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Mannanoligosaccharide (MOS) in Broiler Diet during the Finisher Phase: 2. Growth Traits and Intestinal Histomorpholgy

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NC designed the study while MT, Rafiullah and SA executed it. RUK, MM and SN edited and submitted the paper.

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ABSTRACT

The aim of this study was to find the effect of Mannanoligosaccharide (MOS) on the performance and gut morphology of broiler chicks (Ross 308) during the finisher phase. A total of 180 of 22 days broiler chicks were distributed into 3 treatments with 3 replicates having 20 chicks per replicate. One group was kept as control and the birds in this treatment were fed on basal ration without alteration in feed contents while the other treatments MOS-50 and MOS-100 represented 50 and 100 g MOS/kg feed respectively during the finisher phase. Treatment MOS-100 improved feed intake significantly (P<0.01) at the age of 4th and 5th week followed by MOS-50. Significantly (P<0.01) higher overall body weight gain was recorded for treatment MOS-100 compared to the control. At 5th and 6th weeks of age, significantly (P<0.01) lower FCR was recorded in MOS-100. The highest level of replacement (MOS-100) showed the maximum dressing percentage, weight of bursa, thymus and spleen. Significantly higher villus height, crypt depth and goblet cell count were recorded in MOS-100. It was concluded from the results that improvement in growth performance, intestinal histomorphology and relative weight of lymphoid organs in broiler chicks during finisher phase was attributed to MOS at the level of 100 mg/kg.

INTRODUCTION

Antibiotic growth promoters (AGP) have long been used in all types of livestock production systems particularly poultry (Alhidary *et al*., 2017; Abudabos *et al*., 2018; Chand *et al*., 2018). At therapeutic level, antibiotics are used against different microbes in sick animals and as prophylaxis during period of high risk of infection while at sub therapeutic level they are used as feed additives to improve growth and nutrient availability by regulating microbial populations (Khan *et al*., 2016; Abudabos *et al*., 2017). However, development of antibiotic resistant bacteria, excessive drug residues in poultry meat and eggs and decreases efficiency of antibiotic used for humen and poultry (Alzawqari *et al*., 2016; Abudabos *et al*., 2016) has resulted that AGP is banned in many country of the world. This ban on AGP has lead the nutritionist to found and develop natural alternatives such as prebiotics, probiotics, organic acids, enzymes and yeast cultures (Khan *et al*., 2012a, b, c, d; Tanweer *et al*., 2014; Raza *et al*., 2016).

By composition, Mannan oligosaccharides (MOS) is a derivative of the cell wall of yeast *Saccharomyces cerevisiae* (Chand *et al*., 2016). Dietary supplementation of MOS in broilers has been found to increase growth performance and prevents bacterial colonization (Sultan *et al*., 2015). *Saccharomyces cerevisiae* has high binding affinity thus reduces the pathogenic microorganisms in the gut. Other functions related to MOS are lactate formation due to pH alteration of intestine, formation of antibiotics like substance, enzyme production, antagonist for intestinal adhesive receptors, and competition for feed ingredients, reducing toxin level and stimulating immune system. The MOS plays a significant role in the gut microflora and increases immune response of birds by presenting antagonistic effect to pathological microorganism (Chand *et al*., 2018). Use of MOS improves the structure and enzymatic action of intestine (Iji *et al*., 2001). MOS has been reported to improve the number of goblet cells in broiler gut (Chand *et al*., 2018). Considering the merits of antibiotics and future potential and benefits of using MOS in poultry health and production, the effect of MOS on

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the growth performance and gut improvement in broiler birds need to be explored. Therefore, the present study was designed to investigate the effects of different levels of MOS on growth performance, lymphoid organs and intestinal histomorphology of broiler during the finisher phase.

MATERIALS AND METHODS

Experimental animals, design and management

In the study, 180 broiler birds of 22 days age were selected and distributed randomly among 3 treatments: MOS-0, MOS-50 and MOS-100, each treatment with 3 replicates, each with 20 birds. The above 3 MOS dietary replacement treatments are represented with 3 levels as 0, 50 and 100 g/kg of feed, respectively. MOS-0 is represented as a control group without addition of MOS in feed. The flock was kept in open sided house under similar environmental conditions and was fed with basal broiler finisher ration. Ingredients composition, calculated values and chemical composition of finisher ration are yellow corn, 63.05 %; soyabean meal, 33.0 %; di-calcium phosphate, 2.0 %; sodium chloride, 0.3 %; lime-stone, 0.9 %; vitamin mixture, 0.3 %; vegetable oil, 0.3 %; methionine, 0.1 %; lysine, 0.05 %; ME, 2900 (Kcal/kg); calcium, 0.9 %; phosphorus, 0.45 %; methionine, 0.42 %; methionine and cysteine, 0.75 % and lysine, 1.1 %. Determined chemical analysis are crude protein, 19.3 %; dry matter, 89.7 %; ether extracts, 4.6 %; crude fiber, 3.1 % and ash, 9.7 %. Birds were offered water *ad libitum*. The study was continued for six weeks. During research trial period, daily temperature and humidity were recorded. The birds were vaccinated on the standard schedule.

Growth parameters

Daily feed intake was calculated by provided feed on the particular day minus feed leftover in feeder. Gain in body weight was calculated on weekly basis by recording weight at the end of trial minus weight at the beginning of trial. Feed conversion ratio (FCR) was calculated on completion of trial by total feed consumed by experimental birds divided by total weight gain in birds. For calculation of dressing percentage, at the end of experiment (42 days), 2 broiler birds were randomly selected per replicate, weighed and slaughtered. Skin and non-edible parts were removed. Carcass weight was recorded and dressing percentage was calculated by dividing carcass weight over live weight multiplied by 100.

Measurement of lymphoid organs

At the end of finisher phase, 2 broilers were randomly selected per replicate and were slaughtered. Lymphoid organs (thymus, spleen and bursa of fabricios) were removed and weighed separately. Relative weight (%) of all these lymphoid organs was calculated by dividing organ weight to body weight of particular bird.

Study of lower ileum histomorphology

For the goblet cell count and villus height measurement, 3 birds per replicate were slaughtered and 1cm section was taken from lower ileum and preserved in 10% buffered formalin. The preserved parts of the small intestine were sliced up to 5mm sections and embedded in liquid paraffin. These sections were cut into 2-5mm layers and mounted on glass slides, stained with acid-Schiff reagent and Alcian blue and observed under contrast microscope. Goblet cells were counted per villus at the rate of 4 villi per 3 tissue/slides. The crypt depth was calculated from the region of the alteration between crypt and villi.

Statistical analysis

The statistical analysis was performed in SAS 9.2 (SAS Institute, 2009) using a completely randomized design and least significant difference (LSD) was used for statistical difference among various experimental treatments. Data were analyzed by one-way ANOVA. Duncan multiple range tests were used to compare the means. Significance was declared at P < 0.01.

Table I.- Effect of mannan oligosaccharides on weekly mean feed intake (g) in broiler chicks during the finisher phase.

Group	4^{th} week	5^{th} week	6^{th} week
MOS-0	716.33± 2.40^{c}	903.67± 2.90^{c}	963.33± 3.17^{b}
MOS-50	763.67± 2.60^{b}	974.00± 1.73^{b}	1053.7± 2.90^{a}
MOS-100	779.33± 5.23^{a}	988.67± 2.96^{a}	1062.0± 4.35^{a}

Means in the same column with different superscripts are statistically different (P<0.01).

RESULTS

Effect of various levels of dietary MOS on feed intake is presented in Table I. Weekly and mean feed intake was significantly (P<0.01) influenced by different levels of MOS. Significantly, higher feed intake was recorded at the highest level of MOS. Feed intake was significantly affected by treatments during 4^{th}, 5^{th} and 6^{th} week of age. Overall feed intake during finishing phase was also affected by MOS. Treatments significantly improved feed intake as compared to the control. Significantly higher feed intake was recorded for group MOS-100 during week 4^{th} and 5^{th} and was followed by group MOS-50. At 6^{th} week of age and overall feed intake was significantly higher and the same for group MOS-50 and MOS-100. Overall feed intake was 8.3 and 7.0 % higher for group MOS-50 and MOS-100, respectively, as compared to the control.

Mean value of body weight gain was significantly (P<0.01) influenced by different levels of MOS (Table II). The analysis of variance indicated that treatments significantly improved body weight gain at all recorded ages. Body weight gain was increased with the increasing level of MOS. At the end of week 4, MOS-100 showed the maximum body weight gain followed by MOS-50 and the least weigh gain was recorded for the control group. Week 5 and 6 showed the same trend as week 4. Significantly higher body weight gain was recorded for treatment MOS-100 followed by MOS-50. The least overall body weight gain was observed for the control.

Table II.- Effect of different levels of mannan oligosaccharides on mean body weight gain (g) in broiler chicks during finisher phase.

Group	4th week	5th week	6th week
MOS-0	351.33± 5.20[c]	388.33± 2.30[c]	442.33± 5.48[c]
MOS-50	416.33± 5.78[b]	456.67± 3.48[b]	517.00± 2.88[b]
MOS-100	444.33± 4.17[a]	497.33± 0.88[a]	562.33± 3.48[a]

Means in the same column with different superscripts are statistically different (P<0.01).

Table III.- Effect of different levels of mannan oligosaccharides on mean feed conversion ratio in broiler chicks during finisher phase.

Groups	4th week	5th week	6th week	Overall mean
MOS-0	2.03±0.02[a]	2.32±0.01[a]	2.17±0.03[a]	2.18±9.67[a]
MOS-50	1.84±0.03[b]	2.13±0.01[b]	2.03±5.84[b]	2.01±3.86[b]
MOS-100	1.75±0.04[b]	1.91±0.01[c]	1.88±0.01[c]	1.86±0.02[c]
P value	0.0034	0.0000	0.0003	0.0000

Means in the same column with different superscripts are statistically different (P<0.01).

Analysis of the data showed that mean FCR was significantly (P<0.01) affected by MOS (Table III). At 5th and 6th weeks of age, significantly lower FCR was recorded for group MOS-100 and was followed by MOS-50, while higher FCR was recorded for the control group. Overall the FCR was the best in MOS-100 compared to the control. Dressing percentage showed similar pattern like other parameters. It increased as the level of MOS increased.

Analysis of the data indicated that the highest level of MOS produced maximum dressing percentage compared with control group (Table IV). Weight of lymphoid organs in the present study significantly (P<0.01) varied at all levels of MOS. It was noticed that the highest level resulted in significant increase in the relative weight of lymphoid organs. MOS-100 presented heavier bursa, thymus and spleen followed by MOS-50 and MOS-0 (Table IV).

Table IV.- Effect of dietary mannan oligosaccharides on lymphoid organs of broiler birds during finisher phase.

Treatment	Dressing percentage	Bursa (%)	Thymus (%)	Spleen (%)
MOS-0	64.89±0.02[c]	2.16±0.05[c]	4.16±0.06[c]	2.30±0.05[b]
MOS-50	66.73±0.06[b]	2.70±0.11[b]	5.16±0.03[b]	3.0±0.15[a]
MOS-100	67.55±0.04[a]	3.40±0.05[a]	5.73±0.03[a]	3.30±0.05[a]
P- value	0.0000	0.001	0.001	0.001

[a, b, c] value in each column followed by different superscripts are significantly different at (P<0.01).

Table V.- Effect of dietary MOS on villus height, crypt depth and goblet cells count of broiler birds during finisher phase.

Treatment	Villus height (µm)	Crypt depth (µm)	Goblet cell count
MOS-0	963.33±7.26[c]	130.33±1.45[c]	149.33±1.20[c]
MOS-50	980.00±3.2[b]	142.00±1.15[b]	161.00±0.57[b]
MOS-100	1013.00±2.32[a]	152.67±0.8[a]	169.33±0.33[a]
P- value	0.001	0.001	0.001

[a, b, c] value in each column followed by different superscripts are significantly different at (P<0.01).

Mean values of villus height, crypt depth and goblet cell count are given in Table V. It was observed that MOS-100 resulted in greater villus height followed by MOS-50 and control treatment (MOS-0). Similarly, significant increase was observed with crypt depth and goblet cells count at MOS-100. The histological picture of the intestinal histology and goblet cells count is given in Figures 1 and 2, respectively. The histological features of the intestines in the form of cell dimension was improved and the number of cells were increased in the treated groups compared to the control.

DISCUSSION

In the present study, the performance traits were improved in the treatment groups compared to the control. Improved feed intake in MOS fed groups may be due to healthy microbial environment in gastro-intestinal tract leading to healthy gut which results in better feed consumption in broiler (Chand *et al*., 2014). MOS which is

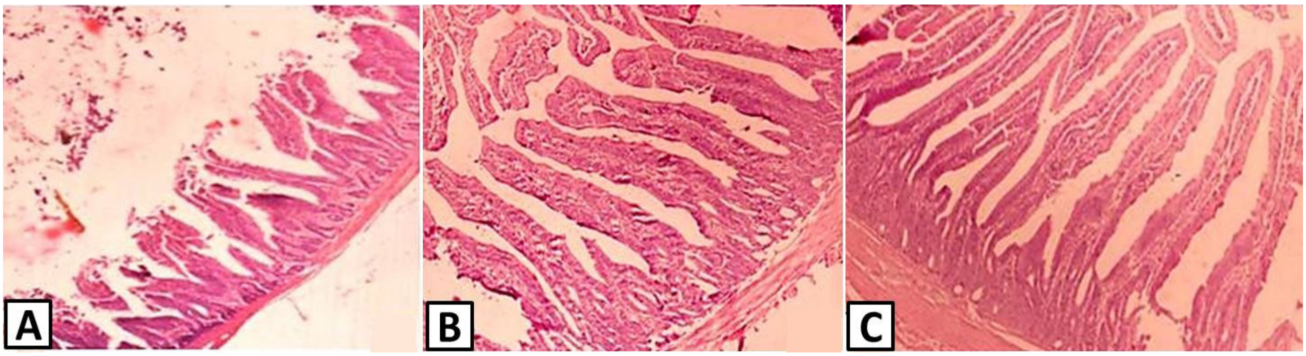

Fig. 1. Histology of intestines in control and MOS treated groups of broiler during the finisher phase (Bar 50µm). A, control; B, 50mg/kg MOS; C, 100 mg/kg MOS.

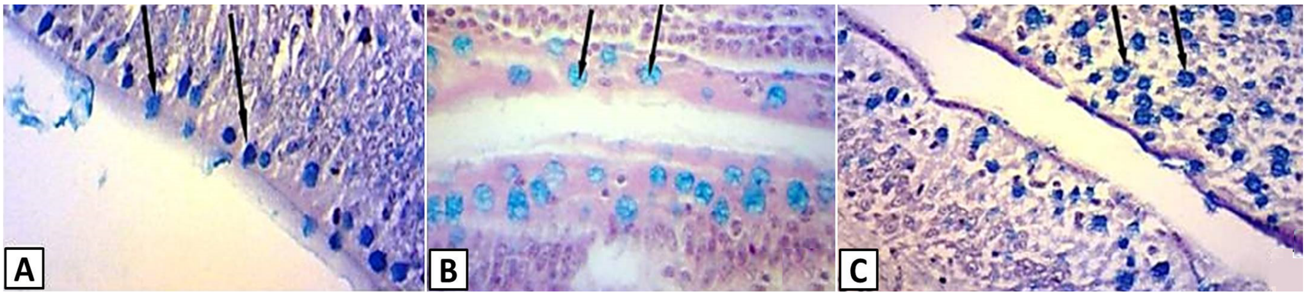

Fig. 2. Number of goblet cells of control and MOS treated broilers during the finisher phase. A, control; B, 50mg/kg MOS; C, 100 mg/kg MOS.

derived from the cell wall of *Saccharomyces cerevisiae* helps in reducing stress and increase the feed intake (Chand *et al*., 2018). Similar findings have been reported in the previous studies (Bozkurt *et al*., 2009; Koc *et al*., 2010).

Higher body weight gain in broiler in the present study may be due to MOS feeding which increases the beneficial bacteria such as Bifidobacteria and Lactobacilli in the gut of broiler (Baurhoo *et al*., 2007). Improvement in microbial population in the gut causes improvement in nutrient absorption and decrease in nutrients loss (Sultan *et al*., 2015). Our results are in line with the findings of previous report (Xu *et al*., 2003) who also reported improved body weight gain in broiler birds by MOS supplementation in finisher ration.

In the present study, at 5th and 6th weeks of age, significantly lower FCR was recorded with MOS-100 and was followed by MOS-50, while higher FCR was reported in MOS-0. Improvement in FCR may be due to the fact that MOS improves gut health and nutrients consumption (Loddi *et al*., 2002). The improved weight of lymphoid organs may be due to the higher weight gain in the corresponding groups of treated birds.

Different levels of MOS significantly increased villus height and crypt depth of broiler during the finisher phase in the present study. Significantly ($P<0.01$) higher villus and crypt depth were recorded with MOS-100 followed by MOS-50 and MOS-0. An increase in villus height and crypt depth is caused by the increased population of Bifidobacteria and Lactobacilli in the gut (Baurhoo *et al*., 2007) that stimulate vascularization and development of the intestinal villi. Improved goblet cells count may also be due to the positive effect of the MOS.

It is concluded that MOS improved the overall performance, relative weight of lymphoid organs and gut histomorphology in broiler chicks during the finisher phase.

Statement of conflicts of interest

The authors declare that they have no conflict of interests.

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