J. Product. & Dev., 26(4): 999- 1016 (2021)

REPRODUCTIVE PERFORMANCE OF RAHMANY EWES FED BASAL RATION SUPPLEMENTED WITH DIFFERENT SOURCES OF ZINC

Abo Elhaded[1], R.M; Eshmawy[2], T.A; Abd Rahim[1], M.I; Elkerdawy[1], D.A. and Tawfeek[1], M.I.

[1]Animal &Poultry Production Department, Faculty of Technology and Development Zagazig University, Zagazig, Egypt.

[2] Animal Production Research Institute, Agricultural Research Center, Egypt.

***Email:** mostafarahim@ymail.com, mostawms@hotmail.com*

ABSTRACT

The present study was designed to investigate, which source of added zinc (Zn) to the basal ration could optimize or increase the reproductive efficiency and maintain the health status of Rahmany ewes and their offspring. To achieve the objectives of the study, forty Rahmany ewes in the last two months of pregnancy with average body weight (49.98±0.64 kg) and 3 years old were used until two months after parturition. Animals were distributed into 4 groups (10 ewes in each). The first experimental group was used as a control and was fed a basal ration without zinc supplementation, and other three groups were fed a basal ration supplemented with 50 mg Zinc in the form of Zinc sulphate (Zn-S) or Zinc methionine (Zn-MS) or Nano -Zinc oxide (Nano-Zn) per kg concentrate feed mixture (CFM), respectively.

The basal ration in this experiment consisted of 50% roughages (clover hay or Egyptian clover and rice straw) and 50% concentrates (CFM + barley grains). The basal ration was formulated to meet the nutritional requirements of pregnant ewes (NRC, 2007). The daily ration of each ewes consisted of one Kg CFM + 300 g barley grains + 4.0 Kg Egyptian clover (fresh) + 400 g rice straw. CFM contained: 38% yellow corn, 17% sunflower meal, 39.0 % wheat bran, 3.0 % molasses, %2.0 lime stone and 1.0 % table salt. The reproductive performance traits, some biochemical blood serum parameters, milk yield and milk composition of Rahmany ewes were used as indices for the study.

***Results of the study showed that** chemical analysis of basal ration recorded: 2.471 kg DM; 15.2 % CP; 3.2 EE; 19.2 % CF; 9.6 % ash, 52.8 % NFE, 0.86% Ca, 0.40% P and 51mg Zn/kg DM.*

Lambs weights at birth and at 15, 30, 45 and 60 days of age and placenta weights were significantly heavier (P < 0.05) with ewes fed *supplemental Zn-M or Nano-Zn than those fed the basal ration only (control) or those fed the supplemental Zn-S. Lambs of the control ewes recorded the lightest weights compared with other groups. Litter size and viability (%) of lambs were insignificantly better with the ewes fed supplemental Zn than those fed the basal ration without Zn supplementation (control).*

The serum total protein (TP) and globulin (Glob) were higher (P < 0.05) in ewes fed supplemental Zn than those fed the basal ration without Zn supplementation (control). The ALT activity level, also in blood serum tended to be higher (P < 0.05) at lambing and after 60 days from lambing in ewes fed supplemental Zn than those fed the control ration. The levels of serum AST, urea-N and creatinine showed insignificant difference among the ewes groups. All the determined blood serum components in all the ewes groups were within the normal range of healthy sheep. Zinc concentration in the blood tended to be the highest (P < 0.05) with ewes fed Nano-Zn and Zn- M, indicating that Zn is more absorbed from the gastrointestinal tract when Zinc is in the form of Nano-Zn or Zn-Methionine.

Milk yield (kg) was greater (P<0.05) with ewes fed supplemental Nano-Zn or Zn-M than those fed the control basal ration or supplemental Zn-S. Zinc supplementation from different sources had no significant effect on milk constituents of ewes including, crude fat, crude protein, lactose, total solids and solids not fat at 15,30,45 and 60 days from lambing .

In conclusion, *Zinc supplementation to the daily ration of pregnant ewes in the form of Nano-Zn or Zn- Methionine at level of 50 mg / kg concentrated feed mixture (CFM) can be recommended to improve reproductive performance and milk production of Rahmany ewes and maintain their health status during pregnancy and lactation.*

Key words: Reproductive performance, Rahmany ewes, supplemented, sources of zinc.

INTODUCTION

One of the many challenges facing a livestock producer is to produce healthy newborns that will survive and perform to their full genetic potential. The long term productivity of an animal is linked to its immune status and that the immune and nutritional status of pregnant dams can have consequences on the health and performance of their offspring.

Zinc has a vital role in the immune system and affects several aspects of humoral and cellular immunity (Keen and Gershwin, 1990 and Sunder *et al*., 2008). Zinc is necessary component of superoxide dismutase (SOD) enzyme, which has a vital role in the antioxidant defense system of the body (Powell, 2000 and Parashuramulu *et al*., 2015). Zn is a component in more than 300 metalloenzymes that modulate many physiological processes in the body of human and animals (Miller *et al*., 1988 and Carroll and Foresberg, 2007). Zinc participates in the structure, catalytic, and regulatory actions of these metalloenzymes (Brandao-Neto *et al*., 1995). Some of the more important Zn-dependent enzymes; include carbonic anhydrase, alcohol dehydrogenase, glutamic dehydrogenase, lactic dehydrogenase, alkaline phosphatase, and carboxypeptidase A and B (McDowell, 1992). In addition to the role of Zn in these enzymes, Zn has also been associated with DNA, RNA, and protein; cellular division, growth, and repair (Miller *et al*., 1988; O'Dell, 2000; Uchida *et al*., 2001; Case and Carlson, 2002; Frassinetti *et, al*., 2006; Stefanidou. *et al.*, 2006 and Abdel Monem *and* El-shahat, 2011).

Zn deficiency could seriously affect reproductive events in most species. For instance, in males, it could affect the espermatogenic process, as well, as primary and secondary sex organs development, and in females, it could affect them in any phase of the reproductive processes (estrus, gestation or lactation). Zn also plays a key role in maintaining the integrity of the epithelia of the reproductive organs, which is necessary for embryo implantation (Hostetler *et al*., 2003 and Robinson *et al*., 2006), besides, adequate concentrations of Zn in the serum and in the diets, Zn play vital role for uterine involution, tissue repair after parturition, and the return to estrus.

Due to the important role of zinc and zinc can't be stored in the body (Zalewski *et al*., 2005), it's necessary to daily supplement the animal feed with Zn to meet the physiological needs of the body.

The bioavailability of Zn in the body is influenced by interactions with other trace elements like Ca, Cd, Ni, and Phytic acid, which can induce a secondary Zn-deficiency even if their intake is high (Haenlein and Anke, 2011). Traditionally, the major forms of supplemental Zn used to meet Zn requirements is in the inorganic form, including oxides, sulfates, chlorides, and carbonates.

Recently, zinc oxide in the form of nanostructure has attracted considerable interest in many areas of animal husbandry (Sangeetha *et al*., 2011 and Zhao *et al*., 2014). The term ″nanostructure″refers to various metal particles of a size smaller than 100 nm. Owing to metals nano scale size, they can pass easily through the intestinal mucosa during absorption (Feng *et al*., 2009). In addition, the surface area of nanoparticles is high, which enhances the absorption leading to reduce in the quantity of metal required in supplements, this in turn reduces the cost of feeding and environmental pollution (Rajendran, 2013). So, these minerals nanoparticles are expected to be effective in small doses, offer better bioavailability and have stable interaction with other components when fed as an alternative to the traditional sources.

The studies explaining the role of nano Zn as a dietary supplement on the reproductive performance of sheep are scanty. Moreover, the optimal concentrations of dietary Zn for sheep are not well established, only NRC (2007) suggested that minimum requirements of Zn for sheep are 20 mg Zn/kg DM for growth and 33 mg Zn/kg DM for maintenance of normal reproductive function in rams and for pregnancy and lactation in ewes. However, NRC did not take into consideration the requirement of Zn for organs and tissues of immune system in the body (Sunder *et al*., 2008 and Parashuramulu *et al.*, 2015).

Reports from the literature (Baker and Halpin, 1988 and Banerjee, 1988) indicated that most of Zn in the natural feed ingredients (soybean meal, cotton seed meal, wheat bran and grains) are presented in unavailable form due to binding them with phytic acid forming Zn- phytate complex resulting in that Zn is insoluble in the intestinal tract. As the previous results, it is necessary to increase the dietary Zn level above the recommended levels of NRC (2007).

Therefore, the present study was undertaken to investigate which source of added Zn to the basal ration could optimize or increase the reproductive efficiency and milk production and maintain the health status of Rahmany ewes and their offspring during and after pregnancy.

MATERIALS AND METHODS

The present study was performed at Research Station located in Mahalet Mosa, Kafr Elshekh Governorate, Animal Production Research Institute, Agricultural Research Center, Ministry of Agriculture, Dokki, Giza, Egypt. The Experimental study was carried out to study the effect of dietary supplementation with three different sources of zinc on reproductive performance of Rahmany ewes. The experiment was initiated in December, 2018 and terminated in May, 2019. Forty Rahmany ewes in the last two months of pregnancy with average body weight 49.98±0.64 kg and 3 years old were used in this experiment until two months after parturition. Animals were distributed into 4 groups (10 ewes in each). The first experimental group was fed a basal ration without zinc supplementation and used as a control, and other three groups were fed a basal ration supplemented with 50 mg Zn /kg CFM in the form Zinc sulphate (Zn-S), Zinc methionine (Zn-MS) or Nano -Zinc oxide (Nano-Zn), respectively.

Zinc sulphate ($ZnSO_4.7H_2O$) contains 22.7% Zn as inorganic Zn, Zinc methionine contains 20% Zn and the size of zinc oxide nanoparticles was 30± 5nm. All the used Zn sources were products from Alpha Chemika Company, India.

The basal ration in this experiment consisted of 50% roughages (clover hay or Egyptian clover and rice straw) and 50% concentrates (CFM + barley grains). The basal ration was formulated to meet the nutritional requirements of pregnant ewes (NRC, 2007). The daily ration of each ewes consisted of one Kg CFM + 300 g barley grains + 4.0 Kg Egyptian clover (fresh) + 400 g rice straw. CFM was purchased from El-Salam Company for Feedstuffs, located at El-Marg (Formulation of the basal ration approved by Ministry of Agriculture), Cairo. Concentrate feed mixture (CFM) contained: 38% yellow corn, 17% sunflower meal, 39.0 % wheat bran, 3.0 % molasses, %2.0 lime stone and 1.0 % table salt. Feed was daily offered to ewes at 08:30 and 17:00 h in two equal portions. Water was available to ewes *ad libitum* throughout the study. At starting of the experiment and after parturition, blood samples were taken from 5 ewes for each group via jugular vein to study the effect of Zn supplementation on blood components as parameters for the health status of the animals. Placenta weight at birth, lambs weight at birth and each two weeks until weaning, litter size and viability rate (%) were recoded as parameters for ewes reproductive performance. Daily milk yield and milk composition for each ewe were taken also as indices for the study. Animals were housed in semi open sheds under natural environmental conditions. After parturition, lambs were allowed to suckle their dams until reaching the age of weaning (at 60 days) and a minimum body weight of 11-12 kg.

***Chemical analysis*:**

The routine chemical analysis and Zn, Ca and P contents of concentrated feed mixture (CFM) and components of the daily basal ration(Table 1) was determined in the Central Laboratory for Soil, Foods and Feedstuffs (International Accredited Lab, has ISO 17025 since 2012), Faculty of, Technology & Development, Zagazig University Zagazig, Egypt.

Chemical analysis was performed according to the International Standard Methods (ISO). Moisture content was according to ISO 6496: 1999, crude ash according to ISO 5984:2002, total nitrogen and crude protein according to ISO 5983-1:2002, crude fat according to the method described in Official Journal of the European Union (EN), 2009, L54/ 37, Volume 52, and crude fiber was according to the method described in Official Journal of the European Union (EN), 2009, L54/ 40, Volume 52. Zinc element concentrations in feed, blood and milk and calcium (Ca) in feed were determined by atomic absorption spectrophotometer (Savant AA, Serial No.A7322, Australia) using ISO 6869:2000.Phosphorus was determined by spectrophotometer (Manufacturer Labomed, Inc., USA, Model Spetro22, S.N 221101) according to ISO

6491:1998.Milk samples were analyzed for fat, total protein, lactose and total solids using Milko-Scan apparatus (133B N. Foss Electric, Denmark).

Blood collection and blood biochemical analysis:

Blood samples were taken from 5 ewes on the first day of experiment and after one month from treatment, at parturition and after 60 days of parturition (at weaning) via jugular vein puncture in non-heparinized tubes prior to the morning feeding. Blood samples were centrifuged at 3,000×g for 15 min and serum was frozen at -20°C in 5 ml polyethylene tubes until blood components analysis.

Serum was analyzed for determination of levels of total protein, albumin, using a commercially available diagnostic kit (Spinreact Co., Santa Coloma, Spain). The globulin value was calculated by subtracting albumin value from total protein value. Zinc concentration**,** Kidney and liver functions parameters levels [Urea nitrogen, creatinine, alanine transaminase (ALT) and aspartate transaminase (AST)] were also determined. All the biochemical blood components were determined in one of the accredited medical laboratory.

Statistical analysis:

Data of the experiment were subjected to the analysis of variance as a completely randomized design according to **Snedecor and Cochran (1982)** and using the Linear Model Program of **SPSS (2014).**

The statistical model used in this study was as follow:

$$Y_{ij} = \mu + T_i + e_{ij},$$

Where; Y_{ij} = The independent variable, μ = The overall mean, T_i = The effect of treatment and e_{ij}= The experimental error.

The differences between means were tested by using Duncan's multiple range test procedures (Duncan, 1955).

RESULTS & DISCUSSIONS

1-*Chemical composition of the experimental basal ration:*

Table (1) show the ingredients and chemical composition of basal ration used in the study. The basal ration contained 2.471 kg DM; 15.2 % CP; 3.2 EE; 19.2 % CF; 9.6% ash, 52.8 % NFE, 0.86% Ca and 0.40% P. The indicated nutritional analysis of basal ration agrees with the recommendation of NRC (2007) for the nutrients requirements of pregnant and lactating ewes. Zinc level in natural ingredients of basal ration recorded by chemical analysis 51mg / kg DM.

The optimal concentration of dietary Zn for sheep is not well established, only NRC (2007) suggested that minimum requirements of Zn for sheep are 20 mg Zn/kg DM for growth and 33 mg Zn/kg DM for maintenance of

Table (1): Ingredients and chemical composition of the daily ration components (As fed bases %).

Items	Chemical composition (%)				**Total nutrients content in basal ration (g)
	*CFM	Barley grains	Egyptian Clover (fresh)	Rice Straw	
Moisture	10.32	10.46	76.53	8.11	3228
DM	89.68	89.54	23.47	91.89	2471
Ash	6.66	2.37	2.49	15.84	237
OM	83.02	87.17	20.98	76.05	2235
CP	13.99	11.88	4.67	3.22	375
EE	3.32	1.87	0.87	1.60	80
CF	8.19	6.06	5.84	35.36	475
NFE	57.52	67.36	9.60	35.87	1305
Ca	0.80	0.04	0.30	0.28	21.24
P	0.60	0.39	0.06	0.08	9.89
Zn(mg)	4.5	3.5	1.5	2.6	126 (about 51 mg Zn/kg DM)

*Concentrated feed mixture (CFM) contained: 38% yellow corn, 17%sunflower meal, 39.0 % wheat bran, 3.0 % molasses, %2.0 lime stone and 1.0 % table salt.

** On basis that each ewes was given daily one Kg CFM, 4.0 Kg Egyptian clover, 300 g barley grains and 400 g rice straw.

normal reproductive function in rams and for pregnancy and lactation in ewes. However, NRC did not take into consideration the requirement of Zn for organs and tissues of immune system in the body (Sunder *et al*, 2008 and Parashuramulu *et al*, 2015). However, the literatures (Baker and Halpin, 1988 and Banerjee, 1988) indicated that most of Zn in the natural feed ingredients (soybean meal, cotton seed meal, wheat bran and grains) is presented in unavailable form due to binding it with phytic acid forming Zn- phytate complex resulting in that Zn is insoluble in the intestinal tract. As the previous results, it was necessary to increase the dietary Zn level above the recommended levels of NRC (2007).

2-Effect of supplemental Zn sources on reproductive performance Traits of Rahmany ewes:

Table (2) show that lambs weights at birth and at 15, 30, 45 and 60 days of age were significantly heavier ($P < 0.05$) with ewes fed supplemental Zn-M or Nano-Zn than those fed basal ration only (control) or those fed the supplemental Zn-S.

Table (2): Reproductive traits of Rahmany ewes fed basal ration supplemented with different Zn sources ($\bar{X}$±SE).

Items	The dietary groups				Sig. test
	Control	Zn-S	Zn-M	Nano- Zn	
Total No. of ewes[(1)]	10	10	10	10	
Total No. of born lambs[(2)]	13	14	13	14	
Total No. of born alive lambs	12	14	13	14	
Total No. of born dead lambs[(3)]	1	0	0	0	
Litter size [(2/1)]	1.3	1.4	1.3	1.4	
Viability rate [(2-3/2*100)]	92.31	100	100	100	
Mortality rate	7.69	0	0	0	
No. Single births	7	6	7	6	
Single births (%)	54	42.86	53.85	42.86	
No. Twines births	3	4	3	4	
Twines births (%)	46	57.14	46.15	57.14	
No. Male lambs	8	7	7	8	
Male lambs (%)	62	50	53.85	57.14	
No. Female lambs	5	7	6	6	
Female lambs (%)	38	50	46.15	42.86	
Average live body weight of Ewes (kg)					
Initial	49.5 ±1.46	50.3 ±1.49	50.6 ±1.3	49.5 ±1.06	**NS**
at lambing	46.7 ±1.45	48.4 ±1.4	48.7 ±1.27	48.1 ±0.98	**NS**
at weaning	49 ±1.53	50.2 ±1.41	50.5 ±1.24	50.1 ±0.96	**NS**
Placenta weight(kg)	0.372 $\pm0.02^{b}$	0.407 $\pm0.03^{ab}$	0.468 $\pm0.01^{a}$	0.448 $\pm0.02^{a}$	*
Average live body weight of lambs (kg) at:					
Birth	2.78 $\pm0.17^{c}$	3.03 $\pm0.12^{bc}$	3.31 $\pm0.1^{ab}$	3.43 $\pm0.11^{a}$	*
15 day	4.71 $\pm0.2^{b}$	5.15 $\pm0.21^{ab}$	5.47 $\pm0.21^{a}$	5.72 $\pm0.19^{a}$	*
30 day	7.50 $\pm0.31^{b}$	7.79 $\pm0.36^{b}$	8.39 $\pm0.36^{ab}$	8.86 $\pm0.36^{a}$	*
45 day	9.84 $\pm0.35^{b}$	10.5 $\pm0.35^{b}$	11.62 $\pm0.35^{a}$	11.72 $\pm0.43^{a}$	*
60 day	12.09 $\pm0.38^{c}$	13.43 $\pm0.41^{b}$	14.39 $\pm0.39^{ab}$	14.65 $\pm0.43^{a}$	*

a, b, c …., Means in the same row with different superscript, differ significantly (P<0.05).
NS= Not significant; * = significantly different (P<0.05);

Lambs of control ewes recorded the lightest weight compared with other groups. Placenta weights had the same trend of lambs weight; it was significantly higher (P < 0.05) in the ewes fed basal ration supplemented with either, Zn-M or Nano-Zn than those fed the control ration or supplemental Zn-S. Litter size and viability (%) of lambs were insignificantly better with the ewes fed supplemental Zn than those fed basal ration without Zn supplementation (control). In general, it could be concluded that reproductive performance traits of ewes have been improved by feeding on daily basal ration supplemented with 50 mg Zn / kg CFM, either as Nano-Zn or Zn-M. In this respect, Kundu *et al*. (2014) reported that supplementing 50 or 100 ppm zinc oxide to the basal diet of Teressa goats significantly improved their reproductive and productive performance compared with those fed basal diet (contained 42.1 mg Zn/Kg) without supplemental Zn. The significant improvement in lambs weight of ewes fed supplemental Zn especially, Nano-Zn and Zn- methionine may be attributed to that Zn is more utilized in the body as nano or organic form (Zn- methionine). Also, Zn is a component in more than 300 metalloenzymes that modulate many physiological processes in the body associated with DNA, RNA, and protein synthesis; cellular division and growth of embryos during pregnancy and during suckling from their mothers (Miller *et al*., 1988; O'Dell, 2000, Uchida *et al*, 2001, Case and Carlson, 2002, Frassinetti *et al*., 2006, Stefanidou *et al*, 2006 and Abdel Monem *and* El-Shahat, 2011). Zinc in particular of new-born depends on maternal transfer via the placenta and the colostrum or the milk (Prasad and Kundu, 1995 and Enjalbert, 2009).

3- *Effect of supplemental Zn sources on blood biochemical parameters:*

Data in Table (3) show that before feeding the experimental rations, there were no significant differences among ewes groups in the determined biochemical blood parameters (AST and ALT activity, TP, Alb, Glob, Alb /Glob ratio, urea and creatinine levels), indicating normal liver and kidneys functions and health status of the experimental ewes.

After one and two month (at parturition) of feeding the experimental rations (Table 3), the serum total protein (TP), globulin (Glob) and Zn levels were higher ($P < 0.05$) in ewes fed supplemental Zn compared with those fed the basal ration without Zn supplementation (control). The ALT activity level also in blood serum tended to be higher ($P < 0.05$) in ewes at lambing and after 60 days from lambing. The levels of serum AST, urea-N and creatinine showed insignificant difference among the ewes groups. All the determined blood serum components in all the ewes groups were within the normal range of healthy sheep. Data in Table (3) show that Zinc concentration in the blood tended to be the highest ($P < 0.05$) with ewes fed Nano-Zn and Zn- M, indicating that Zn is more absorbed from the gastrointestinal tract when Zinc is in the form of Nano-

Table (3): Some biochemical blood serum parameters at different periods of ewes fed basal diet supplemented with different Zn sources ($\bar{X}\pm SE$)**.

The dietary groups	AST (U/L)	ALT (U/L)	TP (g/dl)	Alb (g/dl)	Glob (g/dl)	A/G ratio	Urea (mg/dl)	Creatinine (mg/dl)	Zn (mg/L)
Before treatment									
Control	24.6±1.37	41.4±3.56	5.60±0.37	2.71±0.31	2.89±0.22	0.97±0.14	14.4±1.03	1.10±0.11	3.82±0.37
Zn-S	31.6±2.32	43.8±1.29	6.37±0.42	3.16±0.19	3.21±0.35	1.05±0.16	13.6±1.29	1.21±0.11	3.89±0.16
Zn-M	27.2±2.66	44.4±2.95	6.80±0.24	3.18±0.19	3.62±0.42	0.98±0.23	12.8±1.47	1.26±0.12	4.89±0.49
Nano-Zn	26.8±1.75	43.0±1.95	6.53±0.4	3.21±0.16	3.32±0.37	1.02±0.13	13.35±1.23	1.30±0.08	4.07±0.39
Sig. test	NS	NS	NS	NS	NS	NS	NS	NS	NS
After one month of treatment									
Control	28.2±2.14	43.83±1.5	5.62±0.24[b]	3.02±0.13	2.60±0.16[b]	1.18±0.07	13.2±1.69	1.18±0.10	4.29±0.17[b]
Zn-S	27.8±1.53	45.6±2.26	6.65±0.55[a]	3.46±0.14	3.19±0.46[ab]	1.2±0.21	12.6±1.57	1.20±0.04	4.10±0.27[b]
Zn-M	29.2±1.66	46.2±1.75	7.33±0.09[a]	3.34±0.2	3.99±0.27[a]	0.87±0.12	13.0±1.59	1.34±0.05	5.69±0.61[a]
Nano-Zn	27.6±1.37	44.9±2.08	7.04±0.11[a]	3.24±0.08	3.8±0.08[a]	0.86±0.03	11.6±1.08	1.28±0.04	6.16±0.48[a]
Sig.test	NS	NS	*	NS	*	NS	NS	NS	*
At lambing (Parturition)									
Control	30.2±2.38	39.7±1.41[b]	6.12±0.21[b]	3.54±0.09	2.58±0.16[b]	1.39±0.08	13.6±1.70	1.08±0.10	4.49±0.23[b]
Zn-S	29.0±3.89	50.8±2.23[a]	7.08±0.22[a]	3.46±0.21	3.62±0.4[a]	1.04±0.19	11.2±1.89	1.12±0.08	4.32±0.23[b]
Zn-M	30.0±2.29	48.4±2.43[a]	7.26±0.15[a]	3.54±0.13	3.72±0.2[a]	0.97±0.08	14.6±2.23	1.03±0.10	5.48±0.36[a]
Nano-Zn	31.2±1.6	47.6±2.81[a]	7.36±0.24[a]	3.62±0.13	3.74±0.2[a]	0.98±0.07	12.2±1.40	1.18±0.10	5.62±0.35[a]
Sig. test	NS	*	*	NS	*	NS	NS	NS	*
After 60 days from lambing (at weaning)									
Control	27.6±1.81	46.2±1.16[b]	6.72±0.22	3.52±0.06	3.20±0.18	1.12±0.05	19.2±2.56	1.20±0.04	4.26±0.34[c]
Zn-S	27.8±2.77	50.4±1.21[a]	6.02±0.17	3.24±0.21	2.78±0.13	1.19±0.13	18.2±1.50	1.28±0.14	5.07±0.32[bc]
Zn-M	30.8±1.66	53.4±1.29[a]	6.92±0.39	3.66±0.13	3.26±0.33	1.17±0.12	17.4±1.29	1.25±0.10	5.72±0.56[ab]
Nano-Zn	29.4±1.87	52.8±1.36[a]	6.24±0.28	3.4±0.18	2.84±0.23	1.23±0.12	17.8±1.12	1.28±0.13	6.50±0.21[a]
Sig. test	NS	*	NS	NS	NS	NS	NS	NS	*

a, b, c = Means in the same column with different superscript differ significantly ($P<0.05$).
Note: SE = Standard Error of Means; NS= Not significant; * = Significantly different ($P<0.05$);
**Mean of 5 samples from each group.

Zn or Zn- Methionine.

Zhao *et al*. (2014) reported that the bio-availability of Zn in organic sources is higher than that of inorganic Zn salts. The other blood biochemical parameters showed insignificant differences among the ewes groups. The significant increase of total TP , Glob and ALT in serum of ewes fed the supplemental Zn may be indicate to the increase of utilization of ration amino acids for protein synthesis due to Zn supplementation. This result is supported by the higher body weights of lambs before weaning whose their mothers fed supplemental Zn (Table 2).

Prasad and Kundu, 1995 and Enjalbert, 2009 reported that Zinc in particular and other nutrients of new-born depends on maternal transfer via the placenta and the colostrum or the milk. In this respect, Swain *et al* (2019) reported that supplementation of daily ration with Zn at level of 50 mg/ kg feed DM for inorganic and 25 or 50 mg Nano Zn had no significant effect on RBC (10^6/ μl), WBC (10^3/ μl), PCV (%), neutrophil (%), lymphocytes (%), eosinophil (%), monocyte (%), haemoglobin (g/dL), ALT (IU/L), AST (IU/L), ALP (IU/L) and creatinine (mg/dL) levels of goat blood. However, globulin (g/dL) and total protein (g/dL) significantly varied among the treatment groups ($P<0.01$) without affecting blood albumin (g/dL) and A/G ratio levels. The globulin level was more ($P<0.01$) in Nano-Zn-50 compared to both control and ZnO-50. Total protein (g/dL) was more ($P<0.001$) in Nano-Zn-50 which varied significantly with Nano-Zn-25 and control, but non-significantly with ZnO-50 (6.87±0.01). Hence, zinc supplementation in form of nano zinc significantly improved globulin and total protein without affecting other haematological and blood biochemical parameters in goats, which may be attributed to its better Zn bioavailability than its inorganic counterpart.

4- *Effect of supplemental Zn sources on ewes milk yield:*

Data presented in Table (4) clarify that milk yield (kg) was greater ($P<0.05$) with ewes fed supplemental Nano-Zn or Zn-M than those fed the control basal ration or supplemental Zn-S. This result agree with data of lambs body weights (Table 2) that were significantly the best with lambs of ewes fed supplemental Nano-Zn or Zn-Methionine. In this concern, Mohamed *et al* (2017) showed that ewes fed 10 mg ZnO / kg CFM or 5 mg/ kg CFM Nano-Zn rations yielded significant higher daily milk yield, total milk yield and 6%-FCM than those of control group. On the other hand, Nano-Zn group reached to peak of milk yield earlier (at the 5^{th} week) compared with the other groups. Animals fed ration with Nano-Zn recorded the highest value for milk yield at the end of lactation period (at the 10^{th} week) compare with other dietary

Table (4): Effect of dietary Zn supplementation on milk yield (kg) of ewes after different periods from lambing ($\bar{X}$±SE) **.

Treatments	Milk yield (Kg/head/day) at:			
	15 day	**30 day**	**45 day**	**60 day**
Control	0.56 ±0.04^{b}	0.51 ±0.03^{c}	0.36 ±0.02^{b}	0.19 ±0.01^{c}
Zn-S	0.61 ±0.03^{ab}	0.52 ±0.02^{bc}	0.36 ±0.04^{b}	0.21 ±0.01^{bc}
Zn-M	0.68 ±0.03^{a}	0.60 ±0.01^{a}	0.46 ±0.03^{a}	0.26 ±0.03^{ab}
Nano-Zn	0.69 ±0.03^{a}	0.59 ±0.01^{ab}	0.45 ±0.03^{a}	0.27 ±0.02^{a}
Sig. test	*	*	*	*

a, b, c Means in the same column with different superscript differ significantly (P<0.05).
Note: SE = Standard Error of Means; * = Significantly different (P<0.05);
**Production mean of 5 ewes from each group.

groups. Also Hassan *et al* (2011) reported that milk yield and fat corrected milk (FCM) were significantly increased (P < 0.05) in ewes fed supplemental Zn-Methionine at level 15 or 25 mg / kg DM compared with those fed 25 mg supplemental Zn-sulphate / kg DM.

5- *Effect of supplemental Zn sources on ewes milk composition:*

Data in Table (5) show that milk constituents of ewes including, crude fat, crude protein, lactose, total solids and solids not fat were insignificantly affected by dietary Zn supplementation ,indicating that feeding supplemental Zn either in the form inorganic (Zn-sulphate) or organic (Zn-Methionine) or Nano – Zn oxide had no effect on milk composition. In this respect, Hassan *et al* (2011) reported that milk protein and fat % were higher (P < 0.05), while lactose and solids not fat % were lower (P < 0.05) with ewes fed Zn-Methionine either at level 15 or 25 mg / kg DM compared with those fed 25 mg / kg DM inorganic Zn (Zn-sulphate).

In conclusion, Zinc supplementation to the daily ration of pregnant ewes in the form of Nano-Zn or Zn- Methionine at level of 50 mg / kg concentrated feed mixture (CFM) can be recommended to improve reproductive performance and milk production of Rahmany ewes and maintain their health status during pregnancy and lactation.

Table (5): Effect of dietary Zn supplementation on milk chemical composition (%) of ewes after different periods from lambing ($\bar{X}$ ± SE)*.

Treatments	Milk chemical composition (%)				
	Fat	**Protein**	**Lactose**	**TS**	**SNF**
At 15 days from lambing					
Control	6.54±0.25	5.09±0.25	4.59±0.28	17.74±0.29	11.2±0.12
Zn-S	6.61±0.17	5.2±0.14	4.79±0.04	18.11±0.32	11.5±0.16
Zn-M	6.69±0.16	5.31±0.13	4.86±0.15	17.9±0.25	11.22±0.17
Nano-Zn	6.75±0.11	5.46±0.15	5.06±0.12	18.16±0.41	11.42±0.32
Sig. test	**NS**	**NS**	**NS**	**NS**	**NS**
At 30 days from lambing					
Control	6.63±0.24	5.13±0.15	4.41±0.17	17.67±0.31	11.04±0.51
Zn-S	6.66±0.27	5.17±0.21	4.79±0.15	17.79±0.48	11.13±0.27
Zn-M	7.01±0.16	5.33±0.19	4.99±0.23	18.25±0.27	11.24±0.11
Nano-Zn	6.85±0.15	5.37±0.16	5.18±0.09	18.1±0.38	11.25±0.23
Sig. test	**NS**	**NS**	**NS**	**NS**	**NS**
At 45 days from lambing					
Control	6.76±0.31	5.24±0.21	4.76±0.08	18.19±0.46	11.44±0.36
Zn-S	7.01±0.15	5.47±0.13	5.04±0.21	18.29±0.41	11.28±0.26
Zn-M	7.32±0.16	5.67±0.22	5.23±0.3	18.85±0.2	11.54±0.23
Nano-Zn	7.27±0.22	5.63±0.13	5.09±0.23	18.66±0.26	11.39±0.07
Sig. test	**NS**	**NS**	**NS**	**NS**	**NS**
At 60 days from lambing					
Control	7.16±0.33	5.51±0.19	5.25±0.15	18.93±0.47	11.78±0.16
Zn-S	7.25±0.33	5.58±0.21	5.01±0.15	19.11±0.21	11.86±0.19
Zn-M	7.46±0.18	5.76±0.32	5.41±0.21	19.29±0.51	11.83±0.34
Nano-Zn	7.37±0.21	5.68±0.2	5.59±0.23	19.32±0.52	11.95±0.34
Sig. test	**NS**	**NS**	**NS**	**NS**	**NS**

Note: SE = Standard Error of Means; NS= Not significant; TS= Total Solids; SNF= Solids Not-Fat.

*Mean of 3 samples from each group.

REFERENCES

Abdel Monem, U. M. and El-Shahat, K. H. (2011). Effect of different dietary levels of inorganic zinc oxide on ovarian activities, Reproductive performance of Egyptian Baladi ewes and growth of their lambs. Bulgarian *J. Vet. Med*., 14 (2):116−123.

Baker, D. H. and Halpin, K.M (1988). Zinc antagonizing effects of fish meal, wheat bran and corn-soybean mixture when added to a phytate and fiber free casein-dextrose diet. *Nutrition Research*, 8, pp: 213- 218.

Banerjee, G. C. (1988). *Feeds and Principles of Animal Nutrition*. The 2nd Edition, Oxford and IBH publishing Co. PVT, LTD, pp: 636.

Brandao-Neto, J., V. Stefan, B. B., Mendonca, W. Bloise, and Castro, A. V. B. (1995). The essential role of zinc in growth. *Nut. Res*., 15:335-358.

Carroll, J.A. and Forsberg , N.E. (2007). "Influence of stress and nutrition on cattle immunity." *Vet. Clin. Food Anim*. 23: 105-49.

Case, C.L and Carlson, MS (2002). Effect of feeding organic and inorganic sources of additional zinc on growth performance and zinc balance in nursery pigs. *J. Animal Science*; 80: 1917e24.

Duncan, D.B., 1955. Multiple range and multiple F tests. *Biometrics*, 11:1-42.

Enjalbert, F. (2009). The relationship between trace elements status and health in calves. *Revue. Méd.Vét*.,160 (8-9): 429-435.

Feng, M., Wang, Z. S., Zhou, A. G., and Ai, D. W. (2009). The effects of different sizes of nanometer zinc oxide on the proliferation and cell integrity of mice duodenum-epithelial cells in primary culture. *Pak J. Nutr.*, 8(8), 1164-1166.

Frassinetti, S., Bronzetti, G. L., Caltavuturo, L., Cini, M., and Della Croce, C. (2006). The role of zinc in life: a review. *Journal of environmental pathology, toxicology and oncology*, 25(3).

Haenlein, G.F.W and Anke, M. (2011). Mineral and trace element research in goats. A Review, *Small Rumin Res*, 95: 2–19.

Hassan, A.A.; El Ashry, G.M. and Soliman, S.M. (2011). Effect of Supplementation of Chelated Zinc on Milk Production in Ewes. *Food and Nutrition Sciences*, 2: 706-713.

Hostetler, C.E., Kincaid, R.L. and Mirando, M.A. (2003). The role of essential trace elements in embryonic and fetal development in livestock. *The Veterinary Journal*. 166:125-139.

Keen, C.L. and Gershwin, M.E. (1990). Zinc deficiency and immune function. *Annu. Rev. Nutr*., 10: 415–431.

Kundu, M. S., Arun Kumar De, Jeyakumar, S., Sunder, Jai, Kundu, A. and Sujatha, T. (2014). Effect of zinc supplementation on reproductive performance of Teressa goat. *Veterinary World*, EISSN: 2231-0916. Available at www.veterinaryworld . org/Vol.7/June-2014/3.

McDowell, L. R. (1992). *Minerals in Animal and Human Nutrition*. Academic Press. San Diego, CA.

Miller, J. K., Ramsey, N. and Madsen, F. C. (1988). The trace elements. Pages 383-387 in The Ruminant Animal: Digestive Physiology and Nutrition. D. C. Church ed., Waveland Press, Inc., Prospect Hights, IL.

Mohamed, A.H., M.Y. Mohamed, K. Ibrahim, Fatma T.F. Abd El Ghany and A.A.S. Mahgoup (2017). Impact of nano-zinc oxide supplementation on productive performance and some biochemical parameters of ewes and offspring. *Egyptian Journal of Sheep & Goat Sciences*, Vol. 12, No. 3, P: 49-64. ISSN : 2090- 0368- Online ISSN : 2090- 0376 (Website : http://www.easg.eg.net).

National Research Council (NRC) 2007. Nutrient requirements of small ruminants. National Academy of Sciences, Washington, DC.

O'Dell, B.L. (2000). Role of zinc in plasma membrane function. *J. Nutr.*, 130(5):1432S–1436S.

Parashuramulu, S., Nagalakshmi, D., Srinivasa Rao, D., Kishan Kumar, M. and Swain, P.S. (2015). Effect of zinc supplementation on anti-oxidant status and immune response in buffalo calves. *Animal Nutrition & Feed Technology*; 15(2):179e88.

Powell, S.R. (2000). The antioxidant properties of zinc. *J Nutr.*, 130 (5):1447S–1454S.

Prasad, T. and Kundu, M.S. (1995). Serum IgG and IgM responses to sheep red blood cells (SRBC) in weaned calves fed milk supplemented with Zn and Cu. *Nutrition*,11:712–715.

Rajendran, D. (2013). Application of nano minerals in animal production system. *Res J. Biotech*, 8(3):1–3.

Robinson, J.J., Ashworth, C.J., Rooke, J.A., Mitchell, L.M. and McEvoy, T.G. (2006). Nutrition and fertility in ruminant livestock. *Animal Feed Science and Technology*, 126:259-276.

Sangeetha, G.; Rajeshwari, S. and Venckatesh, R. (2011). Green synthesis of zinc oxide nanoparticles by aloe barbadensis miller leaf extract: structure and optical properties. *Mater Res Bull*, 46(12):2560–2566.

Snedeccor, G.W. and Cochran, W.G. (1982*).* *Statistical Methods*. 6th edition, Towa State University Press, Ames, Iowa, USA.

SPSS (2014). *Statistical Package for Social Science*, Version 14, Chicago, USA.

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

Sunder, G.S., Panda, A.K., Gopinath, N.C.S., Rao, S.V.R., Raju, M.V.L.N., Reddy, M.R. and Kumar, Ch.V. (2008). Effects of higher levels of zinc supplementation on performance, mineral availability, and immune competence in broiler chickens. *J. Appl. Poultry Research*, 17(1):79–86.

Swain P. S., Rao ,S. B. N., Rajendran, D., Poornachandra, K. T., Lokesha, E. and Dhinesh Kumar, R. (2019). Effect of Nano zinc supplementation on Haematological and Blood Biochemical Profiles in Goats. *International Journal of Current Microbiology and Applied Sciences*, ISSN: 2319-7706 Volume 8 Number 09. *Journal homepage:* http:// www. ijcmas. com.

Uchida, K., Mandebvu, P., Ballard, C.S., Sniffen, C.J. and Carter, M.P. (2001). Effect of feeding a combination of zinc, manganese and copper amino acid complexes, and cobalt glucoheptonate on performance of early lactation high producing dairy cows. *Animal Feed Science & Technology* ;93:193e203.

Zalewski, P.D., Ai, Q.T., Dion, G., Lata, J., Chiara, M. and Richard, E.R. (2005). Zinc metabolism in airway epithelium and airway inflammation: basic mechanisms and clinical targets: *A review*. *Pharmacol Ther*; 105:127e49.

Zhao, C.Y., Tan, S.X., Xiao, X.Y., Qiu, X.S., Pan, J.Q. and Tang, Z.X. (2014). Effects of dietary zinc oxide nanoparticles on growth performance and antioxidative status in broilers. *Biol Trace Elem Res*; 160: 361e7. P.S.

الكفاءة التناسلية للنعاج الرحماني المغذاه علي عليقة أساسية مضاف اليها مصادر مختلفة للزنك

***رمضان ابو الحديد – **طارق العشماوي – *مصطفي عبد الرحيم – *دولت الكرداوي – *مصطفي توفيق**

* قسم الإنتاج الحيواني والداجني – كلية التكنولوجيا والتنمية – جامعة الزقازيق – مصر

** معهد بحوث الإنتاج الحيواني –مركز البحوث الزراعية – وزارة الزراعة – مصر

في تجربة تصميم عشوائي كامل ، تم استخدام عدد 40 نعجة رحماني في عمر ثلاث سنوات وفي الشهرين الآخرين من الحمل وتزن في المتوسط 49.98± 0.64 كيلوجرام لدراسة تأثير

تغذيتها علي عليقة أساسية مضاف اليها مصادر مختلفة لعنصر الزنك علي كفاءتها التناسلية و إنتاج اللبن ومكوناته وبعض مكونات سيرم الدم للإطمئنان علي الحالة الصحية.

تمت التجربة بمحطة البحوث التابعة لمعهد بحوث الإنتاج الحيواني بقرية محلة موسي بمركز سخا التابع لمحافظة كفر الشيخ .استمرت التجربة من شهر ديسمبر 2018 وحتي شهر مايو 2019، قسمت النعاج عشوائيا لأربعة مجموعات تجريبية ، المجموعة الأولي اتخذت كمجموعة مقارنة (كنترول) وتغذت علي عليقة أساسية (قاعدية) بدون إضافة أي مصدر للزنك. المجموعة الثانية والثالثة والرابعة أعطيت لها العليقة الأساسية اليومية مضاف اليها عنصر الزنك في صورة زنك معدني (كبريتات زنك) وزنك عضوي (زنك - ميثايونين) ونانو زنك بمستوي 50 ملليجرام لكل كيلوجرام علف مركز علي التوالي.

تكونت العليقة الأساسية اليومية للنعاج من غذاء مالئ وغذاء مركز بنسبة 50-50 %. أعطيت لكل نعجة يوميا واحد كيلوجرام علف مركز +300 جرام شعير + 4 كيلوجرام برسيم أخضر + 400 جرام قش أرز.

تكون العلف المركز من 38% أذرة صفراء + 39% نخالة قمح + 17% كسب عباد شمس + 3% مولاس + 2% حجر جيري + 1% ملح طعام.

تلخصت نتائج التجربة في الآتي :

1- أظهر التحليل الكيميائي للعليقة الأساسية (القاعدية) اليومية إحتوائهاعلي العناصر الغذائية التالية:2.47 كيلوجرام مادة جافة بها 15.2% بروتين خام + 3.2% دهن خام +19.2% ألياف خام +9.6% رماد خام +52.8% كربوهيدرات ذائبة + 0.86% كالسيوم + 0.4% فوسفور + 51 ملليجرام زنك / كيلوجرام مادة جافة مما يشير الي إحتواء العليقة الأساسية علي المقررات الغذائية التي أوصي بها المجلس القومي للبحوث (NRC) عام 2007 .

2- زاد متوسط وزن المشيمة ومتوسط وزن الحملان معنويا (علي مستوي 5%) بعد 15، 30 ، 45 ، 60 يوم من الولادة في مجاميع النعاج المغذاه علي العليقة الأساسية + 50 ملليجرام نانو-زنك أو زنك-ميثايونين / كيلوجرام علف مركز مقارنة بتلك في مجاميع النعاج المغذاه علي العليقة الأساسية فقط (الكنترول) أو العليقة الأساسية + 50 ملليجرام كبريتات زنك/ كيلوجرام علف مركز.

3- لم تتأثر حجم البطن (عدد الحملان المولودة مقسوما علي عدد النعاج في المجموعة) ومعدل الحيوية (%) معنويا باضافة الزنك من مصادر مختلفة.

4- ارتفع مستوي البروتين الكلي والجلوبيولين وانزيم ALT معنويا (علي مستوي 5%) وعدم تأثر المكونات الأخري معنويا (مستوي نشاط انزيم AST - نيتروجين اليوريا – الكرياتنين- A/G) في سيرم دم النعاج المغذاه علي العليقة الأساسية + الزنك من مصادر مختلفة مقارنة بتلك المغذاه فقط علي العليقة الأساسية بدون إضافة الزنك، علما بأن مستوي جميع مكونات سيرم الدم في كل مجاميع النعاج كانت في حدود المستويات الطبيعية للأغنام السليمة صحيا.

5-زاد تركيز الزنك معنويا (علي مستوي 5%) في سيرم دم النعاج المغذاه علي العليقة الأساسية + الزنك في صورة النانو أو الصورة العضوية (زنك- ميثايونين) مقارنة بتلك المغذاه علي العليقة الأساسية فقط أومضاف اليها الزنك في صورة معدنية (كبريتات زنك).

6- زيادة إنتاج اللبن اليومي معنويا (علي مستوي 5%) في النعاج المغذاه علي العليقة الأساسية المضاف اليها الزنك في صورة نانو أو صورة عضوية (زنك-ميثايونين) مقارنة بتلك المغذاه علي العليقة الأساسية فقط أو مضافا اليه الزنك في صورة معدنية (كبريتات زنك).

7- عدم تأثر نسبة مكونات اللبن (الدهن – البروتين – سكر اللاكتوز – الجوامد الكلية – الجوامد غير الدهنية) معنويا والمختبرة بعد 15، 30، 45، 60 يوم من الولادة باضافة الزنك للعليقة الأساسية.

التوصية: إضافة الزنك للعليقة الأساسية للنعاج الرحماني في صورة نانو زنك أو زنك ميثايونين بمستوي 50 ملليجرام لكل كيلوجرام علف مركز يمكن أن نوصي بها من أجل تحسين الكفاءة التناسلية وإنتاج اللبن والمحافظة علي الحالة الصحية للنعاج أثناء الحمل والرضاعة.