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Effect of Zeolite Addition on Physiological, Immunological, Reproductive and Productive Performance of Barki Ewes Under Water Salinity Stress in South Sinai, Egypt

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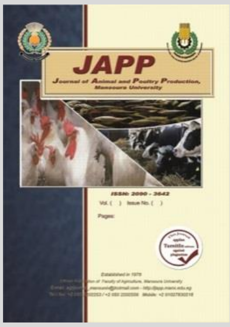

ABSTRACT

Sixty Barki ewes (2.0-3.0 years old and 30.5 ± 1.3 kg ABW) were used to evaluate the effects of zeolite addition on physiological, immunological, reproductive and productive performance under water salinity stress, were randomly assigned into three equal groups (20 ewes / group). (G1, control group); ewes drank fresh (FW) tap water (274 ppm TDS), (G2), ewes drank saline (SW) well water (5980 ppm TDS), both fed the basal diet and (G3), ewes drank SW (5980 ppm TDS) and fed the basal diet supplemented with 60 g zeolite /kg diet (6 %). Fresh and saline water were always available. Results indicated that, total proteins and immunoglobulins were increased in G3 compared with G2. T_3 hormone concentration was higher (P<0.05) in G3 by 43.56 and 20.83 % as compared to G2 and G1, respectively. However, G2 recorded insignificant decrease in T_4 hormone concentration by 9.48 and 21.64 % as compared to G3 and G1, respectively. Number of weaned lambs increased in G3 than that in G2 (18 vs.14 lamb), respectively. Milk yield negatively affected by 12.1% in SW groups (561 vs. 638 ml/h/d, P<0.05), compared to G1. Meanwhile, G3 had slightly improved milk yield by 1.4 % (647 vs. 638 ml/h/d). Lambs average daily gain were significantly higher in G3 and G1 as compared to G2. Addition of 6 % zeolite to the diets of Barki ewes could reduce the negative effect of drinking saline water without any adverse effects on Barki ewes performance under arid conditions of Egypt.

Keywords: Sheep, Zeolite, Salinity, Physiology, Immunity, Reproductive and Productive performance.

INTRODUCTION

In the arid countries, water resources are dwindling both in quantity and in quality. Such countries suffer from severe shortage of fresh water (FW) because of the irregularity of rainfall and the dry climate. Moreover, water resources of large areas of several countries are saline (Choukr-Allah, 1996). Egypt, like other arid and semi-arid developing nations, confronts a serious challenge of limited natural supplies of excellent quality water (Ashour *et al*., 1997). Ingestion of salt in the diet has a less significant influence on reproductive success than exposure to salty water (Digby *et al*., 2011).

Some nations have embraced excellent agricultural techniques that are ecologically friendly, contribute to animal and human health, do not allow the use of chemical and artificial fertilisers, and provide safe and healthy meals as a consequence of growing consumer awareness in recent years. The use of natural or synthetic zeolite in animal feeds has expanded, mostly to enhance animal health and performance, as well as to guard against mycotoxins poisoning (Khachlouf *et al*., 2018). Furthermore, unlike many silicates, powder-form zeolites have no chemical interactions with nutrients or body fluids since they are inert in the digestive system (Ivkovic *et al*., 2004), and thus can be used without ill effects in human and animal nutrition.

Zeolites are crystals with an endless, open specific, three-dimensional nano paroles structure generated from a microporous aluminosilicate skeleton of alkali and alkaline earth cations that are found all over the planet. These materials have unique chemical and physical properties, including the ability to reversibly lose and gain water, absorb substances with a suitable cross-sectional diameter (adsorption property), and switch their cations with cations from their environment, such as K+, NH4 +, Ca2+, and Mg2+, without undergoing major structural changes (Bosi *et al*., 2002 and Filippidis *et al*., 1996). Natural zeolites have been shown to have beneficial benefits on the body's detoxification, immunological system, mineral metabolism, blood circulation, neurological system, and digestion, according to Hecht (2010). As a result, the purpose of this study was to see how dietary zeolite (Clinoptiolite) affected the physiological, immunological, reproductive, and productive performance of Barki ewes drinking saline well water in the dry South Sinai region of Egypt.

MATERIALS AND METHODS

Animals and management:

Sixty mature Barki ewes (2.0-3.0 years old with an average live body weight of 30.5 1.3 kg) were divided into three equal groups (20 ewes each). Ewes in the first group (G1) were fed a basic diet of concentrate

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feed mixture and berseem hay and drank fresh tap water (FW, 274 ppm TDS). Concentrate feed mixture consisted of 43% yellow corn, 22% cotton seed meal, 20% wheat bran, 12% rice bran, 1.5% limestone, 1% sodium chloride and 0.5% minerals mixture (control group). Ewes in the second group (G2) were given the baseline diet and drank salty well water (SW, 5980 ppm TDS). Ewes in the third group (G3) were fed the basal diet + 60 g zeolite/kg food and drank SW (6%). The chemical analysis of FW and SW is depicted in (Table 1). According to Kearl (1982), rations were changed weekly to meet their needs during their physiological state. All groups had access to fresh tap and saline well water throughout the day.

Table 1. Chemical analysis of drinking fresh and saline well water

Parameter	FW	SW	SW/FW ratio
Total dissolved solids (mg/l)	274	5980	21.82
Electric conductivity (μs/cm)	0.53	9.96	18.79
Sodium (mg/l)	2.40	86.00	35.83
Chloride (mg/l)	2.47	61.34	24.83
Calcium (mg/l)	1.75	15.00	8.57
Magnesium (mg/l)	2.25	19.00	8.44
Potassium (mg/l)	0.15	0.36	2.40
Hardness* (mg/l)	4.00	34.00	8.50
Carbonate (mg/l)	0.40	0.20	0.50
Bicarbonate (mg/l)	2.60	3.00	1.15
pH	7.63	7.23	0.95

*** Hardness is a measure of the amount of calcium and magnesium salts in water.**

Blood sampling and analysis:

During mating season, blood samples (10ml) were obtained from 10 ewes in each group in the morning before feeding, through vein puncture (using a clinical needle) on the day of estrus (day 0), and subsequently at biweekly intervals until parturition. For serum separation, blood samples were centrifuged at 3000 rpm for 20 minutes and stored at -20 oC until further analysis. The amounts of total proteins (TP) and albumin (Alb) were measured using commercial test kits provided by Biodiagnostic Company for Laboratory Services. In the meanwhile, globulin (Glb) was computed. Thyroid hormones (T3 and T4), as well as progesterone (P4), were measured using ELISA kits provided by Immunospec Corporation (7018 OweNSMounth Ave. Suite 103 Canoga Park, CA 91303, USA). Immunoglobulins (IgG, IgM, and IgA) were determined using commercial kits provided by Clinical Chemistry Company and evaluated in Tarek Lab, located at 183 Tahrir Street in Cairo, Egypt.

Reproductive parameters:

The mating season was 36 days long (equal to 2 estrous cycles). To minimise ram/group confusion, five fertile rams were permitted to cycle among various ewes' groups. The rams were fed the control concentrate ration and given FW before being separated from the ewes' groups in the morning.

This study determined and documented reproductive variables such as conception (CR) and lambing rates (LR), abortion rate (AR) and stillbirth rates (SBR), number of lambs born alive (NLBL) and number of weaned lambs (NWL), weaning weight (WW), and mortality rate (MR) from birth through weaning age.

Productive parameters:

The born lambs were ear-tagged and weighed to record their birth weight (BW) after lambing, and subsequently biweekly until weaning. Lambs were left with their dams until WW, which occurred at 3 months and was documented. Average daily gain (ADG) and total weight growth were also kept track of. From lambing to 12 weeks (lactation phase, LP), milk yield (MY) was assessed biweekly by completely hand milking the udder after fasting lambs for 12 hours on two consecutive days, once at night and once in the morning to cover 24 hours.

Statistical analysis:

Data of body weight at birth, weaning weight, milk yield and blood biochemical parameters were analyzed by the least square analysis of variance using the General Linear Model Procedure **(SAS, 2004)**. The model was one-way analysis as follows:

$$Y_{ij} = \mu + G_i + e_{ij}$$

Where:

Y_{ij} = any observations of i^th^ animal within j^th^ group.

μ = overall mean

G_i = effect of group, (i: 1-3)

e_{ij} = experimental error.

Means were compared using Duncan Multiple Range Test (Duncan, 1955).

Data of reproductive parameters (conception rate, lambing rate, stillbirth, weaning rate) were analyzed by Chi square analysis.

RESULTS AND DISSCUTION

Physiological parameters:

Total protein and its fractions:

As shown in Table (2), ewes drank FW (control) recorded higher ($P \leq 0.05$) values of TP followed by zeolite group (G3). While SW group (G2) recorded the lowest value (6.18, 5.80 and 5.16 g/dl, respectively). On the other hand, Alb concentration tended to increase ($P \leq 0.05$) in control and G3 than G2 (3.7, 3.4 and 3.7 g/dl for G1, G2 and G3, respectively). However, Glb concentrations were insignificantly higher in control and G3 than G2 (2.48, 2.10 and 1.68 g/dl for G1, G3 and G2, respectively).

These findings are consistent with those of Tata and Widnell (1966), who found a drop in TP, Alb, and Glb concentrations after consuming SW, presumably due to a decrease in hepatic RNA synthesis, which slowed the incorporation of amino acids for protein synthesis. Total protein concentration was decreased with NaCl increase in drinking water in Barbarine sheep, while Alb increased with NaCl increase (Yousef and Ben Salem, 2017). Also, Preeti *et al.* (2018) reported that calves drank different levels of SW led to a decrease in TP and Alb, while Glb did not affect. This decrease in TP and Alb might be due to the increase in the osmolarity of blood which will attract water to maintain homeostasis and in doing so there will be dilution of blood will take place and ultimately protein also (Preeti *et al.*, 2018).

On the other hand, Eltayeb (2006) reported that drinking SW increased serum TP and Alb concentrations significantly compared with the control group of Nubian goats. While, El-Gharbi *et al.* (2015) found that TP did not affected by drinking SW in Barbarine Sheep. Indeed, Valpotic *et al*. (2016) discovered that zeolite supplementation enhanced IgG, TP, and certain microelement absorption in cattle, particularly iron and copper.

Table 2. Effect of treatments on the concentration (g/dl) of blood total proteins and its fraction

Group Item	G1	G2	G3	± SE	P value
Total protein	6.18^{a}	5.16^{c}	5.80^{b}	0.11	0.05
Albumin	3.7^{a}	3.4^{b}	3.7^{a}	0.08	0.05
Globulin	2.48	1.68	2.10	0.13	0.13

a-b means in the some rows with different superscripts differ significantly (P<0.05).
G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3=ewes dank saline well water + zeolite (6 %).

Thyroid hormones:

Thyroid hormones serve an important function in animal growth and development. These hormones are linked to protein, carbohydrate, and fat metabolism (Zanouny *et al*., 2013). Furthermore, proper thyroxine (T4) hormone secretion is critical for normal regulation nervous system function. As a result, decreased thyroid output will result in decreased food metabolism (Shaker, 2014). The mean values of T_3 and T_4 as affected by zeolite addition to ration are presented in Fig (1). T_3 hormone concentration was higher ($P<0.05$) in the ewes of G3 (1.45 ng/dl) followed by the ewes in G1 (1.20 ng/dl).While, the ewes in G2 recorded the lowest value (1.01 ng/dl). On the other hand, ewes in G1 recorded the highest value of T_4 hormone followed by the ewes in G3. While, ewes in G2 showed the lowest value (6.7, 5.8 and 5.25 ng/dl) for G1, G3 and G2, respectively. These values of T3 and T4 hormones within the normal rang reported by El-Malky *et al*., (20119).

These results might indicate that T_3 and T_4 hormones were affected by drinking SW, but zeolite addition play important role in decline the negative effect of drank SW. These findings are consistent with those of Shaker (2014), who observed that thyroid hormones in Barki sheep fed salt plants were reduced by 30.49 %for T3 and 46.57 %for T4 hormones when compared to those given berseem hay. He came to the conclusion that the excessive salt content may be to blame for the declines in thyroid hormones. Metwally (2001) also found that SW therapy in camels reduced both T3 and T4 hormones as a result of lower feed intake, which slowed down the metabolic process.

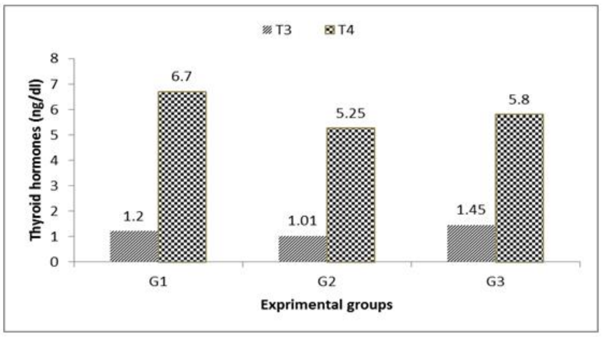

Fig .1. Thyroid hormones (T_3 and T_4) of different groups during experimental period.
G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3=ewes dank saline well water + zeolite (6 %).

Progesterone concentration:

In the present study, P_4 concentration was low in all groups on the day of estrus (0.31±0.03 ng /ml), followed by a gradual increase due to the presence of active corpus luteum (CL). While, in all groups, P_4 concentration was increased with the progress of pregnancy exhibiting higher peak on day 115 (5.33±0.84, 4.71±0.84 and 5.47±0.84 ng/ml for G1, G2 and G3, respectively) of pregnancy and gradually declined thereafter till parturition (Fig 2). Early in pregnancy, a high concentration of P4 is helpful to embryo survival (Parr, 1992), but a quick fall in P4 is required for the commencement of parturition (Rurak, 2001). During the trial, P4 concentration was insignificantly greater not the G3 (zeolite group) ewes than in the control (G1) and SW (G2) groups. This might mean that adding zeolite had no effect on the hormonal profile.

These findings are consistent with those of Digby *et al*. (2011), who found that ewes given SW had lower plasma P4 concentrations. P4 levels were shown to be higher in twin-bearing ewes who ate SW (Potter and McIntosh, 1974), while P4 levels in single-bearing ewes were unaffected by a high salt diet. However, the increase in P4 levels in pregnant ewes' drinking water containing 1.3 %sodium chloride might be attributable to alterations in P4 metabolic clearance via the liver, which would result in a decrease in feed consumption (Digby *et al*., 2008).

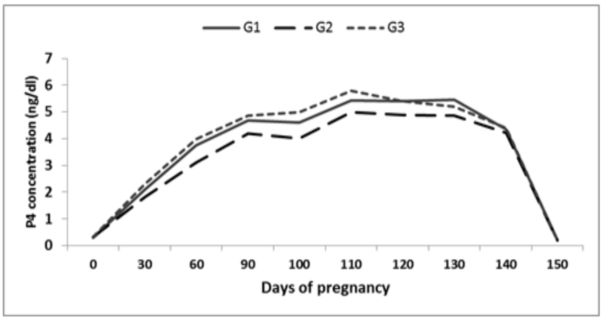

Fig. 2. Progesterone hormone (P_4) concentration during the whole pregnancy period of the experimental groups.
G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3 = ewes dank saline well water + zeolite (6 %).

Immunological responses:

Most zeolite additions were utilised to enhance gut health and general health status in farm animals, such as companion animals and horses (Papaioannou *et al*., 2005), as well as to increase welfare for other farm animals, such as companion animals and horses (Colella, 2011). Immunoglobulin concentrations (IgG, IgM and IgA) were significantly affected by drinking SW (Table 3). All immunoglobulins were significantly increased in G3 followed by G1, while G2 recorded the lowest concentrations. These results indicate that zeolite addition improved immunological responses and decreased the side effects of drinking SW. These results agree with the results of Nik-Khan (2002), who found that using 1 g zeolite/ kg body weight/ daily increased serum immunoglobulins. Furthermore, in pigs fed a basic diet (control) and a diet supplemented with 0.5 %zeolite, Islam *et al*. (2014) found that zeolite supplementation enhanced IgG levels but IgA and IgM levels remained unaltered. Improved IgG transfer and reduced newborn morbidity may be possible with the addition of zeolite to colostrum (Fratric *et al*., 2007 and Gvozdic *et al.,* 2007). Another study found that adding zeolite to colostrum or milk at two different concentrations (1.2 or 3%) for 15 days increased calves' health and illness resistance (Petkova *et al.,* 1983). Furthermore, giving zeolite to calves improved their overall health, particularly their disease resistance (Mohri *et al.,* 2008).

Table 3. Effect of treatments on immunological parameters of Barki ewes

Group Item	G1	G2	G3	±SE	P V
IgG (ng/dl)	0.029^{b}	0.027^{b}	0.034^{a}	0.0018	0.0107
IgM (ng/dl)	0.027^{b}	0.021^{c}	0.035^{a}	0.0012	0.0001
IgA (ng/dl)	0.026^{b}	0.024^{b}	0.034^{a}	0.0017	0.0001

a-c Means in the same row with different superscripts differ significantly at (P<0.05).
G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3=ewes dank saline well water + zeolite (6 %).

According to animal health, Pavelic *et al* (2001) concluded that zeolite addition to animal diets has been successfully used as vaccine adjuvant and for diarrhea treatment for animals.

Reproductive parameters:

As feed additives, zeolites have been extensively used in farm animals to positively influence growth and reproductive performance (Papaioannou *et al*., 2005). As shown in Table (4), number of ewes used in mating season was 60 ewes (20 in each group), but 4 of them were barren being, one ewe in G1 and G3 and two ewes in G2. While, number of stillbirths was 1.0 in G1 and G2. Data in Table (4) showed that CR did not differ significantly between different experimental groups with values being 95, 90 and 95% for G1, G2 and G3, respectively. Zeolite group (G3) recorded the highest percentage of LR (95%), followed by control group (90%), while G2 recorded the lowest percentage (85%). Moreover, NLBL and NWL were higher in zeolite group. These results indicate that addition of zeolite to ewe's diet improved all reproductive studies.

On the other hand, the present study indicated that drinking SW to Barki ewes had insignificant negative effect on reproductive performance. This conclusion is consistent with that of Digby *et al.* (2011), who found that salt in drinking water had a greater impact on sheep reproductive performance than salt in the diet.

Peirce (1968) also found that sheep exposed to 1.3 % salts or 0.9 % sodium chloride in drinking water failed to conceive on occasion. The impact of drinking SW containing 1.3 % sodium chloride on pregnant sheep is linked to variations in progesterone and electrolyte concentrations in blood plasma, although the biological significance of this link is unknown (Digby *et al*., 2011).

The number of lambs killed from birth to weaning (MR percent) was greater in G2 than in the other groups in this research. This study is consistent with Potter and McIntosh (1974), who found that salt concentrations as low as 1.3 %in drinking water can induce neonatal mortalities in lambs (30% to 50% of lambs delivered to ewes drinking salty water), however the cause of these lamb fatalities remains unknown.

Table 4. Reproductive performance of the different experimental groups as affected by zeolite addition

Item	G1	G2	G3	±SE
No. of ewes joined	20	20	20	-
No. of ewes conceived	19	18	19	-
No. of barren ewes	1	2	1	-
Conception rate	95	90	95	3.88
No. of ewes lambed	18	17	19	-
Lambing rate	90	85	95	3.95
No. of stillbirth	1	1	0	-
Stillbirth (%)	5.26	5.56	0	3.88
No of ewes aborted	0	0	0	-
No. of lambs born alive	17	16	19	
No. of lamb weaned	16	14	18	-
Weaning rate	94.1	87.5	94.7	3.32
Mortality from birth to weaning(%)	1(5.9%)	2(12.5%)	1(5.3%)	-

G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3=ewes dank saline well water + zeolite (6 %).

The addition of dietary zeolites to the diet may have improved reproductive performance due to better utilisation of feed nutrients, positive effects on digestion, and protection of animals from the harmful effects of stimulation of liver detoxification processes, mycotoxins, elimination of heavy metals, and radioactive elements present in SW. Zeolites engage in a variety of biochemical activities in the feed because of their characteristics, including high cation exchange capacity, adsorption, catalysis, and dehydration-rehydration (Ivkovic *et al*., 2004 and Khachlouf *et al*., 2018). Dietary zeolite supplementation increased energy status in dairy calves, particularly in early lactation (Katsoulos *et al*., 2006), suggesting that dietary zeolite supplementation may enhance dairy cow reproductive efficiency.

This decrease in SBR and MR from birth to weaning, on the other hand, might be linked to zeolite's adhesion-adsorption, ion-exchange, and cation binding characteristics (Ipek *et al*., 2012).

Productive parameters:

Milk yield:

Ewes' milk yield (MY) was significantly affected by treatments (Fig.3). Milk yield was decreased in the ewes of G2, while zeolite group (G3) recorded the highest value followed by control group (G1) with values being 638, 561 and 647 ml/h/d for G1, G2 and G3, respectively during 90 days lactation period. These results may indicate that ewes drank SW negatively affected milk production, but zeolite addition participated in decreased the negative effect of drinking SW. This finding agreed with those reported by Abdalla *et al.* (2013) who found that milk yield decreased by 36% in Shami goats drank SW as compared to control group which drank FW. In addition, dietary zeolite addition to lactating dairy cow's led to significant increase in milk production (Khachlouf *et al.,* 2019).

Furthermore, Katsoulos *et al.* (2006) discovered that adding 2.5 %DM zeolite to a dairy cow's concentrate diet decreased clinical ketosis and enhanced MY. Many studies have shown that adding zeolite to animal diets improves the average of MY (Ural *et al*., 2013 and Cruywagen *et al*., 2015).

Higher ruminal propionate concentrations, increased post-ruminal starch digestion, increased microbial protein synthesis, increased by-pass protein, or a combination of these variables can all cause an increase in MY (Katsoulos *et al*., 2006). Other researchers claimed that animals treated with zeolite were better able to turn grain into milk (Ural 2014 and Sulzberger *et al*., 2016). According to the findings of this study and the findings of some of the aforementioned studies, adding zeolite to animal diets may have a favourable influence on MY (Katsoulos *et al*., 2006 and Karatzia *et al*., 2013).

Another explanation for the rise in MY might be the possible influence of zeolite on the dietary cation-anion differential in animal diets. Previous research has found that buffers enhance the dietary cation-anion difference, and that the dietary cation-anion difference and MY are linked (Hu *et al*., 2007). The acid-base balance control is influenced by the dietary cation-anion difference of the ration, which results in increased dry matter intake of animals. This might account for some of the rise in MY.

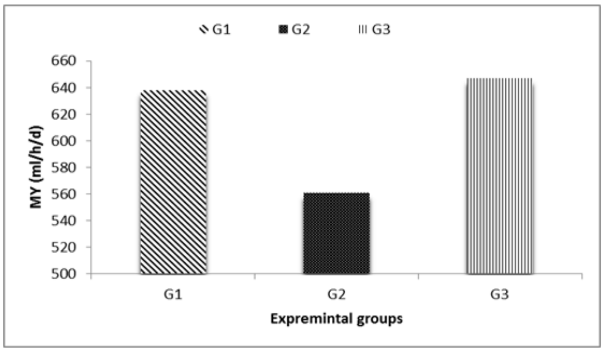

Fig. 3. Milk yield of Barki ewes as affected by zeolite addition during the experimental study.
G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3=ewes dank saline well water + zeolite (6 %).

MY, on the other hand, was unaffected by the addition of zeolite to the diet (Migliorati *et al*. 2007 and Grabherr *et al*. 2009), despite the animals' lower feed intake and hypophosphatemia. MY seems to be unaffected at modest levels of zeolite inclusion (1–1.4 %on a dry matter basis).

Lambs body weight

As shown in Table (5) lambs birth weight (BW) insignificantly increased in zeolite group (G3) followed by control group. While, G2 recorded the lowest weights. From another point of view, lambs weaning weight (WW), average daily gain (ADG) and total body gain were increased ($P < 0.05$) in zeolite group (G3) compared to control (G1) and SW, (G2) groups (Table 5).

Table 5. Effect of water salinity and zeolite addition on body weight and body gain of growing Barki lambs

Item	G1	G2	G3	± SE	P value
Birth weight (kg)	2.96	2.85	3.02	0.71	0.24
Weaning weight (kg)	16.87^{b}	16.56^{b}	18.02^{a}	0.38	0.03
Total body gain (kg)	13.91^{b}	13.71^{b}	15.00^{a}	0.62	0.04
Average daily gain (g)	154.5^{b}	153.2^{b}	166.7^{a}	4.13	0.04

a-b means in the same rows with different superscripts differ significantly at (P<0.05).
G1=ewes drank fresh tap water (control), G2=ewes drank saline well water, G3= ewes dank saline well water + zeolite (6 %).

These findings suggest that lambs born to ewes that drank SW had the lowest BW and ADG. Meanwhile, adding zeolite to the ration lessened SW's deleterious effect. Many investigations have shown comparable results to the current study (Stojkovic *et al*., 2012 and Koknaroglu *et al*., 2006). The inclusion of zeolite to the feed increased animal development, according to the researchers. They ascribed this improvement to the inclusion of dietary zeolites, which have a range of good benefits including greater utilisation of feed nutrients, positive effects on intestinal microbiota and digesting mechanisms, and protection of animals against severe SW effects.

However, Toprak *et al*. (2016) found that average daily gain and weights at slaughter did not affected in lambs fed diets containing 0, 1%, 2% and 3% zeolite.

CONCLUSION

Addition of zeolite at a level of 6 % to the diets of Barki ewes could be an attempt to reduce the negative effect of drinking salty water. It can also improve reproductive and productive performance as well as thyroid hormones under arid conditions of Egypt.

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تأثير إضافة الزيوليت علي الأداء الفسيولوجى، المناعي، التناسلى والإنتاجى للنعاج البرقى تحت إجهاد ملوحة ماء الشرب فى جنوب سيناء

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أستخدم في هذة الدراسة عدد 60 نعجه برقي ناضجة (عمر 2-3 سنة) بمتوسط وزن (30,5±1,3 كجم). يهدف البحث إلي دراسة تاثير إضافه الزيولايت علي الاداء الفسيولوجى, المناعى, التناسلي والانتاجي للنعاج البرقي تحت ظروف تناول ماء البئر المالح. قسمت النعاج عشوائياً إلي ثلاث مجموعات متساوية (20 نعجة / مجموعة). المجموعه الاولي (الضابطة) غذيت علي العليقه الاساسية مع شرب الماء العذب (247 جزء فى المليون أملاح كلية ذائبة) بينما غذيت المجموعه الثانيه علي العليقة الأساسية مع شرب ماء البئر المالح (5890 جزء فى المليون أملاح كلية ذائبة) وغذيت المجموعه الثالثة علي العليقة الأساسية مضاف اليها الزيولايت بمعدل 60جم زيولايت / كجم علف (6 %) مع شرب ماء البئر المالح. أشارت النتائج إلي عدم وجود زيادة معنوية في معدلات الحمل والولادة للمجموعة الضابطة والمجموعة الثانية بالمقارنة بالمجموعة الثالثة بينما كان عدد الحملان المولوده أعلي في مجموعة الزيوليت عن مجموعة الضابطة والمجموعه الثانية (19، 16، 17حمل) علي الترتيب. كما أظهرت النتائج زيادة معنوية في وزن الفطام ومعدل الزيادة اليومية في الوزن في المجموعة الثالثة بالمقارنة بالمجموعة الضابطة والثانية كما أظهرت المجموعة الثالثة زيادة غير معنوية في إنتاج اللبن خلال فترة الحليب (647 مل/رأس/يوم) تلتها المجموعه الضابطة (638 مل/رأس/يوم) في حين سجلت المجموعة الثانية أقل قيمة (561 مل/رأس/يوم). بينما أظهرت المجموعه الثالثة زيادة معنوية في تركيز هرمون الثيرونين ثلاثى اليود مقارنة بالمجموعه الضابطة والثانيه, بينما كان تركيز هرمون الثيروكسين أعلي في المجموعه الضابطة ثم المجموعه الثالثة والثانية. إستنتجت الدراسة أن إضافة الزيولايت بمستوى 6 ٪ فى علائق النعاج البرقى أحد الحلول للحد من التأثير السلبي لشرب المياه المالحة. كما يمكن إستخدام الزيولايت لتحسين الأداء التناسلي والإنتاجي تحت الظروف الحارة - الجافة في مصر.

الكلمات الدالة: الأغنام، الزيوليت،الملوحه، الإستجابات الفسيولوجية، المناعة، الكفاءة التناسلية والإنتاجية.