goats fed traditional diet (Table 5). Pregnancy is characterized by sodium retention and increased extracellular volume necessary for the maintenance of the mother and growth of the foetus (Davison and Lindherimer, 1989). In this context, Digby (2007) demonstrated that the ewes fed a high-salt diet managed the physiological conflict of salt retention for pregnancy and salt excretion for an overload of salt by reducing their plasma aldosterone concentration. When pregnant ewes are fed a normal or low-salt diet, aldosterone is required to increase water re-absorption and thus increase extracellular fluid. When pregnant ewes are fed a high-salt diet, aldosterone is not required as the high salt from the diet results in increased water intake and thus extracellular volume is increased. Therefore pregnant ewes fed high salt were able to avoid complications such as hypertension (Rafestin-Oblin *et al.*, 1991) or neonatal mortalities (Potter and Mclntosh, 1974) by reducing their plasma aldosterone concentration (Digby, 2007). Thus the decline in aldosterone concentrations reported herein was probably the most important adaptive mechanism that allowed the ewes to successfully complete pregnancy while consuming a high-salt diet (Digby, 2007).

The level of aldosterone was decreased from early gestation period and increased in late pregnancy. Aldosterone secretion was in the lowest level when the blood sodium level was increased at early gestation, while the reverse was true during non- gestation (dry period). This emphasized that blood sodium ions mainly regulate aldosterone secretion as stated by Digby (2007). Plasma renin activity (PRA) increases substantially during normal pregnancy (Digby, 2007). Angiotensin II concentrations also increase to nearly twice normal, due to the increase of the renin substrate, angiotensinogen, produced by the liver in response to increased levels of oestrogen whose values are high during that period (Hutchinson-Williams and Decherney 1992). As a result of the increased angiotensin II, aldosterone concentrations increase (Digby, 2007). These data supported by Boulfekhar and Brudieux (1980) who reported increased plasma aldosterone at the end of pregnancy due to the stimulation of rennin substrate production by oestrogens.

CONCLUSION

It could be concluded from the aforementioned results that halophytic forages are increasingly important for the livestock industry because of the increase in saline land. Introducing salt tolerant plants to Shami goats could be a feasible solution to minimize the problem of animal feed shortage under arid conditions of Southern Sinai. However, feeding such salt tolerant plants during gestation periods may have adverse effects on some physiological parameters.

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بعض الاستجابات الفسيولوجية لتغذيه الماعز الشامي على النباتات المقاومه للملوحه أثناء فترات الحمل المختلفه تحت ظروف جنوب سيناء

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لدراسة تأثير تغذية النباتات المقاومه للملوحه على الماعز الشامى خلال مراحل الحمل المختلفه في ظل ظروف جنوب سيناء (محطة بحوث رأس سدر) على بعض الاستجابات الفسيولوجية، تم استخدام أربعة عشر انثى ماعز شامى تتراوح أعمارهم بين 2.5 الى 3.0 سنوات مع متوسط وزن الجسم 25.07 ± 2.44 كجم و قسمت عشوائيا إلى مجموعتين متساويتين (7 حيوانات لكل منهما). تم تغذية المجموعة الأولى (G1) على دريس البرسيم واعتبرت مجموعه مقارنه (ضابطه) وتم تغذيه المجموعه الثانيه (المعامله)(G2) على خليط من النباتات المقاومه للملوحه بالاضافه الى خليط العلف المركز لكلا المجموعتين. وتم تسجيل التغير فى وزن الجسم كل أسبوعين. كما تم جمع عينات الدم من جميع الحيوانات خلال مراحل الحمل المختلفه لتقدير التركيز فى البلازما لكل من البروتين الكلي (TP)، الالبيومين (AL)، والجلوكوز، والكولسترول (CHO)، هرمون الانسولين، انزيمات الكبد (ALT و AST و ALP)، ووظائف الكليه (اليوريا، والكرياتينين)، والصوديوم والبوتاسيوم وهرمون والألدوستيرون (Aldo). اظهرت النتائج ما يلى: لا يوجد فرق فى وزن الجسم بين المجموعه الضابطه والمجموعه المعامله. لا تؤثر التغذيه على النباتات المقاومه للملوحه على مستوى TP، AL، GL والكوليسترول مع وجود تأثير معنوى كبير للحمل على هذه المتغيرات الحيويه. فقد لوحظ انخفاض معنوى لمستوى TP، AL و GL مع تقدم فترات الحمل. كما لوحظ انخفاض معنوى فى مستوى الجلوكوز والألدوستيرون في الماعز الحوامل المغذاه على النباتات المقاومه للملوحه. ارتفع مستوىALT، ALP وهرمون الانسولين بالتغذية على النباتات المقاومة للملوحه بالرغم من انخفاض مستوياتهم مع تقدم مراحل الحمل. كما سجلت تركيزات اليوريا والكرياتينين انخفاضا معنويا فى الماعز المغذاه على النباتات الملحيه مع زياده غير معنويه خلال فترات الحمل. كما تأثرت تركيزات الصوديوم والبوتاسيوم حيث أظهرت زيادة في الحيوانات المعامله خلال مراحل الحمل المختلفة. يمكن ان نستخلص من هذه النتائج أنه يمكن استخدام النباتات المقاومة للملوحه فى تغذيه الماعز الشامي كحلا عمليا للحد من مشكلة نقص الأعلاف الحيوانية في ظل الظروف الجافه في جنوب سيناء رغم وجود بعض المشاكل الفسيولوجية البسيطه التى ممكن ان تتضاعف مع الاجهاد و الضغط الذى يسببه الحمل. وبالتالى تزداد اهمية النباتات المتحمله للملوحه كاعلاف حيوانية فى المناطق الجافه المتأثره بالملوحه.