# RESPONSE OF JAPANESE QUAILS (*COTURNIX JAPONICA*) TO DIETARY SUPPLEMENTATION OF DIFFERENT LEVELS OF MANNAN OLIGOSACCHARIDE AS A GROWTH PROMOTER.

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## SUMMARY

The effect of different levels of the dietary supplementation of mannan oligosaccharide (MOS) on growth performance, carcass characteristics and on some blood metabolites of growing Japanese quails (*Coturnix japonica*) was the main objective in this experimentation. A total of one hundred 1-day-old Japanese quails were randomly divided into 4 experimental groups (25birds/treatment) with 3 replicates of 8 birds per replicate, one replicate in each group contain 9 birds. The experimental design consisted of 4 dietary treatments: 1) a control basal diet without supplementation; 2) a basal diet with a MOS at level of 1 g/kg feed (low MOS); 3) a diet with MOS at a level of 3 g/kg feed (medium MOS) 4) a diet with a MOS at a level of 5 g/kg feed (high MOS). The experiment was terminated when birds were 6 weeks old. The data revealed that, birds fed diets contain medium MOS level (3 g MOS/kg feed) recorded significant improvements in body weight and weight gain, feed conversion efficiency, performance index, energy and protein efficiency compared with those fed the control, low and high MOS diet during grower and overall periods ($P < 0.05$). Medium MOS supplementation increased also the dressing percentage, edible giblets and decreased offal's percentages and carcass abdominal fat efficiently in comparison with those of other MOS levels and control group. Growth performance was optimized at 3 g MOS/ kg diet in the present study, however high dosage of MOS can have negative effects and retard the growth rate of birds. The triglyceride, total cholesterol and total lipids concentrations in quails blood decreased significantly in concomitant with a significant decrease in carcass fat % as a response to dietary supplementation with MOS. Based on the available information, it can be concluded that the responses of Japanese quails to MOS supplementation are influenced by the level of supplementation. Therefore, this factor need to be carefully considered in order to obtain maximal growth-promoting effects of MOS in Japanese quails production.

***Keywords:*** *mannan oligosaccharide, growth performance, carcass characteristics, blood metabolites, Japanese quails.*

## INTRODUCTION

Currently, many parts of the world are experimenting alternative feed additives that may be used to alleviate the problems associated with the withdrawal of antibiotics from feed. Alternatives to antibiotics including enzymes, organic acids, probiotics, prebiotics, herbs and etheric oils, immunostimulants and other management practices. These alternatives promote gut health by several possible mechanisms including altering gut pH, maintaining protective gut mucus, selecting for beneficial intestinal organisms or against pathogens, enhancing fermentation acids, enhancing nutrient uptake, and increasing the humoral immune response (Inborr, 2000). One of these alternatives is prebiotics. Gibson and Roberfroid (1995) defined a prebiotic as a non-digestible food ingredient which beneficially affects the host by selectively stimulating the growth of and/or activating the metabolism of one or a limited number of health-promoting bacteria in the intestinal tract, thus improving the host's microbial balance. The growth of endogenous microbial population groups such as *bifidobacteria* and *lactobacilli* is specifically stimulated and these bacteria species are perceived as beneficial to animal health.

Prebiotics are polysaccharides and oligosaccharides which cannot be digested effectively by the animal, but are readily fermented by anaerobic, colonic bacteria that are regarded as beneficial (Zhang et al., 2003). Prebiotics have shown promise in controlling pathogens such as *Salmonella* and *Escherichia* *coli* and in stimulating the growth of bifidobacteria and lactobacilli, thus promoting health and performance of animals (Chung and Day, 2004; Xu et al., 2003; Zhang et al., 2003). Some researchers have hinted that prebiotics may have cholesterol-lowering properties (Li et al., 2007; Liong and Shah, 2006). Some positive changes in digestive enzymes, gut morphology, and immune system were noticed in birds given prebiotic-supplemented feed (Xu et al., 2003; Zhang et al., 2003; Huang et al., 2007). However, there are many considerations in supplementing prebiotics in animal feed. These include the type of diet (i.e., the content of non-digestible oligosaccharides); the type and inclusion level of the supplements; the animal characteristics (species, age, stage of production); and the hygiene status of the farm (Verdonk et al., 2005).

Japanese quail (*Coturnix japonica*) is a diversified poultry species reared for commercial egg and meat production. It is blessed with unique characteristics of fast growth, early sexual maturity, high rate of egg production, short generation interval and shorter incubation period that makes is suitable for diversified animal agriculture. The information about the effective level of MOS that optimizing growth and maximize production is lacking.

Therefore, the objective of the present study was to examine the effect of different levels of the dietary supplementation of mannan oligosaccharides (MOS) on growth performance, carcass characteristics and on some blood metabolites of the growing Japanese quail (*Coturnix japonica*).

## MATERIALS AND METHODS

### *Birds and housing*

This study was carried out at the quail production unit, Faculty of Veterinary Medicine, South Valley University, Egypt during the period from May to June 2011. Chemical analyses were performed in the laboratories of Faculty of Veterinary Medicine, Department of Nutrition and Clinical Nutrition, Assiut University, Assiut, Egypt. A total number of 100 one day old Japanese quail chicks were divided equally into four treatments (25 birds each); each treatment was equally subdivided into three replicates of 8 birds /battery cage. Only one replicate had 9 birds. Chicks were individually weighed to the nearest gram at the start of experiment, wing-banded and randomly allotted to the dietary treatments. Chicks were raised in electrically heated batteries with raised wire mesh floors and had a free access to the mach feed and fresh water from nipple drinkers throughout the experiment. Light was provided for 23 h/d. Room temperature on day 0 was 33°C and decreased approximately 3°C per week until 21°C was reached, according to standard poultry rearing practices. Batteries were placed into a room provided with continuous fans for ventilation.

### *Dietary treatments*

The dietary treatments were: 1) a control diet without supplementation; 2) a diet with a prebiotic Y-MOS at level of 1 g/kg feed; 3) a diet with Y-MOS at a level of 3 g/kg feed 4) a diet with a Y-MOS at a level of 5 g/kg feed. Diets were fed in mash form. A commercial prebiotic source Y-Mos® (Nutrex, Belgium) was used in this experimentation, the chemical composition of Y-MOS is presented in Table (1). Composition of the basal experimental diet is presented in Table (2). Coccidiostats or antibiotics were not used during the study. Feed and water were provided *ad libitum*. The birds were fasted for 10-12 h prior to determination of the final body weight at slaughter.

**Table (1). Typical chemical composition (%) of mannan oligosaccharide product (Y-MOS)**

| Ingredients | Y-MOS |
|---|---|
| DM | 95 |
| Protein /DM% | 25 |
| Ash | 6 |
| Polysaccharides | |
| β-Glucanes | 28 |
| Mannan oligosaccharides (MOS) | 28 |

### *Growth Performance Traits*

All birds were weighed individually (initial weight) and every week during the course of the experiment. Feed consumption was recorded in the course of the whole experiment per pen basis, at day

21 and 42 of the experiment and the feed conversion rates were calculated subsequently. Feed conversion ratio was calculated as the amount of feed consumed per unit body weight gain and was adjusted to the weight of chicks at the first day. Mortality was recorded as it occurred.

**Table (2). Composition and nutrient content of basal diets for Japanese quails (%, as fed-basis)**

| Ingredients | % |
|---|---|
| Yellow corn | 55.95 |
| Soybean meal (48) | 39.6 |
| Sunflower oil | 1.00 |
| Dicalcium phosphate | 1 |
| Ground limestone | 1.5 |
| Iodized salt | 0.4 |
| Premix | 0.25 |
| L-lysine | 0.1 |
| DL-methionine | 0.2 |
| Total | 100 |
| Calculated composition | |
| Energy ME kcal /Kg | 2937.16 |
| CP (%) | 24.04 |
| EE (%) | 2.36 |
| CF (%) | 3.22 |
| Ca (%) | 0.91 |
| Av. P (%) | 0.31 |
| Lysine (%) | 1.41 |
| Met.+Cys. (%) | 0.75 |

***Blood Collection and Analysis***

At the end of the study period (day 42), 5 broilers were randomly selected from each group and blood samples were collected from the bronchial vein during slaughter. The collected blood samples were centrifuged at 4000 rpm for 15 min and the sera were decanted into aseptically treated vials and stored at –20 °C until further analysis. Serum samples were analyzed for total protein, albumen, glucose, total cholesterol, total lipid and triglycerides, by spectrophotometer using commercial test kits (Spectrum, Cairo, Egypt).

***Statistical analysis***

The data were subjected to statistical analysis with one way ANOVA of using SPSS program for Windows Version 13; (SPSS GmbH, Munich, Germany) to determine if variables differed between groups. Statistical significant effects were further analyzed, and means were compared using Duncan's multiple range test. Statistical significance was determined at $P$ (< 0.05)

## RESULTS AND DISCUSSION

***Growth Performance***

The effects of the experimental treatments on BWG, FI and FCR, performance index of the quail are presented in Table (3). Growth performance of the Japanese quail was affected by dietary addition of MOS. As shown in Table (3), there were no differences (P >0.05) in the initial BW of chicks between the dietary treatments. The average feed intake was not significant different (p>0.05) among treatments at the first 3 weeks. Medium MOS group showed the highest body weight gain (98.25 g) and performance index (53.4) over other groups. In addition, low MOS group showed better weight gain (94.8) than high MOS group (84.9 g) in the first 3 weeks. The feed conversion was significantly (p < 0.05) improved in medium MOS supplemented group in comparison with low and high MOS supplemented groups at the first 3 weeks. The feed intake at the last 3 weeks was higher (p < 0.05) for birds fed the diet supplemented with high MOS compared with the control group. Furthermore, quails fed diet supplemented with medium MOS had significant increases in body weight gain, performance index and improved feed conversion rate in comparison with other dietary groups in the last 3 weeks (4-6 week). The cumulative feed consumption per quail during the experimental period (0-6 weeks) was significantly higher in both low and high MOS supplanted birds in comparison with the control group, however medium MOS supplemented birds showed an intermediate values. Quails fed diet supplemented with medium MOS had significant increases in the cumulative (from 0 to 6 week) body weight gain, performance index and improved feed conversion rate in comparison with other dietary groups. mortality % was relatively low numerically for birds supplemented with MOS in comparison with control group and ranged from 0.08 % to 0.2 %. Generally, Medium MOS had improved quails performance and feed conversion efficiency in comparison with control, low and high MOS groups during the overall periods ($P < 0.05$). Animals reared under commercial field conditions are subjected to stress, depending on the pathogen load in their environment. Stress is generally accompanied by suppression of body weigh and feed intake, which could be the cause of the decline in production. Probiotics, prebiotics and organic acids have been used in the early period of the bird life to prevent the detrimental effects of stress. The addition of specific mannanoligosaccharide (MOS), derived from the outer cell wall of *Saccharomyces cerevisiae*, to a broiler chicken diet has been reported to improve their growth performance (Hooge, 2004; Rosen, 2007, Yang et al., 2008). Also these observations had been depicted in Japanese quails in previous studies (Stanely et al., 2000, Ghosh et al., 2007, Caker et al., 2008, Sahin et al., 2008,). This improvement in growth performance was achieved by saving energy and protein for body growth, which otherwise would be used to combat the growth of pathogenic bacteria (Samarasinghe et al. 2003). By binding pathogenic bacteria possessing type 1 fimbriae, MOS can prevent them from attaching to the gut lining, improving the integrity of the gut lining (Loddi et al., 2002). Gut microflora increase energy costs by modifying the rate of energy-consuming reactions such as protein turnover within the chicken GIT (Choct, 1999). The improvement in quails performance by MOS supplementation in our experimentation could be ascribed to that, prebiotics enhance resistance to enteric diseases and promote growth by by: (1) inhibits colonization of enteric pathogens by blocking bacterial adhesion to gut lining (Spring et al., 2000;Valancony et al., 2001), (2) enhances immunity (Ferket, 2002; Humphrey et al., 2002), (3), brush border mucin barrier (Iji et al., 2001; Loddi et al., 2002), (4) and integrity of the gut lining (Ferket, 2002) and (5) and reduces enterocyte turnover rate (Spring et al., 2000). These properties have the potential to enhance growth rate, feed conversion efficiency and livability in commercial broilers and turkeys and to increase egg production (Hooge, 2004). The adverse effect of high MOS level on quail's performance was also observed by Biggs et al. (2007) who reported that high dosage of prebiotics can have negative effects on the gut system and retard the growth rate of birds.

**Table (3). Feed intake (FI), body weight gain (BWG), feed conversion efficiency (FCE), performance index and mortality of growing Japanese quails fed the experimental diets**

| Items | Control | Low MOS | Medium MOS | High MOS | P |
|---|---|---|---|---|---|
| 1 to 3weeks | | | | | |
| Initial (day1) | 9.68±0.22 | 9.76±0.29 | 9.51±0.25 | 9.71±0.32 | 0.92 |
| FI (g/bird) | 190.95±1.85 | 209.33±7.31 | 198.2±2.6 | 193.87±4.7 | 0.08 |
| BW gain (g/bird) | 92.24±0.59$^{a}$ | 94.8±0.79$^{b}$ | 98.25±0.57$^{c}$ | 84.9±0.98$^{d}$ | 0.000 |
| FC (g/g) | 2.07±.02$^{abc}$ | 2.2±0.01$^{cd}$ | 2.01±0.03$^{b}$ | 2.28±0.05$^{d}$ | 0.02 |
| Performance Index* | 49.3±0.47$^{a}$ | 47.44±1.7$^{a}$ | 53.43±0.71$^{b}$ | 41.46±0.87$^{c}$ | 0.000 |
| 4 to 6 weeks | | | | | |
| FI (g/bird) | 396.66±8.8$^{a}$ | 426.00±3.1$^{cd}$ | 410.0±2.9$^{abc}$ | 430.0±5.8$^{d}$ | 0.01 |
| BW gain (g/bird) | 88.56±1.2$^{a}$ | 97.68±1.4$^{b}$ | 110.16±1.7$^{c}$ | 89.4±1.5$^{a}$ | 0.000 |
| FC (g/g) | 4.48±0.09$^{a}$ | 4.36±0.03$^{a}$ | 3.72±0.02$^{b}$ | 4.8±0.06$^{c}$ | 0.000 |
| Performance Index | 19.79±0.44$^{a}$ | 22.39±0.16$^{b}$ | 29.6±0.21$^{c}$ | 18.59±0.24$^{d}$ | 0.000 |
| 1 to 6 weeks | | | | | |
| B W (final) | 190.48±1.2$^{a}$ | 202.74±1.5$^{b}$ | 217.92±1.7$^{c}$ | 184.00±1.4$^{d}$ | 0.000 |
| FI (g/bird) | 587.62±7.54$^{a}$ | 635.33±2.4$^{b}$ | 608.2±5.3$^{ab}$ | 623.9±8.6$^{b}$ | 0.01 |
| BW gain (g/bird) | 180.8±1.2$^{a}$ | 192.5±1.6$^{c}$ | 208.41±1.7$^{b}$ | 174.29±1.5$^{d}$ | 0.000 |
| FC (g/g) | 3.25±0.04$^{a}$ | 3.3±0.05$^{a}$ | 2.91±0.03$^{b}$ | 3.57±0.05$^{c}$ | 0.000 |
| Performance Index | 58.63±0.75$^{a}$ | 61.31±1.00$^{b}$ | 74.6±0.65$^{c}$ | 51.43±0.7$^{d}$ | 0.000 |
| Mortality, % | 0.2 | 0.08 | 0.08 | 0.12 | |

*Figures in the same raw with different superscript differ significantly ($p < 0.05$).*

*Values are reported as means ± SE.*

*Low MOS (1 g MOS /kg feed); medium (MOS 3 g MOS /kg feed) and high MOS (5 g MOS /kg feed) treatments in the first 3 weeks and last 3 weeks, respectively*

*FI=Feed intake FC= Feed coversion.*

**Performance Index= live weight (g)/ FC ratio*

***Energy and protein efficiency***

Energy and protein efficiency of growing quails fed the experimental diet are exhibited in Table (4). Results in Table (4) showed that energy efficiency (ME intake, kcal/g weight gain) and protein efficiency (protein intake, g/g weight gain) were significantly ($p<0.05$) improved for medium MOS supplemented group in comparison with low and high MOS supplemented birds. That mean birds fed low and high MOS levels consumed more energy and protein per unit gain than those fed on medium MOS level. It is reported that rapid fermentation of prebiotics, leading to high concentrations of organic acids, impaired the barrier function, which reduced the ability of rats to resist salmonella infection in high dietary supplementation (Ten Bruggencate et al., 2003). The low MOS level induced slight improvement growth performance, carcass characteristics and energy and protein efficiency in relation to the control group.

**Table (4): Energy and Protein efficiency of growing Japanese quails fed the experimental diets**

| Items | Control | Low MOS | Medium MOS | High MOS | P |
|---|---|---|---|---|---|
| Energy efficiency* | | | | | |
| 0-21 | 6.08±0.0$^{abc}$ | 6.48±0.22$^{cd}$ | 5.92±0.07$^{b}$ | 6.71±0.14$^{d}$ | 0.02 |
| 22-42 | 13.16±0.29$^{a}$ | 12.81±0.09$^{a}$ | 10.93±0.07$^{b}$ | 14.13±0.18$^{c}$ | 0.000 |
| 0-42 | 9.5±0.12$^{a}$ | 9.6±0.15$^{a}$ | 8.5±0.08$^{b}$ | 10.51±0.15$^{c}$ | 0.01 |
| Protein efficiency** | | | | | |
| 0-21 | 0.49±0.006$^{abc}$ | 0.53±0.01$^{cd}$ | 0.48±0.005$^{b}$ | 0.54±0.01$^{d}$ | 0.000 |
| 22-42 | 1.07±0.02$^{a}$ | 1.05±0.007$^{a}$ | 0.89±0.01$^{b}$ | 1.15±0.01$^{c}$ | 0.000 |
| 0-42 | 0.78±0.01$^{a}$ | 0.79±0.01$^{a}$ | 0.7±0.01$^{b}$ | 0.86±0.01$^{c}$ | 0.000 |

*Figures in the same raw with different superscript differ significantly ($p<0.05$).*
*Values are reported as means ± SE.*
**Energy efficiency (EE) = Energy intake (kcal)/weight gain (g).*
*** Protein efficiency= protein intake (g)/weight gain (g)*

**Table (5). The effects of dietary treatments on carcass characteristics and absolute organ weight of growing Japanese quails**

| Items | Control (n=10) | Low MOS (n=10) | Medium MOS (n=10) | High MOS (n=10) | P |
|---|---|---|---|---|---|
| Live weight | 193.00±2.41$^{a}$ | 204.2±4.43$^{b}$ | 214.00±2.6$^{c}$ | 188.8±5.97$^{a}$ | 0.000 |
| Carcass weight | 131.6±2.62$^{a}$ | 145.2±4.86$^{b}$ | 159.6±3.03$^{c}$ | 132.2±2.22$^{a}$ | 0.000 |
| Dressing % | 68.18±0.84$^{a}$ | 71.1±1.88$^{ab}$ | 74.56±0.59$^{b}$ | 70.57±1.04$^{a}$ | 0.02 |
| Offals weight | 61.4±1.7 | 59.00±4.2 | 54.4±0.87 | 55.6±2.37 | 0.25 |
| Offals, % | 31.82±0.9$^{a}$ | 28.88±1.89$^{ab}$ | 25.99±0.59$^{b}$ | 29.93±1.04$^{a}$ | 0.01 |
| Edible giblet wt | 14.18±0.6 | 13.6±0.82 | 14.6±0.23 | 13.00±0.75 | 0.36 |
| Edible giblet % | 7.34±0.26 | 6.68±0.24 | 6.83±0.18 | 6.88±0.34 | 0.45 |
| Liver | 5.7±0.27$^{a}$ | 5.28±0.42$^{a}$ | 6.78±0.13$^{b}$ | 5.68±0.42$^{a}$ | 0.04 |
| Gizzard | 3.46±0.18$^{a}$ | 3.32±0.31$^{ab}$ | 3.98±0.26$^{a}$ | 2.6±0.2$^{b}$ | 0.01 |
| Heart | 2.33±0.09 | 2.36±0.16 | 2.34±0.1 | 2.28±0.08 | 0.96 |
| Spleen | 0.13±0.02 | 0.13±0.01 | 0.15±0.03 | 0.09±0.01 | 0.44 |
| Head | 12.48±0.5 | 12.5±1.59 | 12.22±0.6 | 11.00±0.07 | 0.65 |
| Abdominal fat | 3.4±0.6$^{a}$ | 2.7±0.33$^{ab}$ | 1.5±0.16$^{b}$ | 2.5±0.35$^{ab}$ | 0.03 |
| Legs | 5.62±0.96$^{a}$ | 4.38±0.28$^{b}$ | 5.56±0.06$^{b}$ | 3.9±0.32$^{b}$ | 0.01 |

*Figures in the same raw with different superscript differ significantly ($p<0.05$).*
*Values are reported as means ± SE.*
*Offals weight= weight of (blood +feather +head+legs)*
*Edible Giblet weight = weight of (liver+gizzard+heart+abdominal fat)*
*Dressing %, offals %, giblet % are calculated in relation to live weight*

***Carcass traits and absolute organ weights:***

MOS supplementation significantly altered ($p<0.05$) carcass characteristics of growing Japanese quails. The data in Table (5) indicated that, the carcass weight, dressing % of medium MOS supplemented quails were significantly ($p<0.05$) higher than those supplemented with low and high MOS levels. Moreover, carcass of medium MOS supplemented quails had lower offal's weight and lower abdominal fat than other MOS levels and the control birds. In addition, the absolute liver and gizzard weight were significantly higher in medium MOS supplemented quails. Table (6) revealed that, the chemical composition of the quails meat that were fed diet supplemented with medium MOS had a lower fat and ash % in comparison with those fed on the control, low and high MOS supplemented diets. The improvements of carcass weights, dressing percentages, offal's weights and the decrease in abdominal fat in medium MOS supplemented quails were in harmony with results of previous studies in broilers (Bozkurt et al., 2008; Zhao et al., 2009) and in Japanese quails (Falaki et al., 2011). It was hypothesized that a decrease in intestinal pathogen challenge provided by MOS would result in improvement nutrient utilization and allocation leading to benefits in lean muscle gain (Ferket, 2004). The improvements of carcass characteristics confirm the results of body weight and body gain in medium MOS supplemented birds (Table 3) and could be attributed to decreased proliferation of pathogenic bacteria (Spring et al., 2000). The decrease in abdominal fat was consistent with results of Ammerman et al. (1989) who added 0.3% oligofructose to the bird's ration, on day 47, decreased the percent of abdominal fat. Recently, an increasing number of consumers have been demanding that food products be safe and healthy. Therefore, low-fat chickens are currently very popular products in international markets.

**Table (6). Effect of MOS on carcass meat composition of Japanese quail (mean±SE)**

| Items | Control (n=3) | Low MOS (n=3) | Medium MOS (n=3) | High MOS (n=3) | P |
|---|---|---|---|---|---|
| Moisture | 72.0±0.57 | 71.67±1.4 | 74.00±0.58 | 72.35±1.2 | 0.37 |
| Crude protein | 20.83±0.44 | 21.63±0.6 | 21.96±0.08 | 21.66±0.33 | 0.11 |
| Fat | 3.67±0.35 $^{a}$ | 2.60±0.31 $^{b}$ | 1.97±0.09 $^{b}$ | 2.17±0.27 $^{b}$ | 0.01 |
| Ash | 1.40±0.05$^{a}$ | 1.67±0.09$^{bcd}$ | 1.3±0.06 $^{b}$ | 1.5±0.05 $^{ad}$ | 0.01 |

*Figures in the same raw with different superscript differ significantly (p< 0.05).*
*Values are reported as means ± SE.*

**Table (7): Effects of dietary treatments on some serum parameters (Data are means of five birds of each group) of growing Japanese quails**

| Items | Control (n=5) | Low MOS (n=5) | Medium MOS (n=5) | High MOS (n=5) | P |
|---|---|---|---|---|---|
| Total protein g/dl | 3.18±0.06 $^{a}$ | 4.30±0.22 $^{b}$ | 4.16±0.12 $^{b}$ | 4.08±0.1 $^{b}$ | 0.000 |
| Albumen g/dl | 1.54±0.09 | 1.96±0.10 | 1.70±0.14 | 1.64±0.14 | 0.11 |
| Glucose mg/dl | 319.8±3.39 $^{a}$ | 366±5.78 $^{b}$ | 348.00±1.92 $^{b}$ | 340.2±6.93 $^{a}$ | 0.000 |
| Total Cholesterol mg/dl | 191.4±3.4$^{a}$ | 172.00±4.06 $^{b}$ | 164.8±5.00 $^{b}$ | 177.6±4.7 $^{b}$ | 0.004 |
| Total lipids mg/dl | 655.0±10.2 $^{a}$ | 554.00±10.4 $^{b}$ | 587.00±5.38 $^{b}$ | 580.27±7.74 $^{c}$ | 0.000 |
| Triglyceride mg /dl | 110.4±1.6 $^{a}$ | 85.2±2.85 $^{b}$ | 81.00±3.7 $^{b}$ | 94.8±3.38$^{c}$ | 0.000 |

*Figures in the same raw with different superscript differ significantly (p< 0.05).*
*Values are reported as means ± SE.*

***Blood metabolites:***

The mean serum concentration of total protein and glucose increased significantly in all MOS supplemented birds and being highest in low MOS level supplemented birds (Table 7). Serum total cholesterol, total lipids and triglyceride pronounced a decreasing (p<0.05) trend with MOS supplementation to growing Japanese quails being higher in medium MOS supplanted quails. Interestingly, in this study, the triglyceride, total cholesterol and total lipids concentration in blood decreased in concomitant with a significant decrease in carcass fat % as a response to dietary treatments with MOS. Triglycerides are secreted from the liver into the blood by triglyceride- rich lipoproteins; therefore, impaired hepatic lipogenesis results in decreased triglyceride concentrations in plasma. These results agree with the results of earlier studies in which prebiotics was found to lower the concentration of blood lipids (Tang et al., 2005; Li et al., 2007; Ashayerizadeh et al. 2009; Rabie et al., 2010; Sharifi et al., 2011). The reduction in serum total cholesterol of quails fed probiotic and prebiotic supplemented diet could be attributed to reduced absorption and or synthesis of cholesterol in the gastro-intestinal tract by probiotic and prebiotic supplementation (Mohan et al., 1996; Ghiyasi et al., 2008). The most important mechanism by which prebiotic eliminates cholesterol would likely be through reducing lipid absorption in intestine by binding bile acids, which results in increased cholesterol elimination and hepatic synthesis of new bile acid (Zhang et al., 2003, Taherpour et al., 2009).

The response of some of the physiological variable was non linear and tended to peak at medium and low concentration of MOS, based on the available information, it can be concluded that the responses of Japanese quails to MOS supplementation are influenced by the level of supplementation. Therefore, this factor need to be carefully considered in order to obtain maximal growth-promoting effects of MOS in Japanese quails production.

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## استجابة السمان الياباني النامي لإضافة مستويات مختلفة من Mannan oligosaccharide (MOS) كمحفز نمو

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أجريت هذه الدراسة بهدف دراسة تقييم تأثير إضافة ثلاث مستويات من **MOS** علي بعض الصفات الإنتاجية ومواصفات الذبيحة وبعض مكونات الدم في السمان الياباني النامي . استخدم في هذه التجربة 100 طائر من السمان الياباني النامي عمر يوم وتم تقسيمهما إلي 4 مجموعات بكل مجموعة 25 طائر وقسمت كل مجموعة إلي 3 مكررات بكل مكررة 8 طيور. غذيت المجموعة الأولي علي العليقة الضابطة بدون أي إضافات، في حين غذيت المجموعة الثانية علي عليقه المقارنة مضاف لها 1 جم MOS/كجم عليقه (مستوي منخفض) والثالثة علي العليقة المقارنة مع إضافة 3 جم MOS /كجم عليقه (مستوي متوسط) كما أضيف 5جم MOS /كجم عليقه (مستوي مرتفع) في المجموعة الرابعة. وانتهت التجربة في عمر 6 أسابيع. أظهرت النتائج أن إضافة المستوي المتوسط من MOS إلي العليقة أعطي أفضل أداء إنتاجي تمثل ذلك في تحسن معنوي في وزن الجسم، والزيادة في وزن الجسم ومعدل الكفاءة التحويلية للغذاء ومؤشر الأداء وكذلك نسبة التصافي والأجزاء المأكولة من الطائر بالمقارنة بالمستويات الأخرى من وكذلك بالمقارنة مع الطيور المغذاة علي العليقة الضابطة . كما لوحظ أيضا أن إضافة المستوي المتوسط من MOS أدي إلي تحسن كفاءة تحويل الطاقة والبروتين إلي زيادة في الوزن. أوضحت النتائج أن المستوي المنخفض من MOS أدي إلي تحسن طفيف في الأداء الإنتاجي للطيور في حين اظهر المستوي المرتفع سلبيا علي الأداء الإنتاجي للطيور. أدت إضافة ال MOS إلي انخفاض الكولسترول والدهون الكلية والجليسريدات الثلاثية في دم السمان الياباني النامي عند جميع المستويات المضافة. من خلال النتائج المتحصل عليها يتضح لنا أن المستوي المتوسط من MOS حقق أفضل النتائج لذلك يجب أن يؤخذ في الاعتبار مستوي إضافة MOS في علائق السمان وذلك لتحقيق اعلي إنتاج دون الحاجة إلي المضادات الحيوية.