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Influence of Antibiotic, Prebiotic and Probiotic Supplementation to Diets on Carcass Characteristics, Hematological Indices and Internal Organ Size of Young Broiler Chickens

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Abstract: This experiment was conducted for comparison the effect of some feed growth promoter additives on carcass characteristics, internal organ weights and hematological indices of 21 days old broiler chickens. Based a randomized completely design, 300 days old Ross 308 broilers were distributed into 30 floor pens and reared for 21 days. A basal diet was formulated according to NRC recommendations for starter (0-21 days) period. The basal diet was also supplemented with antibiotic (Flavomycin), probiotic (Primalac), prebiotic (Biolex-MB) and mixture of primalac plus Biolex-MB (as synbiotic), resulting 5 dietary treatments were prepared including control group. Each dietary treatment was fed *ad libitum* to six replicates group of 10 birds at the bigining of rearing period. The highest ($p<0.05$) thigh percent was recorded for broilers fed the diet supplemented with Flavomycin, meanwhile the lower values were shown for birds fed diet supplemented with primalac. The percent of abdominal fat followed the same trend. Compared with control birds group, all other treatment groups fed growth promoter diets improved the percent of heart, but these differences were significant ($p<0.05$) only for biolex-MB and mixture of primalac plus biolex-MB group treatments. The percent of bursa of fabricius in primalac and mixture of primalac plus biolex-MB supplemented groups were significantly ($p<0.05$) higher than those in control group. The highest cholesterol concentrations were recorded for birds fed both control and diet supplemented with flavomycin groups while least concentration was found for birds fed diet supplemented with primalac.

Key words: Broiler, cholesterol, internal organ, flavomycin, biolex-MB, primalac

INTRODUCTION

Antibiotics have been widely used extensively in poultry feed for >50 years but the ban on antibiotic growth promoters in some parts of the world legislations has promoted to the search for alternatives. Therefore, prebiotics and probiotics, which are considered to be the alternatives as non-antibiotic growth promoters are being more popular in poultry industry (Yalcinkaya *et al*., 2008). But the effectiveness of such compounds and the appropriate level of their use must be analyzed (Javed *et al*., 2002). Probiotics are live microbial feed supplements, which benefically affects the host animal by improving its intestinal balance (Fuller, 1989). Primalac is a kind of commercial probiotic that contains at least 1×108 cfu g^{-1} *lactobacillus casei*, *Lactobacillus acidophilus*, *Bifidobacterium thermophilum* and *Enterococcus faesium* (Chichlowski *et al*., 2007a, b). Prebiotics are nondigestible food ingeredient that benefically affects the host by selectively stimulating the growth and/or activity of one or a limited number of bacteria in the colon (Gibson and Roberfroid, 1995). Biolex-MB is a commercial prebiotic of the mannan-oligosaccharides family, which is obtained by extraction from the outer cell wall of the yeast *Saccharomyces cerviciae*. Various findings on the effect of different probiotics and prebiotics on the carcass characteristics of the broiler chickens was reported (Kabir *et al*., 2004; Piray *et al*., 2007). Hematological indices and internal organs weights are affected by multiple environmental stresses and conditions (Zakia and El-Ghamdi, 2008). These effects differed according to age, period of exposure, single or concurrent stresses, the intensity and the environmental management programs (Kannan *et al*., 2005; Zakia and El-Ghamdi, 2008). Any change in the weight of organs shows a change in their respective functions and related with the bird's health (Chichlowski *et al*., 2007a; Yalcinkaya *et al*., 2008).

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Pathogenic bacteria can leave undesirable effects on the Gastro Intestinal (GI) tract function and are harmful to the bird due to their stimulation of the immune system. It is reported that the use of probiotics and prebiotics have benefit effects in improving the immune system function and the health of the GI tract (Yalcinkaya *et al*., 2008). The aim of this study was comparing the effects of flavomycin, primalac, biolex-MB and the primalac-biolex-MB mixture (as synbiotic) on carcass characteristics, the weight of internal organs and blood parameters of broiler chickens during starting period.

MATERIALS AND METHODS

Experimental design: In this study, 300 broiler chickens of the commercial Ross 308 strain were used in a randomized completely design with 5 treatments and 6 replicates in each treatment and 10 birds replicates^{-1} and reared on the floor pens for 21 days. Before beginning, this study, the dry matter, crude protein, ether extract, crude fiber and ash contents of main feed ingredients were determined in the laborabry to make sure of the presence of sufficient amounts of protein and crude fiber content of the ration (AOAC, 1984). A basal deit was formulated as control according to NRC (1994) recommendations for starter (0-21 days) period. Four tested diets were formulated by supplemented the basal control diet with antibiotic (Flavomycin, 650 g ton^{-1}), probiotic (Primalac, 900 g ton^{-1}), prebiotic (biolex-MB, 2000 g ton^{-1}) and mixture of Primalac (900 g ton^{-1}) + biolex-MB (2000 g ton^{-1}), respectively. Six replicates were used for each treatment (Table 1). During the experiment, water and feed were given to the birds *ad libitum* and antibiotic or coccidiostat were not offered to them.

Sample collection: At 21st day of the experimental period, 3 mL of blood was collected from wing vein from 6 birds in each treatment. Blood samples were centrifuged (at 2,000×rpm for 10 min) and serum was separated and then stored at -20°C until assayed for measuring blood parameters (glucose, total protein, albumin, cholesterol, triglyceride and High Density Lipoprotein (HDL) cholesterol) using appropriate laboratory kits (Friedewald *et al*., 1972; Gordon *et al*., 1977; Gowenlock *et al*., 1988). The serum globulin was calculated by subtracting serum albumin from serum total protein levels. Very Low Density Lipoprotein (VLDL) cholesterol was calculated from triglycerides by dividing the factor 5. The Low Density Lipoprotein (LDL) cholesterol was calculated by using the formula:

LDL cholesterol = Total cholesterol-HDL cholesterol-VLDL cholesterol

Table 1: The experiment basal diets composition and calculated proximate analysis (on dry matter basis)

Ingredients	Starter (0-21 days)
Corn	58.07
Soybean meal	27.12
Cotton meal	10.00
Soybean oil	1.16
Ground limestone	1.17
DCP	1.34
Salt	0.40
Vitamin and mineral premix	0.50
Coccidiostat	-
Vitamin E	0.03
DL-methionine	0.11
L-lysine	0.10
Nutrient content	
ME (kcal kg^{-1})	2850.00
Crude protein (%)	20.48
Crude fiber (%)	4.37

Vitamin and mineral provided per kilogram of diet: Vitamin A, 360000 IU; vitamin D3, 800000 IU; vitamin E, 7200 IU; vitamin K3, 800 mg; vitamin B1, 720 mg; vitamin B9, 400 mg; vitamin H2, 40 mg; vitamin B2, 2640 mg, vitamin B3, 4000 mg; vitamin B5, 12000 mg; vitamin B6, 1200 mg; vitamin B12, 6 mg; Choline: 200000 mg; Manganese: 40000 mg; Iron: 20000 mg; Zinc: 40000 mg, copper, 4000 mg; Iodine: 400 mg; Selenium: 80 mg

Then the birds were weighted and slaughtered for separation of carcasses (Perreault and Leeson, 1992). The liver, pancreas, gizzard, spleen, bursa of fabricius and heart were removed and weighted and expressed as relative organ weight (g/100 of live weights).

Statistical analysis: All data were analyzed using the one-way ANOVA procedure of SAS® (SAS, 1998) for analysis of variance. Significant differences among treatments were identified at 5% level by Duncan's (1955) multiple range tests.

RESULTS AND DISCUSSION

Carcass characteristic: The effects of experimental treatments on some internal organs of the young broiler chickens are shown in Table 2. The growth stimulating additives had no significant effect on the percent of breast, gizzard, liver, spleen and pancreas ($p>0.05$). These findings supported the reports made by Pelicia *et al*. (2004), Kalavathy *et al*. (2003) and Huang *et al*. (2007). The percent of thigh and abdominal fat in Flovomycin treatment was higher than primalac treatment ($p<0.05$). In the birds under primalac treatment, the abdominal fat percent was significantly reduced as compared with those fed a diet containing biolex-MB ($p<0.05$). Santos *et al*. (1995) reported that supplementing of broiler's diet with *Bacillus subtilis* reduced the abdominal fat content significantly. Jin *et al*. (1998), observed a reduction in the abdominal fat content in broilers fed probiotic and

suggested that probiotics could intervene in the accessibility to fatty acids for adipose tissue formation. The percent of the heart in biolex-MB and synbiotic Treatment was higher than that in control group ($p<0.05$). Yalcinkaya *et al*. (2008), using different levels of Mannan Oligosaccharids (MOS) observed significant differences in the weight of hearts between different nutrition treatments. In the study, the difference between the chickens heart size may be due to a difference in the growth rate and a higher need of chickens treated by biolex-MB and synbiotic to oxygen supply in tissues (Witzel *et al*., 1990). Supplementation of primalac and the synbiotic in the diet significantly increased the percent of bursa fabrecius as compared with the control group ($p<0.05$). The same results were reported by Yalcinkaya *et al*. (2008) and Ao *et al*. (2004), which were in contrast whit those reported by Chichlowski *et al*. (2007).

Blood parameters: The effect of experimental treatments on blood parameters are shown in Table 3 and 4. The blood parameters was not affected by treatments, with an exception of cholesterol. In this experiment, the serum cholesterol content of the birds under Primalac and synbiotic treatments was lower as compared whit other groups ($p<0.05$). Also, the birds fed primalac had the lower serum cholesterol level than Biolex-MB treatments ($p<0.05$). In agreement whit our findings, it is reported that the probiotic supplementation significantly reduces the serum cholesterol level of the chickens (Panda *et al*., 2001; Kalavathy *et al*., 2003; Jin *et al*., 1998). Tizard *et al*. (1989) reported that mannans and other similar carbohydrates (such as fructans) prevent from cholesterol absorption in GI tract. In contrast, Yalcinkaya *et al*. (2008) reported that the use of MOS in broiler's diet could not significantly reduce the serum cholesterol and triglyceride levels as compared with the control group. Synthesis of bile acids from cholesterol in the liver is a major route of cholesterol excretion (Wilson *et al*., 1998). The use of probiotics and prebiotics, due to lactic acid bacteria activity can be effective in reducing the cholesterol level by producing enzymes disintegrating bile salts and making

Table 2: The effect of flavomycin, primalac, biolex-MB and synbiotic as feed additives on carcass composition and organs (as percentage of live weight) of broiler chickens (mean±SE)

	Treatments					
Variables	Control	Flavomycin	Primalac	Biolex-MB	Synbiotic	p-value
Thigh	17.700±0.46^{ab}	19.220±0.46^{a}	16.760±0.82^{b}	18.180±1.05^{ab}	18.480±0.56^{ab}	0.234
Breast	15.920±0.40^{a}	15.060±0.82^{a}	15.320±1.07^{a}	17.640±2.58^{a}	15.880±0.17^{a}	0.684
Abdominal	0.830±0.06^{ab}	0.990±0.07^{a}	0.740±0.06^{b}	0.970±0.05^{a}	0.830±0.07^{ab}	0.105
Fat						
Gizzard	2.640±0.03^{a}	2.840±0.09^{a}	2.700±0.08^{a}	2.660±0.12^{a}	2.800±0.10^{a}	0.502
Heart	0.610±0.01^{b}	0.640±0.008^{ab}	0.650±0.03^{ab}	0.710±0.03^{a}	0.700±0.01^{a}	0.107
liver	2.920±0.16^{a}	2.930±0.20^{a}	2.840±0.30^{a}	2.770±0.11^{a}	3.040±0.21^{a}	0.913
spleen	0.080±0.01^{a}	0.090±0.003^{a}	0.090±0.01^{a}	0.100±0.01^{a}	0.090±0.006^{a}	0.884
Bursa	0.210±0.001^{b}	0.212±0.0008^{ab}	0.217±0.005^{a}	0.213±0.002^{ab}	0.216±0.002^{a}	0.090
Pancreas	0.271±0.002^{a}	0.267±0.0033^{a}	0.275±0.005^{a}	0.264±0.004^{a}	0.271±0.014^{a}	0.841

^{a,b,c}: Means in each row with different superscripts are significantly different ($p<0.05$)

Table 3: The effect of flavomycin, primalac, biolex-MB and synbiotic as feed additives on serum total protein, albumin, globulin and glucose of broiler chickens (mean±SE)

Parameters	Total protein (g dL^{-1})	Albumin (g dL^{-1})	Globulin (g dL^{-1})	Glucose (mg dL^{-1})
Treatments				
Control	3.75±0.05^{a}	1.72±0.08^{a}	2.03±0.13^{a}	261.00±17.55^{a}
Flavomycin	3.91±0.16^{a}	1.72±0.13^{a}	2.19±0.12^{a}	256.33±5.89^{a}
Primalac	3.87±0.07^{a}	1.80±0.04^{a}	2.07±0.10^{a}	262.67±13.24^{a}
Biolex-MB	4.01±0.11^{a}	1.84±0.12^{a}	2.16±0.12^{a}	259.00±2.51^{a}
Synbiotic	3.17±0.09^{a}	1.80±0.15^{a}	2.05±0.17^{a}	248.00±14.73^{a}
p-value	0.551	0.915	0.882	0.919

^{a,b,c}: Means in each column with different superscripts are significant different ($p<0.05$)

Table 4: The effect of flavomycin, primalac, biolex-MB and synbiotic as feed additives on on serum lipid concentrations of broiler chickens

Parameters	Cholesterol (g dL^{-1})	Triglycerids (g dL^{-1})	HDL (mg dL^{-1})	LDL (mg dL^{-1})	VLDL (mg dL^{-1})
Treatments					
Control	150.66±1.33^{a}	92.67±6.69^{a}	72.33±1.76^{a}	59.80±2.00^{a}	18.53±1.33^{a}
Flavomycin	155.00±8.14^{a}	93.67±3.17^{a}	77.00±9.29^{a}	59.27±17.15^{a}	18.73±0.63^{a}
Primalac	128.66±4.64^{c}	81.67±5.84^{a}	87.33±2.84^{a}	34.00±6.53^{a}	16.33±1.16^{a}
Biolex-MB	145.33±4.33^{ab}	99.33±11.09^{a}	81.66±8.81^{a}	43.80±10.80^{a}	19.86±2.21^{a}
Synbiotic	134.33±0.88^{bc}	92.00±10.96^{a}	83.33±0.66^{a}	27.60±0.90^{a}	18.40±2.19^{a}
p-value	0.012	0.661	0.448	0.128	0.661

^{a,b,c}: Means in each column with different superscripts are significant different ($p<0.05$); HDL cholesterol: High Density Lipoprotein cholesterol; LDL cholesterol: Low Density Lipoprotein cholesterol; VLDL cholesterol: Very Low Density Lipoprotein cholesterol

themunconjugated, as well as by reducing the pH in the intestinal lumen. The solubility of unconjugated bile acids is reduced at low pH levels and consequently, they are absorbed less by the intestine and are excreted more in the feces (Klaver and Van der Meer, 1993; Surono, 2003). Therefore, the liver for resuming the hepatic cycle of bile acids, converts more cholesterol to the bile and the cholesterol content of tissues and the blood is reduced (Ros, 2000). Lack of a significant difference in other hematological parameters and between the treated and untreated birds illustrate a normal metabolism in their bodies.

CONCLUSION

The use of primalac is the more effective than biolex and flavomycin in reducing the proportion of the abdominal fat as well as reducing the serum cholesterol. This plays an important role in increasing the economic efficiency and conserving the health of consumers.

REFERENCES

Ao, Z., A. Koccher, L.A. Tucher and M. Choct, 2004. The use of oligosaccharides to improve broiler performance. XXII World's Poultry Congress, Istanbul, pp: 477.

AOAC, 1984. Association of Official Analytical Chemists. Official Methods of Analysis. 14th Edn. The William Byrd Press. Inc. Richmond, Verginia, USA.

Chichlowski, M., J. Croom, B.W. McBride, L. Daniel, G. Davis and M.D. Koci, 2007a. Direct-fed microbial primalac and salinomycin modulate whole body and intestinal oxygen consumption and intestinal mucosal cytokine production in the broiler chick. Poult. Sci., 86: 1100-1106. http://ps.fass.org/cgi/reprint/86/6/1100?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&sortspec=relevance&volume=86&firstpage=1100&resourcetype=HWCIT.

Chichlowski, M., J. Croom, F.W. Edens, B.W. McBride, R. Qui, C.C. Chiang, L.R. Daniel, G.B. Havenstein and M.D. Koci, 2007b. Microarchitecture and spatial relationship between bacreria and ileal, cacal and colonic epithelium in chicks fed a direct-fed microbial, primalac and salinomycin. Poult. Sci., 86: 1121-1132. http://ps.fass.org/cgi/reprint/86/6/1121?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&sortspec=relevance&volume=86&firstpage=1121&resourcetype=HWCIT.

Chichlowski, M., J. Croom, B.W. McBride, L. Daniel, G. Davis and M.D. Koci, 2007. Direct-fed microbial primalac and salinomycin modulate whole-body and intestinal oxygen consumption and intestinal mucosal cytokine production in the broiler chick. Poult. Sci., 86: 1100-1106. http://ps.fass.org/cgi/reprint/86/6/1100?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&sortspec=relevance&volume=86&firstpage=1100&resourcetype=HWCIT.

Duncan, D.B., 1955. Multiple Range and F-tests Biometrics., 11: 1-42.

Friedewald, W.T., R.I. Levy and D.S. Fredrickson, 1972. Estimation of the concentration of LDL cholesterol in plasma, without use of the preparative ultracentrifuge. Clin. Chem., 18: 499-504. http://www.clinchem.org/cgi/reprint/18/6/499?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&andorexactfulltext=and&searchid=1&FIRSTINDEX=0&sortspec=relevance&volume=18&firstpage=499&resourcetype=HWCIT.

Fuller, R., 1989. Probiotics in man and animals. J. Appl. Bacteriol., 66: 365-378. DOI: 10.1111/j.1365-2672.1989.tb05105.x. http://www3.interscience.wiley.com/cgi-bin/fulltext/120151931/PDFSTART.

Gibson, G.R. and M.B. Roberfroid, 1995. Dietary modulation of the human colonic microbiota: Introducing the concept of probiotic. J. Nutr., 125: 1401-1412. http://jn.nutrition.org/cgi/reprint/125/6/1401?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&author1=gibson&andorexactfulltext=and&searchid=1&FIRSTINDEX=0&sortspec=relevance&volume=125&resourcetype=HWCIT.

Gordon, T., W.P. Castelli, M.C. Hjortland, W.B. Kannel and T.R. Dawber, 1977. High density lipoprotein as a protective factor against coronary heart disease: The framingham study. Am. J. Med., 62: 707-714.

Gowenlock, A.H., J.R. McMurray and D.M. McLauchlan, 1988. Varley's Practical Clinical Biochemistry. 6th Edn. CAS Publishers and Distributors, New Delhi, pp: 477-549.

Huang, R.L., Z.Y. Deng, C.B.Yang, Y.L. Yin, M.Y. Xie, G.Y. Wu, T.J. Li, L.L. Li, Z-R.Tang, P. Kang, Z.P. Hou, D. Deng, H. Xiang, X.F. Kong and Y.M. Guo, 2007. Dietary oligochitosan supplementation enhances immune status of broilers. J. Sci. Food Agric., 87: 153-159. http://www3.interscience.wiley.com/cgi-bin/fulltext/113448826/PDFSTART.

Javed, M.T., M.A. Sarwar, R. Kausar and I. Ahmad, 2002. Effects of feeding different levels of formalin (37% formaldehyde) and urea on broiler health and performance. Veterinarski ARHIV, 72: 285-302. http://www.vef.hr/vetarhiv/papers/72-5/javed.pdf.

Jin, L.Z., Y.W. Ho, N. Abdullah and S. Jalaludin, 1998. Growth performance, intestinal microbial populations and serum cholesterol of broilers fed diets containing *Lactobacillus* cultures. Poult. Sci., 77: 1259-1265. http://ps.fass.org/cgi/reprint/77/9/1259.

Kabir, S.M.L., M.B. Rahman, M.M. Rahman and S.U. Ahmed, 2004. The dynamics of probiotics on growth performance and immune response in broilers. Int. J. Poult. Sci., 3: 361-364. http://www.pjbs.org/ijps/fin205.pdf.

Kalavathy, R., N. Abdullah, S. Jalaludin and Y.W. Ho, 2003. Effects of *Lactobacillus* cultures on growth performance, abdominal fat deposition, serum lipids and weight of organs of broiler chickens. Br. J. Poult. Sci., 44: 139-144. DOI: 10.1080/0007166031000085445.

Klaver, F.A.M. and R. van der Meer, 1993. The assumed assimilation of cholesterol by lactobacilli and Bifidobacterium bifidum is due to their bile saltdeconjugating activity. Appli. Environ. Microb., 59: 1120-1124. http://aem.asm.org/cgi/reprint/59/4/1120?maxtoshow=&HITS=10&hits=10&RESULTFORMAT=&searchid=1&FIRSTINDEX=0&volume=59&firstpage=1120&resourcetype=HWCIT.

Kannan, M., R. Karunakaran, V. Balakrishnan and T.G. Prabhakar, 2005. Influence of prebiotics supplementation on lipid profile of broilers. Int. J. Poult. Sci., 4 (12): 994-997. http://www.pjbs.org/ijps/fin501.pdf.

NRC, 1994. National Research Council. Nutrient Requirements of Poultry. 9th. Rev. Edn. National Academy Press, Washington, DC. http://books.nap.edu/openbook.php?isbn=0309048923.

Panda, A.K., M.R. Reddy and N.K. Praharaj, 2001. Dietary supplementation of probiotic on growth, serum cholesterol and gut microflora of broilers. Indian J. Anim. Sci., 71: 488-490.

Pelicia, K., A.A. Mendes, E.S.P.B. Saldanha, C.C. Pizzolante, S.E. Takahashi, J. Moreira, R.G. Garcia, R.R. Quinterio, L.C.L.A. Paz and C.M. Komiyama, 2004. Use of prebiotics and probiotics of bacterial and yeast origin for free-range broiler chickens. Braz. J. Poult. Sci., 6: 163-169. DOI:10.1590/S1516-635X2004000300006.http://www.scielo.br/pdf/rbca/v6n3/a06v6n3.pdf.

Perreault, N. and S. Leeson, 1992. Age-related carcass composition changes in male broiler chickens. Can. J. Anim. Sci., 72: 919-929.

Piray, A.H., H. Kermanshahi, A.M. Tahmasbi and J. Bahrampour, 2007. Effects of cecal cultures and aspergillus meal prebiotic (Fermacto) on growth performance and organ weights of broiler chickens. Int. J. Poult. Sci., 6 (5): 340-344. http://www.pjbs.org/ijps/fin807.pdf.

Ros, E., 2000. Intestinal absorption of triglyceride and cholesterol. Dietary and pharmacological inhibition to reduce cardiovascular risk. Atherosclerosis, 51: 357-379. DOI: 10.1016/S0021-9150(00)00456-1.

Santose, U., K. Tanaka and S. Ohtani, 1995. Effect of dried *Bacillus subtilis* culture on growth, body composition and hepatic lipogenic enzyme activity in female broiler chicks. Br. J. Nutr., 74: 523-529. DOI: 10.1079/BJN19950155.

SAS, 1998. SAS/STAT user's Guide Edn.: SAS Institute Inc., Cary, NC.

Surono, I.S., 2003. *In vitro* probiotic properties of indigenous dadih lactic acid bacteria. Asian Aust. J. Anim. Sci., 16: 726-731.

Tizard, I.R., R.H. Carpenter, B.H. McAnalley and M.C. Kemp, 1989. The biological activities of mannans and related complexcarbohydrates. Mol. Biother., 1: 290-296.

Wilson, T.A., R.J. Nicolosi, E.J. Rogers, R. Sacchiero and D.J. Goldberg, 1998. Studies of cholesterol and bile acid metabolism and early atherogenesis in hamsters fed GT16-239, a novel Bile Acid Sequestrant (BAS), Atherosclerosis, 40: 315-324.

Witzel, D.A., W.E. Huff, L.F. Kubena, R.B. Harvey and M.H. Elissalde, 1990. Ascites in growing broilers. Poult. Sci., 69: 741-745.

Yalcinkaya, I., T. Gungor and M. Basalan, 2008. Effect of Mannanoligasaccharide (MOS) from *Saccharomyces cerevisiae* on some internal, gastrointestinal and carcass parameters in broilers. J. Anim. Vet. Sci., 7 (7): 789-792. http://medwelljournals.com/fulltext/java/2008/789-792.pdf.

Zakia, A.M.A. and Z.H. El-Ghamdi, 2008. Multiple environmental stresses and broiler internal organs somatic indices under controlled environment. Int. J. Poult. Sci., 7 (11): 1089-1094. http://www.pjbs.org/ijps/fin1132.pdf.