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# EFFECT OF SEASON OF THE YEAR AND DIETARY ZINC SUPPLEMENTATION ON DOE AND BUCK PERFORMANCE OF NEW ZEALAND WHITE RABBITS, UNDER EGYPTIAN CONDITIONS

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*The numbers of thirty bucks and forty eight does mature (5 – 7 month) New Zealand White rabbits were used in the present study. The rabbits were randomly allotted to six treatment groups, (5 bucks and 8 does each), three groups were reared during winter season and the other three groups were reared during summer (as the hot season). Within each season, the three groups were dietary supplemented with zinc oxide to supply 0, 50 or 100 mg zinc/kg diet, respectively.*

*Temperature-humidity index values were 55.42 and 89.14 under winter and summer conditions, respectively, indicating exposure to very severe heat stress (over than 86.0) during summer. Semen characteristics were significantly (P<0.001) affected by the year season. During summer, semen ejaculate volume, sperm cell concentration and sperm motility percentage decreased significantly (P<0.001) than in winter season, while abnormal spermatozoa parentages increased significantly (P<0.001) during summer than during winter. The increase values were 19.90, 77.82 and 31.28% in semen ejaculate volume, sperm cell concentration and semen motility, respectively, while sperm abnormalities decreased by 34.35% during winter than in summer season. Serum urea, creatinine and ALT decreased significantly (P<0.001, 0.01 and 0.05), while AST and cholesterol values increased significantly (P<0.001 and 0.05) during winter season than during summer season,*

*Semen traits were affected significantly (P<0.001) by zinc addition, except semen volume which was not affected. Serum total protein, albumin, globulin, urea-N, AST and ALT increased as a result of increasing zinc level supplementation in the diets.*

*Regarding the interaction effect, pre-weaning litter weight increased when rabbits reared during winter season as compared with those reared during summer. Rabbit reared during winter recorded higher litter weight at weaning with 31.55% than those reared during the summer. Doe rabbits fed diets supplemented with zinc recorded higher pre-weaning litter size and weight. The higher litter size and weight were obtained in doe rabbits fed a diet supplemented with 100 mg zinc. Bunny mortality rate decreased significantly (P<0.01) with dietary zinc supplementation. Doe milk yield was significantly (P<0.001) affected by zinc additive during the suckling period.*

**Keywords:** Blood, litter size and weight, milk yield, rabbits, season, zinc.

In Egypt, the climate is characterized by a long hot period during the year. Exposure of the growing rabbits to high ambient temperature impairs their growth and increases the mortality rate. Rabbits in hot climate months are very susceptible to heat stress, since they have unfunctional sweat glands and have difficulty in elimination body heat (Marai *et al*., 1996, 1999, 2002; Fernandez *et al.*, 1994 and Finzi *et al*., 1994).

From another point of view, Zinc is an essential element in the nutrition of animals. Zinc in food and water is absorbed through the gut mucosa which is the normal route of entry into the body. It is absorbed at several sites in the gastrointestinal tract. The initial site of absorption is the stomach and occurs within 15 minutes after ingestion (Cheeke, 1987). As an essential cofactor of more than 300 metalloenzymes, zinc plays a crucial role in immunity, cell division and growth. Zinc deficiency may lead to a variety of clinical symptoms, including growth retardation, impaired immune function, neuropsychiatric symptoms, acrodermatitis or hypogonadism and impairment of wound healing (Aggett, 1997 and Watanabe *et al*., 1995). Zinc may promote intestinal epithelial wound healing by enhancement of epithelial cell restitution, the initial step of epithelial wound healing. Zinc supplementation may improve epithelial repair; however, excessive amounts of zinc may cause tissue injury and impair epithelial wound healing (Cario *et al*., 2000). Zinc supplementation has various beneficial effects on body functions, such as acid base balance, nutrient metabolism and immunity protection (Gross *et al*., 1979, Banerjee, 1988 and Hahn and Baker, 1993). Importance of zinc appears from the fact that zinc acts as activator for many enzymes and hormones (Riordan and Vallee, 1976). Abd El-Rahim *et al*. (1995) found that dietary supplementation of rabbit with 170 mg zinc/kg diet increased each of body gain, feed conversion, digestibility of all nutrients and absorption. However, studies on the effect of Zinc supplementation during hot summer season in Egypt are lacking.

The present experiment was conducted to study the doe and buck performances as affected by season of the year, dietary zinc supplementation (0, 50 and 100 mg/kg diet) and their interaction, under Egyptian sub-tropical conditions.

## MATERIALS AND METHODS

The practical work was carried out on a privte rabbit farm at Dakhliya Governorate, Egypt. Total numbers of thirty New Zealand White ( NZW) bucks, and forty eight doe at maturation age (5 – 7 month) at first parity were used in the present study. The rabbits were randomly allotted to six treatment groups, (5 bucks and 8 does each), three groups were reared during winter season and the other three groups were reared during summer (as the hot season). Within each season, the three groups were dietary supplemented with zinc oxide to supply 0, 50 or 100 mg zinc/kg diet, respectively.

All animals were fed *ad libitum* a pelleted diet and water was available all time. Each kilogram of the basal diet consisted of 150 g alfalfa hay, 200 g corn, 210 g soybean meal, 386 g wheat bran, 30 g molasses, 18 g limestone, 3 g sodium chloride, 3 g vitamins and minerals premix. The diet contained 18.67% crude protein, 12.82%

crude fibre (both were analyzed according to AOAC, 1980), 2600 kcal digestible energy and 26.82 mg zinc/kg diet (calculated according to NRC, 1977).

Rabbits in all groups were kept under the same managerial and hygienic conditions. The doe and buck rabbits were individually housed in batteries (75 X 75 X 45 cm) provided with feeders and automatic drinkers. The doe batteries were provided with nest boxes (30 X 25 X 28 cm) for parturition and nursing the bunnies. The batteries were located in a conventional confined and windowed building naturally ventilated. Does were mated and weighed at each mating and palpitation was carried at 10 days of mating to determine pregnancy. If a doe did not conceive, mating and palpation were carried out until pregnancy. Doe studied traits were litter size at birth, 21-day and at weaning, litter weight at birth, 21-day and 28-day, weekly milk yield, and pre-weaning mortality. Milk yield was estimated every day by the difference in doe weight before and after suckling that occurred once every day. The decrease in mother weight was considered as the milk yield.

Semen was collected from five bucks from each experimental male group at the different experimental periods. Sperm cell concentration ($x10^6$ / ml), semen ejaculate volume (ml), sperm abnormalities (%) and sperm motility (%) were determined.

## Semen collection and evaluation:

### *Semen collection:*

Semen was collected from rabbit bucks once weekly by means of an artificial vagina between 08:00 and 10:00 a.m., some rabbit does were used for that particular purpose. The temperature of the inner lining rubber sleeve of the artificial vagina was adjusted to 41-43$^0$C. Lubrication of the inner sleeve was performed using medical white Vaseline with sterile rode. The pressure in the lumen of the artificial vagina was adjusted to suit individual rabbits. Most of the ejaculate passes into the collecting tube. All the yield can be obtained by inverting the artificial vagina and opening the clap to allow the water to run out by reducing the pressure in the inner sleeve. Each ejaculate was kept separately in a water bath at 37$^0$C for examination. All the equipment's of the artificial vagina were washed thoroughly and sterilized before every collection of semen to avoid any contamination.

### *Semen evaluation:*

**Semen-ejaculate volume (ml):** Volume of ejaculated semen was measured in milliliters using a 2ml calibrated collecting tube. Any gel presented in the ejaculate was discarded and semen volume was measured soon after collection.

**Sperm-cell concentration (x $10^6$/ ml):** Semen was extended 200 fold with physiological saline solution (0.9% NaCL) plus drop of eosin stain. Sperm-cell concentration was estimated by using hemocytometer. Examination was made under the high power magnification (X400) and calibrated by using a Spectronic 20 machine of set wave length at 550 millimicrons. A Spectronic 20 tube containing 7.9 ml of 2.9% sodium citrate solution was inserted into machine and adjusted to read 100% transmittance, then removed. Thereafter, 0.1ml semen was added into the tube using serological pipette. The tube containing (7.9 ml of 2.9% sodium citrate and

0.1ml semen) was inserted into a Spectronic 20 machine and the percentage of transmittance after 10 seconds was recorded.

**Sperm motility (%):** Percentage of advanced motility of spermatozoa was estimated by adding one drop of fresh semen to a test tube containing 1ml warm physiological saline solution (0.9% NaCL) and suspended in a water bath at $37^0$C. The mixture was shaken slowly and then extended semen was taken from the test tube with a warm Pasteur pipette and placed on a warm slide. The drop was covered by a warmed cover slip and immediately examined under the high power magnification (X 400).

**Abnormal spermatozoa (%):** The nigrosin / eosin staining procedure of Hackett and Macpherson (1965) was used. Preparation of the stain was carried out by dissolving 10 gm nigrosin and 1.67gm eosin in distilled water up to 100 ml. Seven drops of the stain were added to a testtube and warmed to 37 $^0$C in a water bath and then a drop of fresh semen. The mixture was then shaken and left for 2-3 minutes. One drop of the mixture was removed by a Pasteur pipette and placed at the end of a warm slide. A thin smear was made by drawing the edge of another warm slide across the mixture. The stained slide was allowed to dry on hot stage, then examined under the high power magnification (X 400). The total normal per hundred spermatozoa were estimated by counting the number presented in 100 spermatozoa in different fields on each of the two slides by using a hand counter, and vice versa. Semen collection and evaluation were carried out as described by Salisbury *et al.* (1978).

**Blood analysis:** At the end of the experimental period, a single blood sample was taken from each buck from the ear vein into heparinized tube. The blood samples were centrifuged at 3000 rpm for 20 minutes to separate the serum. The collected serum was stored at -20 °C until assay. Total protein, albumin, urea-N, creatinine, cholesterol and serum transaminase enzymes (AST and ALT) were estimated in blood serum by colormetric methods using commercial kits.

**THI estimation:** Average ambient temperature values were 12.36°C (54.65°F) and 34.21°C (92.98°F) and those of relative humidity 66.12 and 78.32% during winter and summer, respectively.

The temperature-humidity index (THI) was calculated according to LPHSI (1990), using the following formula:

$$THI = Tf - [0.55 - (0.55 * RH / 100)] * (Tf - 58.8),$$

Where, THI = Temperature-Humidity Index, Tf = Air temperature in Fahrenheit and RH = Relative humidity percentages. The obtained values were then classified as follows: <82.0 = Absence of heat stress, 82.0-<84.0 = Moderate heat stress, 84.0-<86.0 = Severe heat stress and 86.0 and over= Very severe heat stress.

## Statistical analyses:

Statistical analyses of the data were carried out by 2 X 3 factorial design according the following model (Snedecor and Cochran, 1982): $Y_{ijk} = \mu + S_i + Z_j + SZ_{ii} + e_{ijk}$, where $\mu$ is the overall mean, $S_i$ is the fixed effect of $i^{th}$ year season (1, 2), $Z_j$ is the fixed $j^{th}$ effect dietary zinc supplementation level (1, 2, 3), $SZ_{ij}$ is the interaction between season and zinc supplementation level and $e_{ijk}$ is the random error. Significant differences were determined by Duncan's Multiple Range test (Duncan, 1955).

## RESULTS AND DISCUSSION

**Temperature-humidity index:**

Temperature-humidity index values were estimated as 55.42 and 89.14 in winter and summer periods, respectively. The index values indicated exposure to very severe heat stress (over than 86.0) during summer season.

**Bucks performance:**

Bucks live body weight was insignificantly affected by seasons and levels of zinc supplementation, while the interaction between season and dietary zinc supplementation had a significant ($P<0.01$) effect on bucks live body weight (Table 1).

Semen characteristics were significantly ($P<0.001$) influenced by the season of the year (Table 1). Semen ejaculate volume, semen concentration and motility percentage decreased significantly ($P<0.001$) during summer season (34.21 °C; hot period) than in winter season (12.363 °C), while percentage of abnormal spermatozoa increased significantly ($P<0.001$) during summer season than in winter ( Table 1). Semen volume, sperm concentration and sperm motility increased by 19.90, 77.82 and 31.28%, respectively, while abnormal spermatozoa decreased by 34.35% during winter season as compared to summer season. These results agreed with El-Masry *et al*. (1994) who reported that there was significant increase in percentage of dead spermatozoa and significantly decreased in total sperm and live sperm concentrations and percentage of sperm motility, during summer. On the other hand, Virag *et al*. (1992) reported that there were seasonal differences only in ejaculate volume. Temperatures around or above 30°C caused a drop in quantity and quality of semen (Bicudo and PaschoaL, 1991; El Marsay *et al.*, 1994; Finzi *et al*. 1994; Viudes-De-Castro and Vicente, 1997).

Semen characteristics were significantly (0.001) affected, while semen volume was not affected by dietary zinc supplementation to bucks, (Table 1). Zinc addition significantly ($P<0.05$) improved the quality of the semen (sperm concentration and motility percentage). This is due to that zinc is important for spermatogenesis, being directly involved in spermatozoa maturation and preservation of germinative epithelium (Underwood and Somers, 1969). It is also essential to cellular division, synthesis and stability of DNA (Devenson, 1993), as well as, in cellular differentiation.

Sperm concentration and abnormal spermatozoa were significantly ($P<0.01$ and 0.05) influenced, while semen volume and sperm motility were insignificantly affected by the interaction between the seasons and zinc additive (Table 1). Bucks reared during winter season and fed diet supplemented with 100 mg zinc recorded the best semen quality. Moce *et al*. (2000) found higher volumes of ejaculates in animals fed diet supplemented with zinc (levels from 35 to 100 ppm) as compared to non-supplemented ones. Also, they observed an increase of spermatozoa quantity (concentration) in the ejaculates of animal fed diet supplemental with zinc.

**Table 1. Semen characteristics of bucks as affected by season of the year and dietary zinc supplementation and their interactions.**

| Items | Body weight (kg) | Ejaculate volume (ml) | Sperm cell concentration ($x10^6$) | Sperm motility (%) | Abnormal spermatozoa (%) |
|---|---|---|---|---|---|
| **Effect of year season:** | | | | | |
| **Summer** | 3112.67± 49.140 | 0.442± 0.009 | 95.79± 4.034 | 43.93± 1.240 | 20.00± 0.676 |
| **Winter** | 3158.67± 41.540 | 0.530± 0.017 | 170.33± 8.019 | 57.67± 1.756 | 13.13± 0.413 |
| **Significance** | **NS** | *** | *** | *** | *** |
| **Dietary zinc supplementation (mg/kg diet)** | | | | | |
| **0** | 3098.00± 61.821 | 0.458± 0.019 | 108.19± 10.362$^{c}$ | 45.90± 2.073$^{c}$ | 18.90± 1.418$^{a}$ |
| **50** | 3174.00± 46.814 | 0.492± 0.012 | 133.50± 12.070$^{b}$ | 50.20± 2.560$^{b}$ | 16.30± 1.136$^{b}$ |
| **100** | 3135.00± 59.184 | 0.508± 0.029 | 157.50± 16.213$^{a}$ | 56.30± 3.095$^{a}$ | 14.50± 1.003$^{c}$ |
| **Significance** | **NS** | **NS** | *** | *** | *** |
| **The interaction effect between year season and dietary zinc supplementation** | | | | | |
| | | | **Summer** | | |
| **0 mg** | 3180.00± 107.935$^{ab}$ | 0.422± 0.015 | 77.98± 4.219$^{e}$ | 40.40± 1.720 | 23.00± 0.707$^{a}$ |
| **50 mg** | 3178.00± 8.337$^{ab}$ | 0.468± 0.014 | 99.40± 1.600$^{d}$ | 43.80± 2.083 | 19.60± 0.510$^{b}$ |
| **100 mg** | 2980.00± 25.495$^{b}$ | 0.436± 0.012 | 110.00± 4.183$^{d}$ | 47.60± 1.536 | 17.40± 0.245$^{c}$ |
| | | | **Winter** | | |
| 0 mg | 3016.00± 46.755$^{b}$ | 0.494± 0.027 | 138.40± 3.010$^{c}$ | 51.40± 1.122 | 14.80± 0.374$^{d}$ |
| 50 mg | 3170.00± 58.310$^{ab}$ | 0.516± 0.012 | 167.60± 8.465$^{b}$ | 56.60±2.159 | 13.00±0.316$^{e}$ |
| 100 mg | 3290.00± 55.678$^{a}$ | 0.580± 0.033 | 205.00± 6.099$^{a}$ | 65.00± 1.703 | 11.60± 0.510$^{f}$ |
| **Significance** | ** | **NS** | ** | **NS** | * |

Means in the same column within each classification bearing different letters, differed significantly (P<0.05). *** P<0.001, ** P<0.01, * P<0.05 and NS = Not significant.

Serum urea-N, creatinine, AST, ALT and cholesterol were significantly affected (P<0.001, 0.01 or 0.05), while total protein and its fractions were insignificantly affected by season of the year (Tables 2 and 3). Serum urea, creatinine and ALT were significantly lower during winter than during summer season, while AST and cholesterol significantly increased. Marai *et al.* (2006) found that serum total protein, albumin and globulin, urea-N, creatinine and SGOT and SGPT were significantly (P<0.001, 0.01 or 0.05) lower in summer than in winter in NZW male rabbits.

**Table 2. Blood serum total protein, albumin, globulin, urea-N and creatinine of rabbits as affected by season of the year and dietary zinc supplementation and their interactions.**

| Items | Total protein (g/dl) | Albumin (g/dl) | Globulin (g/dl) | Urea-N (mg/dl) | Creatinine (mg/dl) |
|---|---|---|---|---|---|
| **Effect of year season** | | | | | |
| **Summer** | 6.366± 0.141 | 3.503± 0.086 | 2.863± 0.088 | 15.427± 0.307 | 1.087± 0.019 |
| **Winter** | 6.312± 0.168 | 3.383± 0.115 | 2.928± 0.091 | 13.467± 0.282 | 1.044± 0.010 |
| **Significance** | **NS** | **NS** | **NS** | *** | * |
| **Dietary zinc supplementation (mg/kg diet)** | | | | | |
| **0** | 5.676± 0.098$^{c}$ | 3.094± 0.101$^{c}$ | 2.582± 0.080$^{b}$ | 13.610± 0.394$^{b}$ | 1.041± 0.015 |
| **50** | 6.408± 0.101$^{b}$ | 3.454± 0.083$^{b}$ | 2.954± 0.053$^{a}$ | 14.470± 0.337$^{ab}$ | 1.079± 0.026 |
| **100** | 6.931± 0.067$^{a}$ | 3.780± 0.075$^{a}$ | 3.151± 0.101$^{a}$ | 15.260± 0.553$^{a}$ | 1.077± 0.015 |
| **Significance** | *** | *** | *** | ** | **NS** |
| **The interaction effect between year season and dietary zinc supplementation** | | | | | |
| **Summer** | | | | | |
| **0 mg** | 5.776± 0.159 | 3.218± 0.116 | 2.558± 0.150 | 14.580± 0.421 | 1.048± 0.027 |
| **50 mg** | 6.420± 0.114 | 3.470± 0.086 | 2.950± 0.089 | 15.300± 0.281 | 1.116± 0.045 |
| **100 mg** | 6.902± 0.109 | 3.820± 0.103 | 3.082± 0.119 | 16.400± 0.560 | 1.098± 0.017 |
| **Winter** | | | | | |
| **0 mg** | 5.576± 0.115 | 2.970± 0.159 | 2.606± 0.077 | 12.640± 0.223 | 1.034± 0.016 |
| **50 mg** | 6.396± 0.181 | 3.438± 0.153 | 2.958± 0.068 | 13.640± 0.298 | 1.042± .015 |
| **100 mg** | 6.960± 0.089 | 3.740± 0.119 | 3.220± 0.171 | 14.120± 0.641 | 1.056± 0.021 |
| **Significance** | **NS** | **NS** | **NS** | **NS** | **NS** |

Means in the same column within each classification bearing different letters differed significantly (P<0.05). *** P<0.001, ** P<0.01, * P<0.05 and NS = Not significant.

All blood components were affected significantly (P<0.001 or 0.01) by dietary zinc supplementation, except serum creatinine and cholesterol concentrations which insignificantly affected (Tables 2 and 3).

Serum total protein, albumin, globulin, urea-N, AST and ALT increased with the increase in zinc level supplementation. Ayyat and Marai (2000) reported that plasma total protein, albumin and globulin were significantly (P<0.01) affected by dietary zinc supplementation, which were increased with increasing dietary zinc level between 0 and 200 mg, then decreased up at 400 mg level.

**Table 3. Blood serum transaminase enzymes (AST and ALT) and cholesterol of rabbits as affected by season of the year and dietary zinc supplementation and their interactions.**

| Items | AST (U/l) | ALT (U/l) | Cholesterol (mg/dl) |
|---|---|---|---|
| **Effect of year season** | | | |
| **Summer** | 31.800±0.363 | 15.060±0.341 | 74.327±0.806 |
| **Winter** | 35.647±0.246 | 14.187±0.282 | 76.467±0.526 |
| **Significance** | *** | ** | * |
| **Dietary zinc supplementation (mg/kg diet)** | | | |
| **0** | 32.900±0.782[b] | 13.740±0.206[b] | 76.110±0.690 |
| **50** | 33.580±0.765[b] | 14.350±0.341[b] | 75.740±0.937 |
| **100** | 34.690±0.551[a] | 15.780±0.345[a] | 74.340±0.999 |
| **Significance** | ** | *** | NS |
| **The interaction effect between year season and dietary zinc supplementation** | | | |
| | **Summer** | | |
| **0 mg** | 30.860±0.730 | 13.700±0.279 | 75.580±0.840 |
| **50 mg** | 31.400±0.297 | 15.200±0.176 | 75.00±1.620 |
| **100 mg** | 33.140±0.220 | 16.280±0.525 | 72.400±1.436 |
| | **Winter** | | |
| **0 mg** | 34.940±0.367 | 13.780±0.334 | 76.640±1.138 |
| **50 mg** | 35.760±0.409 | 13.500±0.363 | 76.480±1.026 |
| **100 mg** | 36.240±0.341 | 15.280±0.368 | 76.280±0.738 |
| **Significance** | **NS** | **NS** | **NS** |

Means in the same column within each classification bearing different letters differed significantly (P<0.05). *** P<0.001, ** P<0.01, * P<0.05 and NS = Not significant.

Interaction between year season and dietary zinc supplementation insignificantly affected all blood components (Tables 2 and 3).

## Doe traits:

Pre-weaning litter weight was affected significantly (P<0.001, 0.01 or 0.05), while pre-weaning litter size was insignificantly affected by season of the year. Pre-weaning litter weight increased during winter than during summer season (Table 4). Rabbit reared during winter recorded higher litter weight value at weaning which was 31.55% more than those reared during summer. On the other hand, mortality rate increased during summer than during winter (Table 5). Doe milk yield significantly (P<0.001) increased during winter than during summer season (Table 5). The lower litter and bunny weights in summer than in winter may be due to the lower milk production of dams and to the lower metabolic activity of the young. These results were similar to those of Marai *et al*. (1996).

Zinc dietary supplementation significantly (P<0.001) affected pre-weaning litter size and weight (Table 4). Doe rabbits fed dietary zinc supplemented recorded higher pre-weaning litter size and weight. The best litter size and weight were obtained when doe rabbits fed diet supplemented with 100 mg zinc. Mortality rate decreased significantly (P< 0.01) with the increase in

**Table 4. Doe traits as affected by season of the year and dietary zinc supplementation and their interactions.**

| Items | Litter size at birth | Litter size at 21 days | Litter size at weaning | Litter weight at birth (g) | Litter weight at 21 days (g) | Litter weight at weaning (g) |
|---|---|---|---|---|---|---|
| **Effect of year season** | | | | | | |
| **Summer** | 6.13± 0.368 | 4.79± 0.426 | 4.54± 0.462 | 281.0± 18.22 | 1648.8± 152.3 | 2162.9± 218.7 |
| **Winter** | 7.04± 0.343 | 5.29± 0.378 | 5.04± 0.373 | 364.8± 19.88 | 2083.3± 149.1 | 2845.4± 208.6 |
| **Significance** | **NS** | **NS** | **NS** | *** | * | ** |
| **Dietary zinc supplementation (mg/kg diet)** | | | | | | |
| **0** | 5.81± 0.467 | 3.50± 0.408$^{c}$ | 3.13± 0.427$^{c}$ | 264.7± 22.49$^{b}$ | 1357.5± 145.1$^{b}$ | 1678.8± 231.1$^{c}$ |
| **50** | 6.69± 0.472 | 5.13± 0.446$^{b}$ | 4.94± 0.433$^{b}$ | 320.9± 25.37$^{b}$ | 1709.4± 161.4$^{b}$ | 2466.3± 224.8$^{b}$ |
| **100** | 7.25± 0.335 | 6.50± 0.303$^{a}$ | 6.31± 0.338$^{a}$ | 383.1± 20.14$^{a}$ | 2531.3± 135.8$^{a}$ | 3367.5± 185.3$^{a}$ |
| **Significance** | **NS** | *** | *** | *** | *** | *** |
| **The interaction effect between year season and dietary zinc supplementation** | | | | | | |
| | | | **Summer** | | | |
| **0 mg** | 5.50± 0.655 | 3.00± 0.535 | 2.63± 0.653 | 230.0± 24.05 | 1136.3± 206.9 | 1306.4± 338.4 |
| **50 mg** | 6.25± 0.726 | 5.00± 0.655 | 4.75± 0.675 | 276.9± 33.45 | 1503.7± 207.6 | 2145.0± 260.2 |
| **100 mg** | 6.63± 0.532 | 6.38± 0.498 | 6.25± 0.526 | 336.3± 27.64 | 2306.3± 201.4 | 3037.5± 274.6 |
| | | | **Winter** | | | |
| **0 mg** | 6.13± 0.693 | 4.00± 0.598 | 3.63± 0.532 | 299.4± 35.29 | 1578.8± 183.0 | 2051.3± 273.5 |
| **50 mg** | 7.13± 0.611 | 5.25± 0.648 | 5.13± 0.581 | 365.0± 32.95 | 1915.0± 237.6 | 2787.5± 345.5 |
| **100 mg** | 7.88± 0.295 | 6.63± 0.375 | 6.38± 0.460 | 430.0± 18.61 | 2756.3± 154.8 | 3697.5± 201.6 |
| **Significance** | **NS** | **NS** | **NS** | **NS** | **NS** | **NS** |

Means in the same column within each classification bearing different letters differed significantly (P<0.05). *** P<0.001, ** P<0.01, * P<0.05 and NS = Not significant.

dietary zinc level supplementation (Table 5). Marai *et al*. (2000) reported that dietary zinc supplementation of heat-stressed doe rabbits with 100 mg zinc oxide significantly (P<0.001) increased litter size at 28 days by 44.3%, and litter weight by 56.5% and significantly (P<0.01) decreased pre-weaning mortality by 42.2%.

Doe milk yield was significantly (P<0.001) affected by zinc addition during the suckling period (Table 5). The increase values were 53.13, 47.14 and 39.2%, when does were supplemented with 100 mg zinc at the 1$^{st}$, 2$^{nd}$ and 3$^{rd}$ weeks of the suckling period respectively.

**Table 5. Litter mortality rate and milk yield of doe rabbits as affected by season of the year and dietary zinc supplementation and their interactions.**

| Items | Mortality rate (%) | Milk yield ml/d at 1st week | Milk yield ml/d at 2nd week | Milk yield ml/d at 3rd week |
|---|---|---|---|---|
| **Effect of year season** | | | | |
| **Summer** | 1.58±0.40 | 88.58±3.47 | 122.21±4.53 | 141.79±4.33 |
| **Winter** | 2.00±0.21 | 120.21±5.27 | 155.42±5.80 | 208.75±7.06 |
| **Significance** | **NS** | *** | *** | *** |
| **Dietary zinc supplementation (mg/kg diet)** | | | | |
| **0** | 2.69±0.49[a] | 82.81±4.03[c] | 111.25±4.71[c] | 148.44± 8.82[c] |
| **50** | 1.75±0.29[ab] | 103.56±0.24[b] | 141.50±5.72[b] | 170.75± 7.89[b] |
| **100** | 0.94±0.21[b] | 126.81±5.80[a] | 163.69±5.71[a] | 206.63±11.27[a] |
| **Significance** | ** | *** | *** | *** |
| **The interaction effect between year season and dietary zinc supplementation** | | | | |
| **Summer** | | | | |
| **0 mg** | 2.88±0.87 | 72.50±5.26[e] | 98.13±5.17 | 117.50±3.07[e] |
| **50 mg** | 1.50±0.57 | 88.25±3.44[d] | 122.38±2.19 | 142.75±2.81[d] |
| **100 mg** | 0.38±0.26 | 105.00±1.83[c] | 146.13±2.51 | 165.13±2.25[c] |
| | | **Winter** | | |
| **0 mg** | 2.50±0.53 | 93.13±3.40[d] | 124.38±4.38 | 179.38±7.10[c] |
| **50 mg** | 2.00±0.19 | 118.88±6.23[b] | 160.63±5.55 | 198.75±5.88[b] |
| **100 mg** | 1.50±0.19 | 148.63±2.17[a] | 181.25±6.73 | 248.13±6.88[a] |
| **Significance** | **NS** | * | **NS** | * |

Means in the same column within each classification bearing different letters differed significantly (P<0.05). *** P<0.001, ** P<0.01, * P<0.05 and NS = Not significant.

The pre-weaning litter size was insignificantly affected by the interaction between season and dietary zinc supplementation. Similar results were obtained by Marai *et al*. (2000).

## REFERENCES

**Abd El-Rahim, M.I.A., El-Gaafary, M.N, Tawfeek, M.I., El-Kelawy, H.M., Rawia, S.A. and Abd El-Rahim, M.I. (1995).** Effect of dietary supplementation with different levels of zinc on growth performance, nutrient digestibility, mineral metabolism, blood constituents, organ histopathology and reproductive efficiency in NZW rabbits. *Egyptian Journal of Rabbit Science*, **5:** 11-31.

**Aggett, P.J. (1997).** *Clinical Zinc Deficiency: an Overview*. In: Zinc and Diseases of the Digestive Tract edited by Kruse-Jarres, J.D., SchoÈlmerich, J., Dordrecht, Boston, London: Kluwer Academic; pp. 27.

**A.O.A.C. (1980).** Association of Official Analytical Chemists. *Official Methods of Analyses*. 13th Edition, Washington, USA.

**Ayyat, M.S. and Marai, I.F.M. (2000).** Growth performance and carcass traits as affected by breed and dietary supplementation with different zinc levels, under Egyptian conditions. *7th World Rabbit Congress*, Valencia, Spain, pp. 83-88.

**Banerjee, G.C. (1988).** *Feeds and Principles of Animal Nutrition*. 2nd Edition, Oxford and IBH Publishing Co. PVT Ltd.

**Bicudo, S.D. and Paschoal, J.P.S. (1991).** Some rabbit semen traits in spring and early summer. In: Congresso Brasileiro De reprodução Animal, 9, Belo Horizonte. *Anais*, Belo Horizonte, CBRA, **2:**457-459.

**Cario, E., Jung, S., Harder d'Heureuse, J., Schulte, C., Sturm, A., Wiedenmann, B., Goebell, H. and Dignass, A.U. (2000).** Effects of exogenous zinc supplementation on intestinal epithelial repair in vitro. *European Journal of Clinical Investigation*, **30:** 419 – 428.

**Cheeke, P.R. (1987).** *Rabbit Feeding and Nutrition*. Academic Press, San Diego, CA.

**Devenson, D.P.; Enerik, R.J. and Jost, L.K. (1993).** Zinc/Silicon interactions influencing sperm chromatin integrity and testicular cell development in the rat as measured by flow cytometry. *J. Anim. Sci.,* **71**: 955-962.

**Duncan, D. B. (1955).** Multiple Range and Multiple F-test. *Biometrics*, **11:** 1-42.

**El-Masry, K.A., Nasr, A.S., Kamal, T.H. (1994).** Influences of season and dietary supplementation with selenium and vitamin E or zinc on some blood constituents and semen quality of New Zealand White rabbit males. *World Rabbit. Sci.,* **2**:79-86.

**Fernandez, C.I., Blas, E. and Concha, C. (1994).** Growth and some carcass traits of adult rabbits under high ambient temperature. *World Rabbit Science*, **2:** 147-151.

**Finzi, A., Moreira, P. and Macchioni, P. (1994).** Modifications of some rabbit spermatic parameters in relationship to high ambient temperatures. *Cahiers Options Mediterraneennes, Rabbit Production in Hot Climates*, Cairo, Vol**. 8.** ,333-336.

**Gross, R.L., Osolin, N., Fong, L. and Newberne, P.M. (1979).** Depressed immunological function in zinc deprived rats as measured by nitrogen response of spleen, thymus and peripheral blood. *American Journal of Clinical Nutrition*, **32**: 1260-1266.

**Hackett, A.J. and Macpherson, J.W. (1965).** Some staining procedures for spermatozoa. *Canadian Vet. J*., **6:** 55-62.

**Hahn, J.D. and Baker, D.H. (1993).** Growth and plasma zinc responses of young pigs fed pharmacological levels of zinc. *Journal of Animal Science*, **71**: 3020-3024.

**Hossain, S. and Bertechini, A.G. (1993).** Requirement of zinc for growing rabbits. *Arquivo Brasileriro de Medicina Veterinaria e Zootecnia*, **45**: 323-329.

**Kulikov, N.E., Morozova, K.N. and Aleksandrova, V.S. (1985).** Requirement of young rabbits for minerals. *Krolikovodstvo i Zverovodstvo*, **1**: 14-15.

**Lebas, F. (1975).** Nutrient requirements of rabbits. *The Commercial Rabbit Journal*, **3**: 7.

**LPHSI (1990).** *Livestock and Poultry Heat Stress Indices*. Agriculture Engineering Technology Guide, Clemson University, SC 29634, USA.

**Marai, I.F.M., Ayyat, M.S., Gabr, H.A., and Abdel-Monem, U.M. (1999).** Growth performance, some blood metabolites and carcass traits of New Zealand White broiler male rabbits as affected by heat stress and its alleviation, under Egyptian conditions. *Cahiers Options Mediterraneennes*, **41**: 35-42.

**Marai, I. F. M., Habeeb, A. A. M. and Gad, A. E. (2002).** Rabbits productive, reproductive and physiological performance traits as affected by heat stress. *Livestock Production Science*, **78** (22): 71-90.

**Marai, I. F. M., Ayyat, M. S. and Abd El-Monem, U. M. (2006).** Growth performance, blood components and slaughter traits of New Zealand White male growing rabbits as affected by dietary supplementation with calcium, sodium or potassium, in sub-tropical Egypt. *Tropical and Subtropical Agro ecosystems*, **6** : 149-155.

**Marai, I.F.M.; Ayyat, M.S.; Gabr, H.A.; Abd El-Monem, U.M.. (1996 )**. Effect of summer heat stress and its amelioration on production performance of New Zealand White adult female and male rabbits, under *Egyptian conditions. 6th World Rabbit Congress*, Toulouse, France, **2**: 197-208.

**Mocé, E., Aroca, M., Lavara, R., Pascual, JJ. (2000).** Effect of dietary zinc and vitamin supplementation on semen characteristics of high growth rate males during summer season. *Proc. 7th World Rabbit Congress*, Valencia, Vol A, p 203-209..

**NRC (1977).** National Research Council. *Nutrient Requirements of Rabbits*. 2nd Edition. Wasington, D.C.

**Rirodan, J.F. and Vallee, B.L. (1976).** *Trace elements in human health and disease. Structure and function of zinc metalloenzymes*. Academic Press, New York, London, pp. 227-256.

**Salisbury, G.W., Van Demark, N. L. and Lodge, J. R. (1978).** *Physiology of Reproduction and Artificial Insemination of Cattle.* W.H. Freeman and Company, San Francisco, USA

**Snedecor, G.W. and Cochran, G.W. (1982).** *Statistical methods*. 6th Ed. The Iowa State University. Press Ames, USA.

**Underwood, E. J. and Somers, M. (1969).** Zinc nutrition. *Aust. J. Agric.*, **20**(2):889.

**Virag, G., Mezes, M. and Bersenyi, A. (1992).** Effects of independent factors on semen characteristics in rabbits. *Journal of Applied Rabbit Research*, **15** (A): 499-504.

**Viudes De Castro, M. P. and Vicente, J. S. (1997).** Effect of sperm count on the fertility prolificity rates of meat rabbits. *Anim. Reprod. Sci*., **46** (1):313-319.

**Wang, Y.Z., Yan, D.Z., Zhang, Y.Q. and Hua, S.R. (1989).** Effect of nutrient additive on growth of Angora rabbits. *Fur Animal Farming*, **43:** 3-6.

**Watanabe, T., Arakawa, T., Fukuda, T., Higuchi, K., Kobayashi, K. (1995).** Zinc deficiency delays gastric ulcer healing in rats. *Digestive Diseases and Sciences*, **40**:1340-1344.

## تأثير مواسم السنة وإضافة الزنك للغذاء على أداء اناث و ذكورالأرانب النيوزيلندى الأبيض تحت الظروف المصرية .

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- أستخدم فى هذه الدراسة عدد 30 ذكر وعدد 48 انثى نيوزيلندى أبيض فى عمر النضج ( 5-7 شهور)، وتم تقسيم الأرانب عشوائيا إلى 6 معاملات كل معاملة تتكون من ( 5 ذكور، 8 أمهات ) الثلاثة مجاميع الأولى تم تربيتها خلال موسم الشتاء والثلاثة مجاميع الاخرى تم تربيتها فى موسم الصيف ( تحت ظروف الإجهاد الحرارى ) وفى كل موسم تم إضافة اكسيد الزنك بمعدلات 0 ، 50، 100 مليجرام زنك /كم غذاء على التوالى.
- متوسط قيم دليل الحرارة و الرطوبة كان ( 55.42،89.14) تحت ظروف الشتاء والصيف على التوالى وقيمة الدليل تشير إلى تعرض الأرنب المعاملة لإجهاد حرارى شديد صيفا ( اكثر من 86 ) .
- صفات السائل المنوى تأثرت معنويا بمواسم السنة فأثناء موسم الصيف انخفض حجم قذفة السائل المنوى وتركيز الحيونات المنوية والنسبة المئوية لحركة الحيونات المنوية معنويا عنه فى موسم الشتاء، بينما زادت نسبة الحيونات المنوية الغير طبيعية معنويا فى الصيف عن الشتاء .

- وجد أن حجم قذفة السائل المنوى وتركيزالحيوانات المنوية وحركة الحيوانات المنوية زادت بنسبة 19.90 ، 77.82 و 31.28 % على التوالى بينما نسبة الحيونات المنوية الغير طبيعية انخفضت بنسبة 34.35 % اثناء موسم الشتاء مقارنة بقيم موسم الصيف.
- تأثرت معنويا صفات السائل المنوى بأضافة الزنك لعليقة الذكور ماعدا حجم القذفة الذى لم يتأثر.
- انخفضت قيم اليوريا و الكرياتينين وALT معنويا، بينما زاد ت قيم AST والكوليستيرول معنويا اثناء موسم الشتاء عنه في موسم الصيف.
- البروتين الكلي با لسيرم والالبيومين والجلوبيولين واليوربا نيتروجين و AST ،ALT زادت نتيجة لزيا د ة مستوي الزنك المضاف بالعليقة .
- زاد وزن الخلفة قبل الفطام اثناء موسم الشتاء مقارنة بموسم الصيف والارانب التي تم تربيتها بموسم الشتاء سجلت وزن خلفة عند الفطام أعلي بنسبة 31.55% عن الأرانب التى تربت فى موسم الصيف.
- امهات الأرانب التى تغذت على عليقة أضيف لها الزنك سجلت أعلى حجم ووزن خلفة قبل الفطام .
- أفضل حجم بطن ووزن حصلنا عليه من أمهات الأرانب التى تغذت على عليقة أضيف لها 100 مجم زنك / كجم عليقة .
- معدل نفوق الخلفة أنخفض معنويا بأضافة الزنك للعليقة .
- محصول لبن الأمهات تأثر معنويا بأضافة الزنك للعليقة أثناء فترة الرضاعة .

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