

**STUDY ON PRODUCTIVE PERFORMANCE,  
HEMATOLOGICAL AND IMMUNOLOGICAL  
PARAMETERS IN A LOCAL STRAIN OF CHICKEN AS  
AFFECTED BY MANNAN OLIGOSACCHARIDE UNDER  
HOT CLIMATE CONDITIONS**

By

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**ABSTRACT:** *The experiment was conducted to study productive performance, hematological and immunological parameters in a local strain of chicken as affected by mannan under hot climate conditions. A total of 200 females and 40 males of Mandarah chickens at 20 weeks of age were randomly assigned in individual cages at four equal groups (50 females and 10 males in each group). Females and males were fed on a basal diets supplemented with 0.0, 0.05, 0.1 or 0.2% mannan oligosaccharide (MOS) for 12 weeks during the summer season. Supplementation of 0.2 % MOS in laying hens diet caused a significant ( $P \leq 0.05$ ) increase in body weight. Egg production percentage was significantly increased ( $P \leq 0.05$ ) with the different levels of MOS supplementations, whereas, feed intake and egg weight were not significantly affected. Moreover, in cocks, body weight and feed intake were higher ( $P \leq 0.05$ ) in treated groups compared with the control group. Egg quality was not affected by MOS inclusion in the diet except egg shell thickness was significantly ( $P \leq 0.05$ ) increased compared with the control group. Ejaculate volume, advanced motility (%) and alive sperm (%) were significantly ( $P \leq 0.05$ ) increased by addition of different levels of MOS in the diet, whereas, medium and high levels of MOS were significantly ( $P \leq 0.05$ ) increased sperm concentration compared with the other groups. Also, fertility and hatchability percentages were significantly ( $P \leq 0.05$ ) increased by MOS supplementation. Levels of hemoglobin, RBC`s, WBC`s, serum total protein, albumin, globulin and calcium concentrations were higher ( $P \leq 0.05$ ) in treated hens. While, serum GOT and GPT were not influenced by dietary treatment. Addition of MOS at 0.1 and 0.2 % in cocks diet caused significant increase ( $P \leq 0.05$ ) in hemoglobin, RBC`s and WBC`s compared with those in the other groups. In Mandarah chickens, antibody responses against infectious bursal disease virus (IBDV), serum IgG, IgM and IgA*

were increased ( $P \leq 0.05$ ) in MOS treated groups compared with the control group. Relative weight of spleen was significantly ( $P \leq 0.05$ ) increased for hens fed high level (0.2%) of MOS, while, this increase was observed in males fed medium and high levels of MOS compared with other groups. Furthermore, relative weight of thymus gland was increased ( $P \leq 0.05$ ) in the MOS groups in Mandarrah chickens. Whereas, no significant effect was observed in relative weights of testes and ovary in all groups.

*In conclusion MOS supplementation in the diets could improve productive performance, hematological and immunological parameters in Mandarrah local chickens during summer season.*

## INTRODUCTION

The harmful effects of high temperature on the performance of laying hens have been well studied. Feed intake (**Marsden and Morris, 1987**), egg production, egg weight, and shell quality (**Deaton *et al.*, 1981**) are decreased in heat-stressed birds. High environmental temperature has not only an adverse effect on laying performance but also can impede disease resistance. Environmental stress may depress the immune function of birds by impeding production of antibodies and effective cell-mediated immunity (**Zulkifli *et al.*, 1994**). The phagocytic potential of chicken macrophages is decreased during heat exposure (**Miller and Qureshi, 1992**). **Guo *et al.* (1998)** reported that high temperature resulted in restraint of the development of immune organs of broilers. In addition, research has shown that body temperature increases and semen quality is depressed in heat-stressed broiler breeders (**McDaniel *et al.*, 1995, 1996**). Moreover, **Karaca *et al.* (2002)** found that males with good semen quality prior to being heat stressed were more dramatically affected by high ambient temperature than those with poor semen quality.

The dietary characteristics (level of nutrients or the type of ingredients) can modulate the susceptibility of birds to infectious challenges (**Klasing, 1988**). It is not known if the harmful effect of heat stress on the immune function of birds can be overcome by nutritional methods. Mannan oligosaccharides (MOS) have been shown to have a positive effect on immune response in several species. Mannan oligosaccharides are indigestible complex polysaccharide molecules derived from the outer cell wall of yeast. Some previous researches proved that prebiotic product, which includes fructooligosaccharide, galactooligosaccharide and mannan oligosaccharides are thought to have beneficial effects, such as combat against intestinal pathogen germs in birds, through the immune response modulation and through the improvement of the intestinal mucosae

structural integrity (**Spring, 1999; Spring et al., 2000**). Results of many trials indicated that MOS can be one of the best alternatives to antibiotic growth promoters (**Hooge, 2003**), and even trace amounts of MOS (0.1%-0.4%) added to a ration were quite effective in increasing the health status and production of poultry (**Savage and Zakrzewska, 1997**).

Supplementation of poultry diets with MOS improved production in terms of body weight gain and feed conversion (**Parks et al, 2001**), partly due to its hypothesized nutrient sparing effect but primarily due to its influence on nutrient utilization in the gastrointestinal tract (**Savage et al., 1997; Sonmez and Eren, 1999**). In addition, previous reports suggest that MOS supplementation resulted in significant improvement in antibody responses in broiler and layers (**Raju and Devegowda, 2002; Cotter et al., 2000**). Furthermore, researchers have noticed an improvement in sperm density, antibody titers and all the production traits excluding egg production in broiler breeders which supplemented with MOS in the diets (**Shashidhara and Devegowda, 2003**). Therefore, the objective of our study was to investigate the effects of adding graded levels of MOS to the diets on productive and reproductive performance, hematological and immunological parameters in Mandarah local strain of chicken under hot climate conditions.

## MATERIALS AND METHODS

The experimental work of the present study was carried out at El-Sabahia Poultry Research Station (Alexandria), Animal production Research Institute, Agricultural Research Center, Ministry of Agriculture. Two hundred females and forty males from Mandarah local strain chickens at 20 weeks of age were used and housed individually in single cages in an open system house at four equal experimental groups (50 females and 10 males in each group). Birds were fed a basal diet of layers (Table 1) or basal diets supplemented with 0.05, 0.1 or 0.2 % mannan oligosaccharide during the experimental period (12 weeks). Mannan oligosaccharides are commercially available as BioMos®, a nutritional supplement manufactured by Alltech, Inc. (Nicholasville, KY). Diets and fresh water were provided *ad libitum*. The experiment was conducted from June to August 2008. During the experiment, house temperature and relative humidity (RH) were measured four times a day. The mean value of temperature and RH during that period in the house was  $35 \pm 3^{\circ}\text{C}$  and  $55 \pm 5$ , respectively.

Body weights of females and males were individually recorded at the beginning and at the end of the experimental period (32 wk of age). Feed

intake was measured weekly. Egg number and egg weights were recorded daily and egg production (%) was calculated.

At 26 weeks of age all birds were immunized using killed infectious bursal disease viruses (IBDV) after 6 wk of treatment. Four weeks after vaccination (30 wk of age), blood samples were collected in nonheparinized tubes from 20 birds (10 females and 10 males) in each treatment from the brachial vein. Serum was separated and stored at  $-20^{\circ}\text{C}$ . Individual serum samples were analyzed for antibody responses against IBDV, IgG, IgM and IgA by ELISA technique using commercial kits.

At 30 weeks of age, cockerels were massaged and semen was collected to determine some semen physical properties such as ejaculate volume (ml), advanced motility (%), alive sperm (%) and sperm concentration ( $10^6 / \text{mm}^3$ ). At 31 wk of age, laying hens were inseminated once every three days with 0.05 mL undiluted semen from cocks that received same treatment diets. At 32 wk of age, eggs were collected and numbered daily for one week and then placed in an incubator. On the 18<sup>th</sup> day of incubation, the eggs were transilluminated in order to test fertility percentage and then removed according to the groups to the hatcher, for hatchability percentage estimation.

At 32 weeks of age, ten eggs were randomly taken from each group for egg quality measurements [yolk (%), albumen (%), shell (%), Haugh units, yolk index, shape index and shell thickness (mm)]. At the end of the experiment, blood samples were obtained in heparinized tubes from the brachial vein of randomly ten birds (5 females and 5 males) in each group. Hemoglobin concentration (Hb), red blood cells (RBC`s) count and white blood cells (WBC`s) count were determined. Another five blood samples from females were centrifuged at 3000 rpm for 15 minutes to separate clear serum which was stored at  $-20^{\circ}\text{C}$ . Females serum samples were used to determine total protein (TP), albumin, calcium, glutamic oxaloacetic transaminase (GOT) and glutamic pyruvic transaminase (GPT) concentrations by spectrophotometer using available commercial Kits produced by Sentinel, Italy. Also, globulin was calculated in serum of the same samples. At the age of 32 weeks, 5 random birds from each of females and males in each group were slaughtered. The relative weights of ovary, testes, spleen and thymus were calculated as percentages of body weight.

Data were analyzed using the SAS general linear model procedure (SAS, 1996). Mean values were compared using Duncan multiple rang test (Duncan, 1955).

## RESULTS AND DISCUSSION

### Body weight, feed intake and egg production traits

No significant effect on initial body weight was observed while; final body weight of Mandarah chickens at the age of 32 wk was significantly influenced by MOS addition to the diets (Table 2). The MOS supplementation at 0.2% in laying hen diets significantly ( $P \leq 0.05$ ) increased body weight compared with other groups. Whereas, all experimental levels of MOS significantly ( $P \leq 0.05$ ) increased body weight in males compared with the control group. Also, MOS supplementation had no significant effect on feed intake in laying hens. Generally, there were some numerical increases in feed intake with increase of MOS supplementation in laying hen diets. Whereas, feed intake was significantly ( $P \leq 0.05$ ) increased in male chickens fed the different levels of MOS compared with the control group. Similar results were obtained by **Chukwu and Stanley (1997)** who indicated that the MOS and *Saccharomyces cervisine* added singly and combined at 0.05 / kg of feed to White Leghorn laying hens at ambient temperatures ranging from 23 to 32 C° significantly improved body weight compared with the control group. **Berry and Lui (2000)** reported that broiler breeder hens at 65 wk of age receiving (1lb/ ton) Bio- Mos had significantly greater final body weight than the control group. **Zdunczyk et al., (2005)** found that the body weight of turkeys at the age of 16 wk was significantly influenced by MOS addition to the diets. The heaviest turkeys were those fed 0.2 % MOS in the diet. **Kumprecht and Zobac (1997)** reported that the inclusion of Bio-MOS in broiler finisher diets resulted in a significant improvement in BW. While, **Hulet and Cravener (2005)** showed no significant differences in feed intake of turkeys fed diets supplemented with MOS.

Generally, **Hooge (2003)** explained the mode of MOS action by which broiler or turkey performance could be improved. The adsorption of pathogenic bacteria containing type 1 fimbriae via a receptor analog mechanism (strongly binding to, and decoying pathogens away from, the sugar coated intestinal lining) or via agglutination of MOS by different bacterial strains (**Spring et al., 2000**) could improve intestinal function or gut health (e.g., increased villi height, uniformity, and integrity) **Loddi et al., 2002**.

Addition of MOS in laying hen diets had a significant effect on egg production percentage during the experimental period (Table 2). Moreover, MOS at 0.05, 0.1 or 0.2% in laying hen diets caused a significant ( $P \leq 0.05$ ) increase in egg production percentage by 31.26, 35.05 and 45.11 %

respectively, compared with the control group. Whereas, MOS supplementation in laying hen diets had no significant effect on egg weight during the experimental period (12 wk). These results are in agreement with those reported by **Chukwu and Stanely (1997)** who indicated that supplementation of MOS and *Saccharomyces cerevisiae* at 0.05 / kg of feed as singly or combined to White Leghorn laying hens at ambient temperatures ranging from 23 to 32 C° caused increase in egg production percentage without decreasing egg weight. **Hanan and Mona (2007)** showed that adding of 0.1 % MOS in diets of laying hens improved egg production percentage and egg weight. **Guerrero (1995)** and **Berry and Lui (2000)** reported considerable improvement in egg production in the MOS-fed birds. **Stanley *et al.* (2000)** found that MOS supplementation in Leghorn laying hen diets at 0.05% from 20 to 35 wk of age improved egg production percentage and egg weight.

### **Egg quality**

No significant differences were observed in egg yolk %, egg albumen%, egg shell % , Haugh unit, yolk index and egg shape index of eggs produced by hens fed diets contained different levels of MOS compared with those of hens fed a basal diet. While, MOS supplementation in laying hen diets significantly increased ( $P \leq 0.05$ ) shell thickness compared with the control group under high environmental temperature (Table 3).The increase in egg shell thickness under high environmental temperature for groups fed MOS supplementation in the diet in the present study could be due to the increase of serum calcium concentration as shown in Table 7. The results obtained in the present study are in agreement with the finding published by **Berry and Lui (2000)** and **Shashidhara and Devegowda (2003)** who reported that MOS improved egg shell quality traits in older breeder females and that it could be due to the improvement in calcium availability. Also, **Cristina (2009)** reported that MOS improved eggshell quality in laying hens by improving intestinal  $Ca^{2+}$  absorption rate. The better results obtained for the eggshell quality parameters could due to the prebiotic influence on the metabolic activity of the beneficial bacteria colony in layers intestine, which positively influenced mineral absorption rate, especially those of  $Ca^{2+}$  and  $Mg^{2+}$  (**Roberfroid *et al.*, 2000**).

### **Semen physical properties**

Results in Table 4 indicates that ejaculate volume (ml), advanced motility (%) and a live sperm (%) were significantly ( $P \leq 0.05$ ) increased for MOS treated groups compared with the control group. Moreover, sperm concentration ( $10^6 /mm^3$ ) was significantly ( $P \leq 0.05$ ) increased with 0.1 and

0.2% MOS treatments compared with other groups. The results of semen quality are in agreement with a previous report by **Mc- Daniel (1991)** who indicated that sperm concentration had improved for breeders fed diets supplemented with yeast culture. The observed improvement in sperm concentration in the MOS-fed males might have been due to enhanced availability of nutrients facilitated by more efficient nutrient absorption at the level of the gastrointestinal tract. Furthermore, several workers have reported higher antioxidant activity in chickens and piglets fed MOS-supplemented diets (**Zhou et al., 1999**). From this perspective, a key aspect that should be deliberated upon is possible improvement in the activity of antioxidants such as glutathione peroxidase and superoxide desmutase in MOS-fed birds and its importance in spermatozoa production and maturation (**Shashidhara and Devegowda, 2003**). High levels of glutathione peroxidase are found in the testes, and it acts as a powerful antioxidant in the developing spermatids and spermatozoa (**Ursini et al., 1999**). Spermatozoa are subject to the damaging effects of high concentrations of peroxides in testes, semen, and uterovaginal sperm host glands (**Lenzi et al., 2000; Surai et al., 2001**).

In organs such as testes that have high metabolic rates, levels of antioxidants required to ensure survival of spermatozoa in those aerobic environments are high. Thus, high semen quality recorded in MOS-fed males in this study may be due to its influence on the antioxidant activity.

#### **Fertility and hatchability traits**

Significant effects of MOS treatment on fertility and hatchability percentages are shown in Table 5. Fertility percentages were significantly ( $P \leq 0.05$ ) higher in MOS treated groups than the control group. An increase of fertile eggs in MOS treated groups could be due to significant increase of ejaculate volume, advanced motility, a live sperm and sperm concentration compared with those in the control group. Also, hatchability percentages significantly ( $P \leq 0.05$ ) higher in MOS groups compared to the control group. Such increase may depend on egg shell thickness improvement in most treated groups compared with the control group. These results approach with those reported by **Brillard and Antoine (1990)** who indicated that the number of spermatozoa in the perivitelline membrane of eggs was found to be dependent on the quantities of spermatozoa inseminated, and a highly significant correlation was observed between the perivitelline spermatozoa and the proportion of uterovaginal sperm storage tubules containing spermatozoa. Several workers have recorded similar correlation between fertility, sperm-egg penetration, sperm density in storage tubules in the oviduct, and quantity of sperm inseminated (**Eslick**

and **McDaniel, 1992; McDaniel *et al.*, 1995**). Generally, the results obtained from the present study are in agreement with that of **Shashidhara and Devegowda (2003)** who reported that the MOS influences fertility and hatchability in older breeder female by improving egg shell quality and sperm production in male breeders.

#### **Blood hematological and biochemical parameters in laying hens**

Results of blood hematological parameters for females and males are presented in Table 6. Means of Hb, RBC's and WBC's were significantly ( $P \leq 0.05$ ) increased in hens fed experimented levels of MOS supplementation compared with the control group. While, means of Hb, RBC's and WBC's were significantly ( $P \leq 0.05$ ) increased for cocks fed 0.1 and 0.2 % MOS supplementation compared with the control group. **Onifade (1997)** reported a positive correlation between dietary levels of *Saccharomyces cerevisiae* with the haematological indices like, RBC, WBC and PCV in broiler chickens and he suggested that these correlations may be an additional mechanism growth promotion by supplemental yeast.

Hens fed diets supplemented with MOS significantly ( $P \leq 0.05$ ) increased serum total protein, albumin, globulin and calcium concentrations comparing to those in the hens fed a basal diet (Table 7). Results show that addition of MOS to laying hen diets could improve synthesis of total protein, albumin, globulin and calcium concentrations in blood during summer season. Elevation of these traits in blood serum as a result of MOS supplementation in laying hen diets agree with those reported by **Hanan and Mona (2007)** who showed that adding of 0.1 MOS in the diets of laying hens caused significant increases in serum total protein and albumin concentration compared with the hens fed a basal diets. **Ghosh *et al.*, (2008)** showed that MOS supplementation in Japanese quails diets increased plasma calcium concentration.

Addition of different concentrations of MOS had not any significant effect on serum GOT and GPT concentration in hens (Table 7). These results are in agreement with those reported by **Stanley *et al.*, (1997)** and **Sarica *et al.*, (2005)** who mentioned that the addition of MOS in laying hens and broiler chicken diets did not significantly affect blood GOT and GPT concentrations. Whereas, **Yalcinkaya *et al.*, (2008)** indicated that blood GOT and GPT levels were decreased in response to addition of MOS in broiler chicken diets, whereas, MOS reduced both of those enzymes to the range of normal levels, which represent the nonpathological metabolism of the liver and heart.

### **Immunity responses**

Results presented in Table 8 showed higher significant antibody responses against infectious bursal disease virus (IBDV) in chickens at 30 weeks of age fed MOS compared to those in the control group. These results are in agreement with those obtained by **Shashidhara and Devegowda (2003)** who observed that the antibody response to infectious bursa disease virus (IBDV) was higher by MOS supplementation to broiler breeder diets, this effect on antibody titers may be due to the influence of the MOS on immune system and / or improved intestinal absorption of some related nutrients, such as Zn, Cu, Se. In addition to the reduction of the pathogenic bacteria load in the intestine and preventing the acute immune response against such bacteria (**Finucane et al., 1999 and Spring et al., 2000**). Moreover, **Ferket et al., (2002)** showed that immune modulation could also be improved by stimulating gut-associated and systemic immunity as a non pathogenic antigen, providing an adjuvant like effect.

On the other hand, MOS supplementations at 0.05, 0.1 and 0.2 % in chicken diets at 32 weeks of age caused significant increases serum IgG, IgM and IgA levels compared with those in the control group (Table 8). These results are in agreement with those obtained by **Cotter et al., (2000)** who reported that including MOS at 0.05, 0.1 or 0.2 Kg/ton in turkey diets caused elevated plasma IgG and IgA levels. **Cetin et al., (2005)** found that addition of MOS in poults diet resulted in significant increases in the serum IgG and IgM levels compared with those in control group.

In previous studies, MOS has been shown to have a positive influence on humoral immunity and immunoglobulin status. **Savage et al., (1996)** reported an increase in plasma IgG and bile IgA in male turkey fed diets supplemented with 0.11% MOS. An increase in antibody response to MOS would be expected because of the ability of the innate immune system to react to foreign antigenic material of microbial origin. Portions of the cell wall structure of the yeast organism, *Saccharomyces* contained in MOS has been shown to elicit powerful antigenic properties (**Ballou, 1970**).

### **Some organ weights**

Results presented in Table 9 indicated that feeding diet supplemented with different levels of MOS had no significant effect on relative weights of ovary and testes of Mandarrah chickens. Moreover, there were some numerical increase in these traits with the increase of MOS levels in the chicken diets. This increase could be reflected on egg production increase in laying hens, semen quality and semen production in cocks fed MOS compared with the control group during summer season.

Also, relative weight of spleen significantly ( $P \leq 0.05$ ) increased for hens fed high level of MOS (0.2%) while, this increase was observed in males fed medium and high levels of MOS supplementation compared with other groups. Moreover, relative weight of thymus gland was significantly affected with all levels of MOS supplementation in chicken diets. Relative weight of thymus gland was significantly ( $P \leq 0.05$ ) increased with increasing MOS supplementation level in chicken diets except the medium and high levels of MOS had the same effect in females. Therefore, MOS supplementations in chicken diets could improve physiological function of lymphoid organs. Consequently, relative weights of spleen and thymus gland were increased.

Results of the current research revealed that supplementation of MOS to the diet have a positive effect on the performance especially egg production, shell thickness, semen quality, fertility, hatchability, hematological parameters and immune response in Mandarah local chickens under hot climate conditions.

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**Table 1:** Composition and calculated analysis of basal diet.

Ingredients	%
Yellow corn	64.00
Soybean meal 44%	24.78
Wheat bran	1.00
Di-calcium phosphate	1.61
Limestone	7.91
DL-Methionine	0.10
Sodium chloride	0.30
Vit. & Min. Mixture*	0.30
<b>Total</b>	<b>100.00</b>
<b>Calculated analysis:</b>	
Metabolizable energy (Kcal/Kg)	2718.00
Crude protein %	16.02
Crude fiber %	3.46
Crude fat %	2.96
Calcium %	3.34
Available phosphorous %	0.42
Lysine %	0.89
Methionine %	0.39
Met+cystine %	0.66

\*Supplied per kg diet: Vit A, 10000IU; Vit D<sub>3</sub>, 2000 IU; Vit E, 10 mg; Vit K<sub>3</sub>, 1 mg; Vit B<sub>1</sub>, 1 mg; Vit B<sub>2</sub>, 5mg; Vit B<sub>6</sub>, 1.5 mg; Vit B<sub>12</sub>, 10 mcg; Niacin, 30 mg; Pantothenic acid, 10 mg; Folic acid, 1 mg; Biotin, 50mcg; Choline, 260 mg; Copper, 4 mg; Iron, 30 mg; manganese, 60 mg; Zinc, 50 mg; Iodine, 1.3 mg; Selenium, 0.15mg; Cobalt, 0.1mg.

**Table 2: Body weight, feed intake and egg production traits of Mandarrah chickens fed diets supplemented with mannan oligosaccharide (MOS) during the experimental period (Means ± SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
<b>Females:</b> =====				
Initial body weight (g)	1345.2±30.1	1346.0±25.5	1340.5±27.8	1343.3±29.9
Final body weight (g)	1475.8± 41.5 <sup>b</sup>	1536.0±41.5 <sup>b</sup>	1546.9±36.8 <sup>b</sup>	1656.0±27.6 <sup>a</sup>
Feed intake (g/ hen / day)	100.1±1.20	105.11±1.45	108.90±1.88	109.32±1.53
Egg production (%)	45.33±1.39 <sup>c</sup>	59.5±1.43 <sup>b</sup>	61.72±1.60 <sup>b</sup>	65.78±1.43 <sup>a</sup>
Egg weight (g)	44.36±0.70	45.84±0.58	45.62±0.62	46.10±1.31
<b>Males:</b> =====				
Initial body weight (g)	1647.8±36.4	1648.9±37.5	1645.9±40.1	1644.9±35.9
Final body weight (g)	1949.4±49.3 <sup>b</sup>	2189.4±41.8 <sup>a</sup>	2232.5±66.0 <sup>a</sup>	2312.5±66.7 <sup>a</sup>
Feed intake (g/ cock / day)	107.56±0.95 <sup>b</sup>	117.51±1.77 <sup>a</sup>	119.78±1.62 <sup>a</sup>	118.63±3.25 <sup>a</sup>

a,b,c = Means having different letters exponents within each row are significantly different at P≤0.05.

**Table 3: Some egg quality characteristics at 32 weeks of age of Mandarah laying hens fed diets supplemented with mannan oligosaccharide (MOS) (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
Egg yolk (%)	30.32 $\pm$ 0.48	30.02 $\pm$ 0.82	30.47 $\pm$ 0.57	28.93 $\pm$ 0.80
Egg albumen (%)	56.25 $\pm$ 0.60	55.26 $\pm$ 1.44	55.24 $\pm$ 0.66	57.24 $\pm$ 1.28
Egg shell (%)	13.53 $\pm$ 0.30	14.72 $\pm$ 0.84	14.28 $\pm$ 0.46	13.83 $\pm$ 0.52
Haugh unit	78.75 $\pm$ 2.96	78.54 $\pm$ 2.52	79.54 $\pm$ 2.38	82.18 $\pm$ 4.92
Yolk index	48.6 $\pm$ 0.17	46.0 $\pm$ 0.24	49.6 $\pm$ 0.16	53.0 $\pm$ 0.20
Egg shape index	74.55 $\pm$ 0.52	75.98 $\pm$ 0.69	74.87 $\pm$ 1.22	75.90 $\pm$ 1.07
Shell thickness (mm)	0.334 $\pm$ 0.005 <sup>b</sup>	0.392 $\pm$ 0.018 <sup>a</sup>	0.396 $\pm$ 0.007 <sup>a</sup>	0.404 $\pm$ 0.005 <sup>a</sup>

a,b = Means having different letters exponents within each row are significantly different at  $P \leq 0.05$ .

**Table 4: Some semen physical properties at 30 weeks of age of Mandarah cocks fed diets supplemented with mannan oligosaccharide (MOS) (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
Ejaculate volume (ml)	0.14 $\pm$ 0.031 <sup>c</sup>	0.23 $\pm$ 0.025 <sup>b</sup>	0.35 $\pm$ 0.043 <sup>a</sup>	0.36 $\pm$ 0.032 <sup>a</sup>
Advanced motility (%)	76.88 $\pm$ 0.91 <sup>c</sup>	84.38 $\pm$ 1.48 <sup>b</sup>	88.75 $\pm$ 1.25 <sup>a</sup>	90.63 $\pm$ 1.48 <sup>a</sup>
Alive sperm (%)	81.25 $\pm$ 1.31 <sup>c</sup>	88.25 $\pm$ 0.96 <sup>b</sup>	90.50 $\pm$ 0.42 <sup>b</sup>	94.25 $\pm$ 0.45 <sup>a</sup>
Sperm concentration ( $10^6/\text{mm}^3$ )	1.78 $\pm$ 0.09 <sup>b</sup>	2.65 $\pm$ 0.19 <sup>b</sup>	3.89 $\pm$ 0.43 <sup>a</sup>	4.25 $\pm$ 0.25 <sup>a</sup>

a,b,c = Means having different letters exponents within each row are significantly different at  $P \leq 0.05$ .

**Table 5: Fertility and hatchability percentages at 32 weeks of age of Mandarah chickens fed diets supplemented with mannan oligosaccharide (MOS) (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
Fertility (%)	87.13 $\pm$ 1.49 <sup>c</sup>	91.13 $\pm$ 0.58 <sup>b</sup>	94.30 $\pm$ 0.55 <sup>a</sup>	95.00 $\pm$ 0.32 <sup>a</sup>
Hatchability of fertile eggs (%)	84.43 $\pm$ 0.69 <sup>c</sup>	88.63 $\pm$ 1.15 <sup>b</sup>	90.22 $\pm$ 0.84 <sup>ab</sup>	91.50 $\pm$ 0.55 <sup>a</sup>

a,b,c = Means having different letters exponents within each row are significantly different at  $P \leq 0.05$ .

**Table 6: Hematological parameters at 32 weeks of age of Mandarah chickens fed diets supplemented with mannan oligosaccharide (MOS) (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
<b>Females</b> =====				
Hb(g/dl)	10.18 $\pm$ 0.38 <sup>b</sup>	12.84 $\pm$ 0.64 <sup>a</sup>	12.94 $\pm$ 0.64 <sup>a</sup>	13.42 $\pm$ 0.73 <sup>a</sup>
RBC's (10 <sup>6</sup> )	2.19 $\pm$ 0.09 <sup>b</sup>	3.63 $\pm$ 0.32 <sup>a</sup>	3.76 $\pm$ 0.26 <sup>a</sup>	3.79 $\pm$ 0.24 <sup>a</sup>
WBC's (10 <sup>3</sup> )	4.76 $\pm$ 0.99 <sup>b</sup>	10.38 $\pm$ 1.18 <sup>a</sup>	10.25 $\pm$ 1.42 <sup>a</sup>	10.98 $\pm$ 1.19 <sup>a</sup>
<b>Males</b> =====				
Hb(g/dl)	10.23 $\pm$ 0.38 <sup>b</sup>	11.80 $\pm$ 0.71 <sup>ab</sup>	12.87 $\pm$ 0.95 <sup>a</sup>	13.57 $\pm$ 0.41 <sup>a</sup>
RBC's (10 <sup>6</sup> )	2.40 $\pm$ 0.39 <sup>b</sup>	3.53 $\pm$ 0.39 <sup>ab</sup>	3.98 $\pm$ 0.52 <sup>a</sup>	3.83 $\pm$ 0.19 <sup>a</sup>
WBC's (10 <sup>3</sup> )	6.88 $\pm$ 0.62 <sup>b</sup>	6.82 $\pm$ 0.35 <sup>b</sup>	12.50 $\pm$ 1.15 <sup>a</sup>	10.13 $\pm$ 0.90 <sup>a</sup>

a,b = Means having different letters exponents within each row are significantly different at P  $\leq$  0.05.

**Table 7: Biochemical parameters at 32 weeks of age of Mandarah laying hens fed diets supplemented with mannan oligosaccharide (MOS) (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
Total protein (g/dl)	3.77 $\pm$ 0.54 <sup>b</sup>	6.97 $\pm$ 0.44 <sup>a</sup>	6.57 $\pm$ 0.53 <sup>a</sup>	6.48 $\pm$ 0.57 <sup>a</sup>
Albumin (g/dl)	1.52 $\pm$ 0.12 <sup>b</sup>	2.60 $\pm$ 0.24 <sup>a</sup>	2.37 $\pm$ 0.14 <sup>a</sup>	2.28 $\pm$ 0.13 <sup>a</sup>
Globulin (g/dl)	2.25 $\pm$ 0.18 <sup>b</sup>	4.37 $\pm$ 0.79 <sup>a</sup>	3.77 $\pm$ 0.52 <sup>a</sup>	4.20 $\pm$ 0.12 <sup>a</sup>
Calcium (mg/dl)	10.78 $\pm$ 0.91 <sup>b</sup>	15.30 $\pm$ 0.66 <sup>a</sup>	16.24 $\pm$ 0.40 <sup>a</sup>	17.10 $\pm$ 0.99 <sup>a</sup>
GOT (U/L)	34.00 $\pm$ 0.40	34.45 $\pm$ 0.35	33.85 $\pm$ 0.26	35.10 $\pm$ 0.38
GPT (U/L)	16.89 $\pm$ 1.44	17.70 $\pm$ 2.71	17.77 $\pm$ 1.71	16.80 $\pm$ 2.20

a,b = Means having different letters exponents within each row are significantly different at P  $\leq$  0.05.

**Table 8: Effect of mannan oligosaccharide (MOS) on infectious bursal disease virus antibody titers (IBDVAb), serum IgG, IgM and IgA of Mandarah chickens at 30 weeks of age (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
<b>Females</b> =====				
IBDVAb	7818 $\pm$ 115 <sup>c</sup>	11357 $\pm$ 67 <sup>b</sup>	11420 $\pm$ 78 <sup>b</sup>	14193 $\pm$ 112 <sup>a</sup>
IgG	337.96 $\pm$ 18.46 <sup>b</sup>	440.38 $\pm$ 17.37 <sup>a</sup>	460.12 $\pm$ 20.47 <sup>a</sup>	463.26 $\pm$ 20.16 <sup>a</sup>
IgM	229.34 $\pm$ 19.89 <sup>b</sup>	315.82 $\pm$ 5.93 <sup>a</sup>	319.32 $\pm$ 8.90 <sup>a</sup>	336.22 $\pm$ 18.03 <sup>a</sup>
IgA	122.66 $\pm$ 7.09 <sup>c</sup>	185.20 $\pm$ 2.59 <sup>b</sup>	196.04 $\pm$ 3.80 <sup>a</sup>	199.58 $\pm$ 4.11 <sup>a</sup>
<b>Males</b> =====				
IBDVAb	9520 $\pm$ 60 <sup>b</sup>	7652 $\pm$ 126 <sup>a</sup>	9938 $\pm$ 88 <sup>a</sup>	9763 $\pm$ 75 <sup>a</sup>
IgG	398.23 $\pm$ 4.50 <sup>c</sup>	430.43 $\pm$ 11.75 <sup>b</sup>	497.23 $\pm$ 7.34 <sup>a</sup>	499.1 $\pm$ 9.64 <sup>a</sup>
IgM	254.19 $\pm$ 26.50 <sup>b</sup>	316.03 $\pm$ 8.46 <sup>a</sup>	333.13 $\pm$ 6.97 <sup>a</sup>	347.07 $\pm$ 7.12 <sup>a</sup>
IgA	135.30 $\pm$ 2.94 <sup>b</sup>	210.51 $\pm$ 5.84 <sup>a</sup>	216.63 $\pm$ 5.04 <sup>a</sup>	218.30 $\pm$ 9.94 <sup>a</sup>

a,b,c = Means having different letters exponents within each row are significantly different at P  $\leq$  0.05.

**Table 9: Relative weight of some organs at 32 weeks of age in Mandarrah chickens fed diets supplemented with mannan oligosaccharide (MOS) (Means  $\pm$  SE).**

Items	control	MOS 0.05%	MOS 0.1%	MOS 0.2%
Females =====				
Relative weight (%)				
Ovary	0.250 $\pm$ 0.03	0.261 $\pm$ 0.05	0.279 $\pm$ 0.03	0.306 $\pm$ 0.03
Spleen	0.112 $\pm$ 0.010 <sup>b</sup>	0.117 $\pm$ 0.022 <sup>b</sup>	0.123 $\pm$ 0.011 <sup>b</sup>	0.161 $\pm$ 0.017 <sup>a</sup>
Thymus	0.028 $\pm$ 0.008 <sup>c</sup>	0.052 $\pm$ 0.004 <sup>b</sup>	0.088 $\pm$ 0.004 <sup>a</sup>	0.089 $\pm$ 0.007 <sup>a</sup>
Males =====				
Relative weight (%)				
Testes	0.405 $\pm$ 0.03	0.445 $\pm$ 0.04	0.467 $\pm$ 0.05	0.509 $\pm$ 0.04
Spleen	0.122 $\pm$ 0.007 <sup>b</sup>	0.133 $\pm$ 0.014 <sup>b</sup>	0.177 $\pm$ 0.009 <sup>a</sup>	0.181 $\pm$ 0.012 <sup>a</sup>
Thymus	0.05 $\pm$ 0.005 <sup>d</sup>	0.098 $\pm$ 0.006 <sup>c</sup>	0.121 $\pm$ 0.007 <sup>b</sup>	0.152 $\pm$ 0.009 <sup>a</sup>

a,b,c,d = Means having different letters exponents within each row are significantly different at  $P \leq 0.05$ .

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### الملخص العربى

## دراسة على الأداء الانتاجى و مقاييس الدم و المناعة فى سلالة محلية من الدجاج نتيجة لأضافة المنان أوليجوسكريد تحت ظروف المناخ الحار

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أجريت هذه التجربة لدراسة الأداء الانتاجى و مقاييس الدم و المناعة فى سلالة محلية من الدجاج كنتيجة لأضافة المنان أوليجوسكريد تحت ظروف المناخ الحار. حيث أستخدم 200 دجاجة و 40 ديك من سلالة المندره المحليه عمر 20 أسبوع وزعت عشوائياً فى أقفاص فردية فى أربعة مجموعات متساوية (50 دجاجة و 10 ديوك فى كل مجموعة) حيث غذيت كل من الاناث و الذكور على العليقة بالمستويات صفر ، 05 ، 1 ، 2 ، % منان لمدة 12 أسبوع خلال فصل الصيف. حيث أدى أضافة المنان أوليجوسكريد فى علف الدجاج البياض بالمستوى 2 ، % إلى زيادة معنوية فى وزن الجسم بينما أدى أضافة المنان أوليجوسكريد بالمستويات المختلفه إلى زيادة معنوية للنسبة المنوية لانتاج البيض دون تأثير على الغذاء المستهلك ووزن البيضة . كما وجد زيادة معنوية فى وزن الجسم و الغذاء المستهلك للمجموعات المعاملة من الديوك. وأضافة المنان أوليجوسكريد إلى العلف لم تؤثر على صفات جودة البيض بأستثناء سمك القشرة حيث ازداد معنوياً فى المجموعات المعاملة مقارنة بمجموعة الكنترول. كما أدى أضافة المستويات المختلفه من المنان أوليجوسكريد إلى زيادة حجم القذفة و الحركة التقدمية و عدد الحيوانات المنوية الحية معنوياً بينما تركيز الحيوانات المنوية أزداد معنوية بأضافة المستوى المتوسط و العالى من المنان أوليجوسكريد مقارنة بمجموعة الكنترول. و وجد أن أضافة المنان أوليجوسكريد أدت إلى زيادة معنوية للنسبة المنوية للخصوبة و الفقس. فى الاناث البياضة وجد أن تركيز الهيموجلوبين و عدد كرات الدم الحمراء و البياض و تركيز البروتين الكلى و الألبومين و الجلوبيولين و الكالسيوم أزدادت معنوياً بينما لم يتأثر كل من أنزيم GOT, GPT فى المعاملات. كما أدى أضافة المنان أوليجوسكريد بالمستويات 1 ، 2 ، % فى علف الديوك إلى زيادة معنوية فى تركيز الهيموجلوبين و كرات الدم الحمراء و البياض مقارنة بالمجموعات الأخرى. كما وجد زيادة معنوية لاستجابة الأجسام المضادة للتحصين بمرض الجمورو و مستوى IgG, IgM, IgA فى المجموعات المعاملة مقارنة بمجموعة الكنترول. كما وجد زيادة معنوية للوزن النسبى للطحال للاناث البياضة المغذاه على المستوى 2 ، % من المنان أوليجوسكريد بينما لوحظ أن المستوى المتوسط أو العالى أدى إلى زيادة معنوية فى الوزن النسبى للطحال فى الذكور مقارنة بالمجموعات الأخرى. كما وجد زيادة معنوية للوزن النسبى للغدة التيموسية فى المجموعات المعاملة فى دجاج المندره فى حين لم يلاحظ أى تأثير معنوى على الأوزان النسبية للخصية و المبيض فى كل المجموعات.

و بذلك توضح هذه النتائج أن أضافة المنان أوليجوسكريد فى العلائق يحسن الأداء الانتاجى و مقاييس الدم و المناعة فى دجاج المندره المحلى خلال فصل الصيف.