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YOUNG DOE RABBIT PERFORMANCE TRAITS AS AFFECTED BY DIETARY ZINC, COPPER, CALCIUM OR MAGNESIUM SUPPLEMENTS, UNDER WINTER AND SUMMER CONDITIONS OF EGYPT

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ABSTRACT

A preliminary study was carried out on New Zealand White (NZW) female rabbits of 6 months of age. The aim of the study was to investigate the effects of zinc, copper, calcium and magnesium dietary supplementation on their reproduction traits, under winter and summer conditions of Egypt. The estimated temperature-humidity index values indicated absence of heat stress (57.9) during winter, and exposure of the animals to severe heat stress (84.7), during summer experimental period. In summer, gestation period, as well as, pre-weaning mortality at 21,28 and 0-28 days were significantly (P<0.001 or 0.05) higher, while litter and bunny weights at 0 and 21 days were significantly (P<0.001 or 0.05) lower than in winter, in NZW doe rabbits. Treatment of NZW doe rabbits with zinc oxide at level 100 mg, copper sulfate at level 50 mg, calcium oxide at level 100 mg or magnesium sulfate at level 50 mg decreased significantly (P<0.001) pre-weaning morality at 21, 28 and 0-28 days and increased significantly (P<0.001 or 0.01) the final values (at 28 days) of each of litter size with 44.3, 40.4, 28.4 and 23.5%, litter weight with 56.5, 63.6, 35.1 and 25.4%, bunny weight with 7.5, 14.9, 3.5 and 0.1%, bunny gain weight with 7.6, 15.3, 2.9 and 5.4% and milk yield with 74.1, 67.9, 60.2 and 45.0%, respectively. Interaction values between season and treatment on the studied doe traits were mostly not significant.

Key words: Doe rabbit performance, heat stress, zinc, copper, calcium, magnesium, supplementation.

INTRODUCTION

In Egypt, the breeding season for rabbits normally begins at October and ends at April each year, due to the negative effects of heat stress of summer conditions on production and reproduction. Such negative effects are caused by disturbances in animals biological functions thorough depression in feed intake (Marai *et al*., 1991 and Habeeb *et a*l., 1992; Ayyat and Marai, 1996 and Marai *et al*., 1996). Corrections of such unfavorable effects in water, protein and energy were tried by many workers (Habeed *et al.*, 1994, Ayyat and Marai 1996 and 1997 and Marai *et al*., 1994, 1996 and 1999). However, similar trials by using minerals dietary supplements to doe rabbits, are lacking.

The objectives of the present work were to study performance traits of NZW doe rabbits as affected by dietary supplementation with each of zinc, copper, calcium or magnesium, which may have roles in restoring the losses that occur in growth, fertility or both, in the heat-stressed animals.

MATERIALS AND METHODS

A preliminary study was carried out on NZW doe rabbits at the Rabbitry of the Department of Animal Production, Faculty of Agriculture, Zagazig University, Zagazig, Egypt, during the periods October – February (as the mild climate period; winter); i.e. during the breeding season and May – September (as the hot climate period, i.e. during the summer breeding pause).

The number of 50 NZW adult female rabbits of 6 months of age was used either in winter or summer. The animals were divided in each season to five groups (of 10 animals each). One of the groups was kept without any treatment control. Each of the other 4 groups was treated with 100 mg/kg diet zinc oxide, 50 mg/kg diet copper sulphate, 100 mg/kg diet calcium oxide or 50 mg/kg diet magnesium sulphate. Mating of all groups was carried out by natural mating with males of 6 months and age exposed to the normal climatic conditions inside the Rabbitry, without treatment. Detection of conception was carried out by palpation at 10 days after mating and the non pregnants were remated immediately.

All animals were feed and watered *ad libitum*. Tap water was supplied to all groups. The basal diet consisted of 31.0% alfalfa hay, 14.0% soybean meal, 25.0% wheat bran, 25.0% barley, 3.0% molasses, 1.6% limestone, 0.3% sodium chloride, 0.1% vitamins and minerals premix. The basal diet contained 16.87% crude protein (CP), 13.25% crude fibre (CF) and 10.19 MJ/kg digestible energy (DE) calculated according to Maertens *et al*., 1990).

The rabbits were kept under similar managerial and hygienic conditions, during the experimental period. The building was naturally ventilated and provided with sided electric fans . The ambient temperature and humidity average values were 14.4±0.39°C and 55.0±0.43% during the mild weather and 35.5±0.06°C and 76.0±3.33%, respectively, during the hot climate period. Mercury thermometer was used to the nearest 0.1°C for recording the ambient temperature and hair hygrometer to the nearest 1% for recording the relative humidity. The females were allotted to individual cages of commercial type (59 x 55 x 34 cm) and were provided with nest boxes (40 x 32 x 29 cm). No mortality occurred between the adult females, during the experimental period.

The temperature humidity index (THI) was calculated according to LPHSI (1990), using the following formula: db°F – (0.55 – 0.55 RH) (db°F – 58), where db°F = dry bulb temperature in Fahrenheit and RH = relative humidity percentage /100. The obtained values were then classified as that applied for small animals as follows: <82 = absence of heat stress, 82-<84 = moderate heat stress, 84-<86 = severe heat stress and 86 and more = very severe heat stress.

Statistically, the obtained data were analyzed by 2 x 4 factorial experiment (Snedecor and Cochran, 1982) according to the following model, $Y_{ijk} = \mu + S_i + T_j + St_{ij} + e_{ijk}$, where μ is the overall mean, S_i is the fixed effect of i<u>th</u> season, T_j is the fixed of effect j<u>th</u> dietary supplementation level, ST_{ij} is the interaction effect of i<u>th</u> season and j<u>th</u> treatment and e_{ijk} is the random error. Significant differences were determined by Duncan´s Multiple Range test (Duncan, 1995)

RESULTS AND DISCUSSION

Temperature-humidity index: The temperature-humidity index values were 57.9 and 84.7during the breeding season (October – February; winter) and the summer breeding pause (May – September; summer) periods, respectively, indicating absence of heat stress during the mild climate (less than 82) and exposure of the animals to severe heat stress (between 84 and 86) during the hot climate period, in the present study.

Effect of heat stress: Tables 1 –3 show that gestation period, as well as, pre-weaning mortality at 21 and 0 –28 days were significantly ($P<0.001$ or 0.05) higher, while litter and bunny weights at 0 and 21 days were significantly ($P<0.001$ or 0.05) lower in summer than in winter, in NZW doe rabbits. Similar results were obtained in litter weight at birth and weaning by Askar (1989), Ahmed *et al*. (1991) and Marai *et al*. (19996) in NZW rabbits. Abd El-Moty *et al*. (1991) also reported similar results in litter size and weight at birth and in mortality rate, but not in gestation period which showed contrary trend. The recorded high values for mortality rate in summer may be attributed to the direct effect of heat stress on the sensitive offspring, in addition to reduction of dams milk production (Bober *et al*., 1980; Kamal *et al*., 1989 and Ayyat *et al*., 1995) due to the general depression of metabolic activity in summer conditions (Shafei *et al*., 1984). Regarding the lower litter and bunny weights in summer than in winter may be due to the lower dams milk production and to the lower metabolic activity of the young, in the first than in the second season.

Table 1. Service / conception, gestation period and mortality / litter as affected by season, supplementation of zinc, copper, calcium or magnesium and their interactions.

Items	Service/ conception	Gestation Period (d)	Birth	Mortality / litter at 21 (d)	28 (d)	0-28 (d)
Season:						
Summer	1.11±0.04	31.56±0.11[a]	0.79±0.11	1.01±0.10[a]	1.51±0.13[a]	2.31±0.16[a]
Winter	1.17±0.03	31.16±0.03[b]	0.82±0.08	0.85±0.06	1.14±0.08[b]	1.96±0.10[b]
Significance	NS	***	NS	*	***	*
Treatment:						
Control	1.13±0.06	31.32±0.17	1.10±0.16	1.19±0.15[a]	1.77±0.22[a]	2.87±0.23[a]
Zinc	1.14±0.06	31.52±0.14	0.86±0.15	0.44±0.09[b]	0.80±0.11	1.66±0.20[b]
Copper	1.12±0.05	31.17±0.13	0.91±0.15	0.64±0.12[b]	0.93±0.12b	1.83±0.17[b]
Calcium	1.22±0.06	31.07±0.13	0.53±0.11	1.22±0.09[a]	1.67±0.16[a]	2.20±0.18[b]
Magnesium	1.14±0.06	31.38±0.15	0.74±0.15	1.17±0.12[a]	1.36±0.13[a]	2.10±0.17[b]
Significance	NS	NS	NS	***	***	***
Interaction	**between**	**season and**	**treatments:**			
Summer:						
Control	1.00±0.00	31.78±0.22	1.00±0.17	1.33±0.24	2.22±0.22	3.22±0.28
Zinc	1.05±0.05	31.43±0.25	1.10±0.28	0.38±0.11	0.71±0.17	1.81±0.35
Copper	1.14±0.10	31.50±0.23	0.86±0.27	0.86±0.23	1.07±0.22	1.93±0.31
Calcium	1.17±0.09	31.44±0.23	0.39±0.14	1.39±0.14	2.17±0.27	2.56±0.29
Magnesium	1.2±0.20	31.901±0.18	0.60±0.27	1.60±0.27	2.00±0.26	2.60±0.34
Winter:						
Control	1.18±0.08	31.14±0.21	1.14±0.22	1.14±0.19	1.59±0.28	2.73±0.30
Zinc	1.21±0.09	31.59±0.16	0.69±0.16	0.48±0.13	0.86±0.15	1.55±0.23
Copper	1.11±0.06	31.00±0.15	0.93±0.18	0.54±0.14	0.86±0.15	1.55±0.23
Calcium	1.26±0.09	30.82±0.12	0.63±0.16	1.11±0.11	1.33±0.18	1.96±0.21
Magnesium	1.13±0.06	31.22±0.18	0.78±0.18	1.03±0.12	1.16±0.14	1.94±0.20
Significance	NS	NS	NS	NS	NS	NS

Means bearing different letters within the same classification, differ significantly (P<0.05).
***P<0.001, *P<0.05 and NS = Not significant

Table 2. Litter size and weight as affected by season, supplementation of zinc, copper, calcium or magnesium and their interactions.

Items	Litter size at Birth	21 (d)	28 (d)	Litter weight at Birth	21 (d)	28 (d)
Season:						
Summer	8.38±0.10	6.71±0.09	6.42±0.09	379.9±5.6[a]	2481.1±34.6[a]	3373.8±61.4
Winter	8.74±0.15	6.93±0.12	6.43±0.14	423.4±9.0[b]	2635±51.9[b]	3386.5±85.5
Significance	NS	NS	NS	***	*	NS
Treatment:						
Control	7.84±0.19[b]	5.55±0.10[d]	4.97±0.15[c]	315.2±9.3[ac]	2044.2±45.9[d]	2434.5±56.6[a]
Zinc	8.80±0.21[a]	7.50±0.13[a]	7.14±0.13[a]	402.8±7.9[ab]	2796.8±50.1[a]	3810.4±72.2
Copper	8.81±0.19[a]	7.26±0.12[a]	6.98±0.12[a]	417.9±9.0[a]	2683.1±57.0[ab]	3982.3±87.2[a]
Calcium	8.58±0.13[a]	6.82±0.13[b]	6.38±0.15[b]	424.3±11.8[a]	2573.4±54.9[bc]	3288.3±90.5[b]
Magnesium	8.24±0.18	6.33±0.12[c]	6.14±0.11[b]	389.3±10.2[b]	2423.7±56.4[c]	3052.1±61.0
Significance	**	***	***	***	***	***
Interaction	**between**	**season and**	**treatments:**			
Summer:						
Control	7.82±0.24	5.55±0.13	5.09±0.19	305.2±11.1[e]	2030.5±55.8	2475.5±72.0
Zinc	8.79±0.23	7.62±0.17	7.24±0.18	405.0±10.9[bc]	2809.0±61.7	3850.2±108.7
Copper	8.64±0.24	7.18±0.15	6.86±0.13	401.1±9.4[bc]	2635.0±66.3	3981.8±113.6
Calcium	8.44±0.19	6.70±0.15	6.48±0.18	395.2±10.9[b]c	2468.7±59.7	3333.2±100.3
Magnesium	8.09±0.20	6.28±0.13	6.16±0.12	376.9±11.1[cd]	2369.7±60.4	3062.2±67.5
Winter:						
Control	7.89±0.26	5.56±0.18	4.67±0.24	339.4±14.8[de]	2077.8±95.4	2334.4±79.6
Zinc	8.81±0.39	7.33±0.19	7.00±0.18	399.8±11.5[bc]	2780.0±85.3	3755.5±85.6
Copper	9.14±0.31	7.43±0.20	7.21±0.21	451.4±16.6[d]	2779.3±107.1	3983.6±135.1
Calcium	8.78±0.17	7.00±0.23	6.22±0.27	468.1±20.8[d]	2655.6±100.5	3221.1±171.6
Magnesium	8.70±0.37	6.50±0.27	6.10±0.28	429.0±19.8[ab]	2596.5±127.9	3020.0±144.0
Significance	*NS*	*NS*	*NS*	*	*NS*	*NS*

Means bearing different letters within the same classification, differ significantly at P=0,05
***P<0.001, **P<0.01, *P<0.05 and NS = Not significant

Effect of treatment: 1 –3 show that treatments of heat – stressed doe rabbits with 100 mg zinc oxide, 50 mg copper sulfate, 100 mg calcium oxide or 50 mg magnesium sulfate decreased significantly (P<0.01) pre-weaning mortality with 42.2, 36.2, 23.3 and 26.8%, respectively, and increased significantly (P<0.001 or 0.01) the final values (at weaning at 28 days) of litter size with 44.3, 40.4, 28.4 and 23.5% respectively, litter weight with 56.5, 63.6, 35.1 and 25.4%, respectively, bunny weight with 7.5, 14.9, 3.5 and 0.1% and bunny gain weight with 7.6, 15.3, 2.9 and 5.4%, respectively, than in the control group. Such significant improvements are due to that zinc is essential in metabolism (Banerjee, 1987), immunity protection (Gross *et al*.,1979), growth and fertility (Apgar, 1971), while copper plays a role in fertility (Hafez and Dyer. 1969), calcium supplementation is required to correct calcium plasma drop that occurs during parturition (Barlet, 1980) and magnesium maintains growth in rabbits (Kunkel and Pearson, 1948).

Milk yield also increased (P<0.001) with 74.1, 67.9, 60.2 and 45.0% by the above mentioned supplements, respectively. These results agreed with those of Kulikov *et al*. (1985). The same authors suggested that a dam suckling 6-8 young and producing an average of 107 ml milk daily for 45 days required daily 1.22 mg calcium, 1.36 mg magnesium, 32.0 mg zinc and 5.06 mg copper. The increase in milk yield caused increase in litter and bunny weights. From another point of view, the highest improvement values of doe traits were shown by dietary supplementation with 100 mg zinc oxide or 50 mg copper sulphate, in the present study.

Table 3. Bunny weight and gain and milk yield as affected by season, supplementation of zinc, copper, calcium or magnesium and their interactions.

Items	Birth	Bunny weight at 21 (d)	28 (d)	Bunny gain (g) 0-28	Milk yield (g)	Milk (g)/ g gain	Milk/100g doe W
Season:							
Summer	50.3±0.4[a]	370.6±2.8[a]	523.9±4.6	16.92±0.16	154.5±2.5	9.19±0.15	4.47±0.08
Winter	53.1±0.6[b]	380.4±3.9[b]	524.8±4.6	16.85±0.16	157.8±3.7	9.38±0.22	4.61±0.12
Significance	***	*	NS	NS	NS	NS	NS
Treatment:							
Control	46.9±1.2[b]	37.02±8.1	495.9±10.1[c]	16.04±0.36[c]	101.6±1.9[d]	6.48±0.24c	2.83±0.05[d]
Zinc	50.9±0.7[a]	373.8±4.8	534.2±4.2[a]	17.26±0.16[a]	176.9±2.6[a]	10.29±0.18[a]	5.29±0.08[a]
Copper	52.9±0.7[a]	369.4±4.5	570.7±8.0[b]	18.49±0.28[b]	170.6±2.5[a]	9.32±0.20[b]	4.68±0.08[b]
Calcium	52.5±0.8[a]	373.3±4.7	514.4±5.3[c]	16.50±0.19[c]	162.8±3.1[b]	9.90±0.19[ab]	4.90±0.10[b]
Magnesium	51.8±0.5[a]	382.0±4.6	497±5.7[c]	15.91±0.20[c]	147.6±2.7c	9.33±0.19[b]	4.25±0.08[c]
Significance	***	NS	***	***	***	***	***
Interaction	**Between**	**Season and**	**Treatments:**				
Summer:							
Control	45.8±1.3	368.4±10.4	492.5±13.5	16.00±0.48	103.6±2.4	6.66±0.30	2.89±0.07
Zinc	50.2±1.1	369.5±5.1	531.5±6.2	17.19±0.23	178.8±3.3	10.44±0.21	5.35±0.10
Copper	52.2±0.9	367.3±5.3	579.7±10.2	18.84±0.36	167.7±2.7	8.98±0.22	4.57±0.09
Calcium	50.5±0.5	369.4±6.4	514.2±6.5	16.56±0.23	153.5±3.5	9.93±0.25	4.91±0.11
Magnesium	51.5±0.5	376.9±5.5	497.9±7.1	15.95±0.25	148.4±3.1	9.36±0.21	4.29±0.10
Winter:							
Control	49.6±2.3	374.6±12.2	504.0±11.5	16.23±0.42	96.7±2.8	6.02±0.31	2.69±0.07
Zinc	51.9±0.6	379.8±12.2	504.0±11.5	16.23±0.42	96.7±2.8	6.02±0.31	2.69±0.07
Copper	54.4±1.2	373.6±8.8	552.8±12.0	17.80±0.42	176.4±4.9	9.99±0.37	4.91±0.13
Calcium	55.5±1.7	379.3±6.7	514.7±9.1	16.40±0.31	161.7±5.8	9.86±0.31	4.89±0.18
Magnesium	53.1±1.4	398.3±5.0	495.2±7.9	15.79±0.28	145.0±5.4	9.23±0.45	4.13±0.13
Significance	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Means bearing different letters within the same classification, differ significantly (P<0.05).***P<0.001, *P<0.05 and NS = Not significant W = Weight

Interaction between season and treatment: No significant interaction was observed between season and treatment, except on litter weight at birth (P<0.05); so only the main effects were discussed.

In conclusion, it could be recommended to supplement young doe rabbits with either 100 mg zinc oxide, 50 mg copper sulphate, 100 mg calcium oxide or 50 mg magnesium sulphate due to the significant improvements that may be obtained in the animals traits. However, further studies are needed with more numbers of animals and with combinations of minerals.

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