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Original Research

Studies on Effect of Mannan oligosaccharides, β-glucan and their Combination on Immune Status and Litter Condition of Broilers Reared under Hot Climatic Condition

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Abstract

An experiment was conducted to evaluate the immune status litter condition of broilers by supplementation of mannan oligosaccharides (MOS), β-glucan and their combination. 320 one day old straight run Vencobb400 chicks were weighed and distributed randomly into four treatment groups viz, A, B, C and D with four replicates consists of 20 chicks in each replicate. Treatment group A was serving as control without supplementation of MOS and β-glucans. Supplementation of β-glucans @5g/100kg and MOS@ 50g/100kg of feed was done in treatment group B and C respectively. The treatment D was a combination of treatment B and C. The results revealed non-significant influence of supplementation of MOS, β-glucans and their combination on Ranikhet Disease (RD) titre at 21st and 42nd days of age. There were non-significant differences with pH and the litter moisture. It may be concluded that the supplementation of β-glucans, MOS and their combination did not record any adverse effect on litter quality and RD titer.

Keywords: β-glucan, Broiler, Immune Status, Litter Moisture, Litter pH, Mannan oligosaccharides (MOS)

Introduction

Mannan oligosaccharide (MOS) is a mannan based carbohydrate derived from the cell wall of yeast *Saccharomyces cerevisiae* (Iqbal *et al.,* 2015). It is considered that MOS exerts its effect on growth by accelerating the maturation of GIT microflora (Yang *et al.,* 2007). Dietary MOS also modulates mucin synthesis by increasing the expression of different goblet cell types and up-regulating MUC2 and mRNA expression (Chee *et al.,* 2010).

The supplementation of β-glucans protects against a number of economically-important pathogens and improves gut health and increases disease resistance (Huff *et al.,* 2010; Shao *et al.,* 2013). Yeast β-glucans supplementation enhances lysozyme and complement levels, improves phagocytic activity and alters tight junction protein expressions (Chuammitri *et al.,* 2011). Broilers supplemented with yeast β-glucans have increased humoral and cell-mediated immune responses (Kumar *et al.,* 2011; Shao *et al.,* 2013). In addition, supplementation with yeast cell wall extract prevents production loss, regulates intestinal innate immune responses (Yitbarek *et al.,* 2012). There are very few previous studies reports dealing with single and combined effects of dietary mannan- oligosaccharides (MOS) and β-glucan on immune status and litter quality in chicken. Therefore, study was planned to evaluate the effects of dietary oligosaccharides (MOS) and β-glucans on immune status and condition of litter in broiler.

Materials and Methods

The experiment was carried out at Broiler unit of Department of Poultry Science, COVAS, Parbhani. The quality feed ingredients were procured from local market and rations were prepared as per BIS (2007), at feed mixing plant COVAS, Parbhani. The experimental design and composition of various treatment diets fed to the experimental birds are given in Table 1 and 2, respectively. The data obtained was statistically analyzed by using Randomized block design (Snedecor and Cochran, 2002)

Table 1: Experimental design for housing of broiler with supplementation MOS, β-glucan and their combination

Treatment group	Treatment group details	No. of birds/pen/ replication	No. of replicates	Total No. of birds
A	Control diet	20	4	80
B	Control diet + β-glucans @ 5g/100kg	20	4	80
C	Control diet + MOS@ 50g/100kg	20	4	80
D	Control diet + β-glucans @ 5g/100kg + MOS @ 50g/100kg	20	4	80
	Total	4	16	320

The pre-starter, starter and finisher rations were offered for first seven days, 8th day to 20th day and 21st to 42nd day of age, respectively. Mannan-oligosaccharide (MOS**)** and β-1,3-glucan were procured from B.V. BIO-CORP PVT. LTD, Pune-412206

Table 2: Percent ingredient and nutrient composition of (basal diet) pre-starter, starter and finisher rations with supplementation of MOS, β-glucan and their combination.

Feed Ingredients	Pre-Starter	Starter	Finisher
Maize	524.48	571.04	623.04
Soybean meal	402.32	372.05	310.51
Oil (veg)	31.32	17.24	28.96
Salt	3.8	3.8	3.8
DL-Methionine	2.04	2.21	1.89
Di-Calcium Phosphate	19.97	17.24	16.17
Shell grit	10.6	11.45	10.89
Trace mineral mixture1	1	1	1
AB2D3K[2]	0.15	0.15	0.15
B-Complex[3]	0.1	0.1	0.1
Choline Chloride, 60%	0.5	0.5	0.5
Toxin Binder	2	2	2

Antibiotic	0.5	0.5	0.5
L-lysine HCL	0.72	0.41	0
Coccidiostat	0.5	0.5	0.5
Total	**1000**	**1000**	**1000**
Nutrient Composition (calculated)			
ME (kcal/kg)	2960	3060	3160
Protein (%)	23	21	19.5
Calcium (%)	0.9	0.85	0.8
Available phosphorus (%)	0.45	0.4	0.38
Lysine (%)	1.36	1.2	1.07
Methionine (%)	0.56	0.55	0.5

Temperature-Humidity Index (THI)

Average of weekly temperature humidity index were recorded in the broiler shed and tabulated as below.

Table 3: Average week wise Temperature –Humidity Index recorded in shed at 2.30 PM

THI Weeks						
	1	**2**	**3**	**4**	**5**	**6**
THI	80.89	80.74	83.92	83.16	83.37	87.17
THI	80.83	82.24	84.13	85.17	84.21	85.29
THI	81.42	82.18	83.99	82.97	85.14	84.8
THI	81.8	82.3	83.78	82.37	84.84	86.69
THI	80.74	83.48	84.88	85.72	85.31	91.24
THI	81.64	83.47	84.49	83.17	86.56	87.91
THI	82.11	83.88	85.48	84.29	86.67	84.71
Average	**81.34**	**82.61**	**84.38**	**83.83**	**85.16**	**86.83**

i) Mild heat stress caused with THI: 72-79; ii) Moderate heat stress caused with THI : 80-88;
iii) Sever heat stress caused on birds with THI: 89 and above

The experiment was approved by Institutional Animal Ethics Committee vide resolution no. **IAEC/52/19 dated 2/3/2019**. The standard feeding, watering, floor space and vaccination schedule were followed.

Immune Status (RD Titre)

Serum sample from one bird per replicate was collected on the 21st and 42nd day post R.D. vaccination. Antibody titre against RD was estimated in the laboratory of Poultry Diagnostic and Research Centre of Venkateshwara Hatcheries Pvt. Ltd., Loni-Kalbhor, Pune, as per O.I.E. procedure (1992)

Moisture Percentage of Litter Material

The litter moisture was estimate as per the standard procedure AOAC, (1990) at 42nd Day of age as per the method described by Brake *et al.* (1992). Before taking the sample litter was raked. Litter samples were collected from five locations within each pen and thoroughly mixed to obtain litter material representative of the entire pen. At least 200g of litter was taken and immediately brought to the laboratory for moisture estimation. Samples were kept at 100±5°C for 12 hours in hot air oven and then cooled in a desiccator and the moisture content was determined as the weight loss during the heating-

$$Moisture\ \% = \frac{Loss\ in\ weight\ (W1g - W2g)}{Weight\ of\ sample\ (W1 - Wg)} \times 100$$

Where,

Wg = Weight of empty tin
W1G = Weight of empty tin + Sample before drying
W1-Wg = weight of the sample taken
W2g = Weight of empty tin + Sample after drying
W1g-W2g = Loss in weight.

Litter pH

The litter pH was measured according to the method described by Brake *et al.* (1992). The upper 10cm of litter was collected at each sample position and transported back to the laboratory for determination of pH. The pH of each litter type was measured after litter samples of 10g were suspended for 30 min in 100mL of deionized water and stirred for 5 min using pH meter. pH value was recorded until constant values were obtained (LABMAN 920 Precision pH/ OPH meter). The data collected were subjected to statistical analysis by using Randomized Block Design by Snedecor and Cochran (2002). The treatment means were compared by Critical Differences (CD) and Analysis of Variance.

Results and Discussion

Immune status (RD Titre)

The means of antibody titre against Newcastle disease (ND) at 21st and 42nd day of age were presented (Table 4). The non-significant influence (P<0.01) was revealed by supplementation of MOS, β-glucans and their combination on ND titre at 21st and 42nd days of age. The non-significant influences of supplementation of MOS, β-glucans and their combination on ND could be attributed to the severed heat stress caused on birds. The heat stress might have suppressed the immunity. The THI was moderate to severe in broiler shed during the experimental period (Table 3). These results are in agreement with Lopes *et al.* (2009). They concluded that non-significant influence on supplementation of β-glucans on RD antibody titer. In contrast, An *et al.* (2008) observed significantly (P<0.05) higher antibody titer by supplementation of β-glucans. The results in present study are not in agreement with Vesna *et al.* (2007). They concluded that the supplementation of MOS in diet significantly increased antibody titer against ND. Similar results were also revealed by Sadeghi *et al.* (2013), Waqas *et al.* (2018).

Table 4: Antibody titre of broilers against Ranikhet disease at 21st and 42ndday of age as influenced by dietary supplementation of MOS, β-glucan, and their combination

Treatments	RD Titer @ 8 HAU			
	21st day		42nd day	
	Mean	SE	Mean	SE
A	1	0.65	1	0.65
B	0.5	0.58	4	1
C	0	0.5	11	4
D	0	0	8	7

Table 5: ANOVA for Antibody titre of broilers against Ranikhet disease at 14th and 21st day of age as influenced by dietary supplementation with β- glucans, MOS and their combination

	21st day				42nd day		
Sources	**Df**	**SS**	**MSS**	**F**	**SS**	**MSS**	**F**
Treatments	3	2.75	0.917	1.571	232	77.333	0.595
Errors	12	7	0.583	-	1560	130	
Total	15		-	-			

Table 6: Moisture, percentage and pH of litter at 42nd days for different age groups supplemented with β- glucans, MOS and their combination

Moisture percentage of litter				
Samples no.	**Treatment**			
	A	**B**	**C**	**D**
I	23.25	23.31	22.51	19.60
II	21.82	24.21	23.33	19.23
III	23.64	17.76	17.63	23.37
IV	20.69	22.49	20.62	18.14
Overall mean	22.35	21.94	21.02	20.08
pH of Litter				
I	6.41	6.89	6.90	6.40
II	6.39	7.11	6.87	6.37
III	6.29	7.13	6.62	6.30
IV	6.53	7.89	6.31	7.07
Overall mean	6.40	7.25	6.67	6.78

Table 7: ANOVA for moisture percentage and pH of Litter at 42nd age groups supplemented with β- glucans, MOS and their combination

Moisture percentage				
Sources	**Df**	**SS**	**MSS**	**F**
Treatments	3	12.252	4.084	0.753
Replica	12	65.08	5.423	
Total	**15**	**77.332**	**0.001**	
pH of Litter				
Sources	**Df**	**SS**	**MSS**	**F**
Treatments	3	1.5092	0.503067	**1.989717**
Replica	12	3.034	0.252833	
Total	**15**	**4.5432**		

Moisture Percentage of Litter Materials

The supplementation of MOS, β-glucans and their combination did not influence litter moisture, however, numerically lower litter moisture was recorded for these treatment groups indicating the supplementation of MOS, β-glucans and their combination inhibited the colonization of gastrointestinal tract by pathogenic microorganism, thereby reduced viscosity of gut and ultimately resulted in low moisture percentage of litter. MOS significantly increased the goblet cell numbers. The goblet cells are responsible for the production of mucin, which binds pathogenic microorganisms and reduce their colonization of the gut mucosa (Blomberg *et al.,* 1993). The lower litter moisture obtained in β-glucans, MOS and their combination groups might be due to their effect of on the mucosal layer of the intestine. The present findings are in agreement with Sarica and Cam (1998) who reported non-significant findings with the litter moisture, Stanley *et al.* (2004) reported non-significant differences in the litter moisture when diet was supplemented with yeast cell culture, Cheraghi *et al.* (2014) and Yalcin *et al.* (2014) also reported non-significant findings with the litter moisture when the diet was supplemented with yeast cell wall / yeast extracted β-glucans. However, Rezaei *et al.* (2011) reported that the inclusion of micronized insoluble fibre @ 0.5 percent resulted in significant ($p<0.05$) decrease in the litter moisture. Hassan and Ryu (2013) revealed that fecal ammonia and CO_2 gas emission was significantly ($P<0.05$) decreased in multi-prebiotics diet supplemented group. Sadeghi *et al.* (2013) reported that inclusion of prebiotic-based mannan-oligosaccharide and β-glucan resulted in

lowest litter moisture percent compared with other treatment groups. However, Onwurah *et al.* (2013) revealed that supplementation of yeast in diet was resulted to void more water in their droppings may be due to more heterotrophic gastrointestinal tract of the birds fed yeast content diet.

Litter pH

The supplementation of MOS, β-glucans and their combination did not influenced pH values. However, a pH value of litter was within limit of ideal conditions. The findings of the present study are in agreement with, Meluzzi *et al.* (2008) who reported that the litter pH was unaffected by both rearing condition and litter type. Miles *et al. (*2011) concluded that lower NH_3 production in the litter is indicative of ideal litter pH. Cheraghi *et al.* (2014) reported non-significant findings with litter pH when the diets were supplemented with yeast extracted β-glucans and α-mannans. Tasistro *et al* (2007) indicated that Sodium bisulphate can be a best alternative to suppress the NH_3 emission from the litter, Ritz *et al.* (2009) stated that the litter moisture should not exceed 25 percent as excess litter moisture may increase ammonia emission (>25 ppm) from the litter and thereby the pH of litter may also be altered. Youssef *et al.* (2011) revealed that ammonia was produced in wet litter because of microbial activity on uric acid and thereby increased the pH of litter .

Conclusion

It may be concluded that the supplementation of β-glucans, MOS and their combination did not record any adverse effect on litter quality as well as litter pH. However, there were significant differences ($P<0.01$) between antibody titer against Ranikhet disease at 21st day of age.

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Conflict of Interests

There is no conflict of interest.

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References

1. An, B. K., B. L. Cho., S. J. You., H. D. Paik., H. I. Chang., S. W. Kim., C. W. Yun., and C. W. Kang. (2008). Growth Performance and Antibody Response of Broiler Chicks Fed Yeast Derived β-Glucan and Single-strain Probiotics, *Asian-Australasian Journal of Animal sciences*, 21(7), 1027 – 1032.
2. A.O.A.C. (1990). Association of Analytical Chemists. Official Methods of Analysis. *15th Edn.Collegiate Press, Washington. D.C.*
3. BIS (2007). Indian standards *Poultry feed specification* (fifth revision) 3-5
4. Blomberg, L., Henriksson., A. and Conway., P.L. (1993). Inhibition of adhesion of Escherichia coli K88 to piglet ileal mucus by Lactobacillus ssp. *Appl Environ Microbiol*, 59, 34-39.
5. Brake, J. D., C. R. Boyle., T. N. Chamblee., C. D. Schultz. and E. D. Peeble. (1992). Evaluation of the chemical and physical properties of hardwood bark used as a broiler; litter material. *Poult, Sci*, 71,467–472.
6. Chee, S.H., Iji, P.A., Choct, M., Mikkelsen., L.L. and Kocher, A. (2010). Characterization and response of intestinal microflora and mucins to mannanoligosaccharide and antibiotic supplementation in broiler chickens. *Br. J. Poult. Sci*, 51,368-380.
7. Cheraghi, A., H. Khosravinia., S.M. Mousavi., and B. Massori. (2014). Effects of dietary levels of yeast extracted β-glucans and α-mannans (Alphamune TM) on performance of broiler chicken raised in normal and thermal-stressed conditions. *Europ. Poult. Sci.*, 78.
8. Chuammitri, P., Redmond, S.B., Kimura, K., Andreasen, C.B., Lamont, S.J., Palic, D. (2011). Heterophil

functional responses to dietary immunomodulators vary in genetically distinct chicken lines. *Vet. Immunopathol*. 142, 219–227.

9. Hassan, Md R., and Kyeong-Sun Ryu. (2012). Naturally Derived Probiotic Supplementation Effects on Physiological Properties and Manure Gas Emission of Broiler Chickens. *Journal of Agriculture & Life Science*,46(4), pp.119-127.
10. Huff, G.R., Huff, W.E., Farnell, M.B., Rath, N.C., Solis de Los Santos, F., Donoghue, A.M. (2010). Bacterial clearance heterophil function, and hematological parameters of transport-stressed turkey poults supplemented with dietary yeast extract. *Poult. Sci*. 89, 447–456.
11. Iqbal, A.I., Roohi, N., Akram, M. and Khan, O. (2015). Egg quality and egg geometry influenced by Mannan-Oligosaccharides (MOS), a prebiotic supplementation in four close bred flock of Japanese quail breeders (*Coturnix coturnix japonica*). *Pakistan J. Zool*., 47,641-648.
12. Kumar, S., Ciraci, C., Redmond, S.B., Chuammitri, P., Andreasen, C.B., Palic, D., Lamont, S.J. 2011. Immune response gene expression in spleens of diverse chicken lines fed dietary immuno modulators. *Poult. Sci*. 90, 1009–1013.
13. Lopez R., E. Auclair., F. García., E. Esteve-Garcia., and J. Brufau (2009). Use of yeast cell walls; β-1, 3/1, 6-glucans; and mannoproteins in broiler chicken diets. *Poult. Sci*, 88,601–607.
14. Meluzzi, A., C. Fabbri , E. Folegatti., & F. Sirri. (2008). Effect of less intensive rearing conditions on litter characteristics, growth performance, carcase injuries and meat quality of broilers. *British Poult. Sci*., 49(5),509-515.
15. Onwurah, F.B., J. Okejim., K. U. Amaefula. (2013). Effect of yeast as water additives in the management of litter in the production starter broiler. Vol. 2, No. 1.
16. O.I.E Manual for diagnostic test and vaccine (1992).Second edition published by office International Disepizootics.
17. Rezaei, M., M. A. Karimi Torshizi, and Y. Rouzbehan (2011). The influence of different levels of micronized insoluble fibre on broiler performance and litter moisture. *Poult. Sci*., 90,2008-2012.
18. Ritz, C.W.,Brian D.Fairchild., and Michael P.Lacy (2009). Litter quality and broiler performance. Learning for life. *Extension poultry Scientists Bulletin* 1267.
19. Sadeghi, Ali Asghar., Amineh Mohammadi., Parvin Shawrang., and Mehdi Aminafshar. (2013). Immune responses to dietary inclusion of prebiotic-based mannan-oligosaccharide and β-glucan in broiler chicks challenged with Salmonella enteritidis. *Turkish Journal of Veterinary and Animal Sciences*, 37, 206-213.
20. Sarica, M., and M. Akif Cam. (1996). The effect of reused litter materials on broiler performances and litter properties. *Tr. Journal of Veterinary and Animal Sciences*,22,213-219.
21. Shao, Y., Guo, Y., Wang, Z. 2013. beta-1,3/1,6-Glucan alleviated intestinal mucosal barrier impairment of broiler chickens challenged with Salmonella enterica serovar Typhimurium. *Poult. Sci*. 92, 1764–1773.
22. Snedecor, G. W. and W. G. Cochran (2002). *Statistical Methods, 8th Edition*, Oxford and IBH publishing company Calcutta, Bombay and New Delhi.
23. Stanley, V. G., C. Gray, M. Daley.,W. F. Krueger., and A. E. Sefton. (2004). An Alternative to Antibiotic-Based Drugs in Feed for Enhancing Performance of Broilers Grown on Eimeria spp.-Infected Litter. *Poult. Sci*., 83, 39–44.
24. Tasistro, A.S., C.W. Ritzand., & D.E. Kissel. (2007). Ammonia emissions from broiler litter: response to bedding materials and acidifiers. *British Poultry Science* ,48(4) 399-405.
25. Vesna, T., Lazarevic M., Sinovec. Z., and Tokic, A. (2007). The Influences of Different Feed Additives to Performance and Immune Response in Broiler Chicken. *Acta Veterinaria* (Beograd),57(2-3), 217-229.
26. Waqas, M., S. Mehmood, A. Mahmud, Saima, J. Hussain, S. Ahmad, M. Tahir Khan, A. Rehman, M.W. Zia and M.S. Shaheen. (2018). Effect of yeast based mannan oligosaccharide (Actigen™) supplementation on growth, carcass characteristics and physiological response in broiler chickens. *Indian J. Anim. Res*., ISSN:0976-0555
27. Yalcin, Sakine., Suzan Yalcin Handan., Eser Aydın Sahin. Songul Yalcin., safak Gucer. (2014). Effects of Dietary Yeast Cell Wall Supplementation on Performance, Carcass Characteristics, Antibody Production and Histopathological Changes in Broilers. *Kafkas Univ Vet Fak Derg*, 20 (5): 757-764, (2014).
28. Yang, Y., Iji, P.A. and Choct, M. (2007). Effects of different dietary levels of mannanoligosaccharide on growth performance and gut development of broiler chickens. *Asian-Aust. J. Anim. Sci*., 20:1084-1091
29. Yitbarek, A., Echeverry, H., Brady, J., Hernandez-Doria, J., Camelo-Jaimes, G., Sharif, S., Guenter, W., House, J.D., Rodriguez-Lecompte, J.C. (2012). Innate immune response to yeast-derived carbohydrates in broiler chickens fed organic diets and challenged with Clostridium perfringens. *Poult. Sci*. 91,1105–1112.

30. Youssef, I. M. I., A. Beineke., K. Rohn., and J. Kamphues. (2011). Effects of Litter Quality (Moisture, Ammonia, Uric Acid) on Development and Severity of Foot Pad Dermatitis in Growing Turkeys. *Avian diseases*, 55,51–58.

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