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Effect of yeast (*Saccharomyces cerevisiae*) supple-mentation on the growthperformance,haematological and serum biochemical parameters of broiler chicken

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Abstract

A total number of one hundred and sixty five (165) unsexed day old Cobb® 500 broiler chicks were randomly allotted into five (5) dietary groups in a completely randomized design to evaluate the effect of yeast (Saccharomyces cerevisiae) supplementation on the growth performance, haematological and serum biochemical indices of broiler chicken. The experiment lasted for 56 days. Yeast was incorporated into the experimental diets at varying levels of 0.0, 1.5, 2.0, 2.5 and 3.0% to formulate five dietary treatments. Each treatment group consisted of three (3) replicates of eleven (11) birds per replicate. Data were collected on the growth performance and blood samples were collected and utilized in assessing haematological and serum biochemical indices of broiler chicken. Results showed that yeast supplemented diets had significantly (P<0.05) influenced growth parameters. Although there were no significant difference (P>0.05) in birds fed yeast supplemented diets but those in 3% yeast supplemented diets recorded the highest numerical values in total weight gain (2044.80 g/b) and the best feed conversion ratio (1.94). Haematological parameters such as Packed cell volume, White blood cell, Heterophil, Monocytes, Eosinophil and Mean corpuscular haemoglobin concentration were significantly (P<0.05) influenced by the dietary treatments unlike the mean corpuscular haemoglobin, mean corpuscular volume, lymphocyte, haemoglobin and Red blood cells count. Significant differences (P<0.05) were observed on all the serum biochemical indices except the total protein, globulin and glucose. Nevertheless, values obtained in this study fell within the normal range recommended for healthy broiler chickens. Conclusively, yeast can be supplemented up to 3.0% in the diets of broiler chicken without any detrimental effect on the performance and the health status of broiler chicken.

Keywords: *Yeast, Broiler chicken, Growth and Blood profile*

Description of Problem

One of the major obstacles faced by the poultry farmers in the developing world is about improving efficiency of production. To meet this challenge and maintain the efficiency of feed utilization, many attempts have been made to improve the utilization of the available nutrients present in the diet by adding dietary supplementation of several growths feed additives such as *Saccharomyces cerevisiae*, that contains numerous enzymes from different sources (1). However, yeast has long been included as a feed additive to increase broiler's growth rate and disease control (2). It is a performance enhancer through improvement in protein utilization and significant retention of crude fibre and degradation of fibrous material in poultry feeds. (3) reported that inclusion of active dried yeast in the diet of birds improved their growth performance. Yeast is considered as one of the living microorganism that when administered

through digestive tract had positive impact on broiler health through its nutritional effects (4). It also boosts immune level resulting in a better protection against infection (5). Some studies have confirmed the effects of yeast culture as an alternative to antibiotics in feed of broiler chicks (6). Yeast cells improve the internal mucosa of the fed birds and it might suggest why the performance of broiler chicken is improved. Broiler receiving yeast to replace part of the premix had better average weight gain and feed conversion ratio (7). Better weight gain and feed conversion were found among broilers fed with 0.2 to 1.0% of brewer's yeast. (8). Blood is a major index of physiology, pathology and nutritional status of any animal (9). The analysis of blood is important chemically because it provides a means of accessing the health status of the animal. Therefore, the objectives of this study was to evaluate the growth characteristics, haematological and serum biochemical indices of broiler chicken fed yeast (*Saccharomyces Cerevisiae*) supplemented diets

Materials and Methods

Experimental site, Animals, Management and Design

The experiment was conducted at the Teaching and Research Farm of the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan.

A total of one hundred and sixty five (165) day old Cobb® 500 chicks were purchased from a reputable hatchery in Ibadan and used for this experiment. They were brooded for two (2) weeks under similar managerial and hygienic conditions. All vaccination schedules and medication were administered according to the scheduled of the farm. Birds were fed same feed and water during the two (2) weeks of brooding until after adaptation periods. After the adaptation period, the birds were randomly allotted to five dietary treatments containing different levels of yeast in a completely randomized design and the experiment lasted for eight weeks. The birds were reared in a deep litter system with feed and water provided *ad libitum* during the experimental period (8 weeks). The chemical composition of yeast (*Saccharomyces Cerevisiae*) was also determined and all the diets were formulated to meet the nutrient requirements of the broiler chicken (10).

Preparation of Experimental Diet: Yeast was incorporated into the diets at varying levels of 0.0, 1.5, 2.0, 2.5 and 3.0% respectively to formulate five diets.

Data Collection

Feed intake and live weight changes

The weight changes of the birds in response to the experimental diets was monitored by taking their pre-experimental body weights, followed by weekly weighing purposely to determine weight changes

Feed intake was computed on daily basis by considering the daily feed offered less the refusal per bird. Average feed intake, body weight gain and feed conversion ratio (feed/gain) were calculated for the overall experimental periods.

Collection of blood samples

6ml of blood sample was collected from the nine (9) randomly selected experimental birds per treatment via the jugular vein using hypodermic needle and syringe. Blood collection was at the eight

week of the experiment. 3ml out of the 6ml blood sample collected was released into a sample bottles containing Ethyl Diamine Tetra Acetic Acid (EDTA) as anticoagulant and the bottles were gently shaken to ensure proper mixing of the blood with EDTA to prevent coagulation for haematological assay (11). The remaining 3ml of blood samples was poured into a plain sample bottles and left to coagulate for serum biochemical indices determination. Blood samples were analyzed according to routinely available clinical methods. The following parameters Packed cell volume (PCV), Haemoglobin (Hb), Red blood cell (RBC), white blood cell (WBC), Mean corpuscular volume (MCV), Mean corpuscular haemoglobin concentration (MCHC), Mean corpuscular haemoglobin (MCH), Differential WBC namely; Monocytes, Neutrophils, Lymphocytes and heterophil. The PCV was determined using the wintrobe haematocrit method described by (12). WBC and RBC were determined using haemocytometer after appropriate dilution (13), Haemoglobin and Mean corpuscular volume (14). Biochemical components of the serum samples estimated were total protein (g/dl) was determined according to Biuret Method (15) while albumin (g/dl) level was obtained using Bromocresol green method as described by (16). Blood glucose (mg/dl) level was determined according to the method recommended by (17), urea (mg/dl), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined using spectophotometric methods.

Chemical Analysis and Statistical Analysis

Aliquot of daily feed samples (concentrates) was collected, oven-dried, ground and sieved through a 2-mm sieve and stored in airtight containers for proximate (18). Data collected were subjected to analysis of variance while significant means among variables were separated using Duncan Multiple Range test according to procedure of (19).

Results and Discussion

The effects of feeding graded levels of yeast *Saccharomyces cerevisiae* (SC) on the growth performance of broiler chickens is shown in Table 3. Yeast supplemented diets significantly ($P<0.05$) increased the feed intake of the broiler chicken compared to the value gotten for the birds on control diet. The increased feed intake of the broiler chicken fed yeast supplemented diets could be attributed to the influence of yeast supplementation on the palatability of the diet. (20) Stated that the voluntary feed intake of any animal is a primary determinant of the nutrient digestibility and productivity. (21) reported that nutrient intake is the most important factors that affect animal performance. The result obtained in this study was in agreement with the reported of (22) who reported that yeast supplemented based diet improved feed/gain ratio and BW gain. The total weight gain values observed in this study increased significantly across the dietary treatments as the yeast inclusion level increased. Values for total weight gain and daily weight gain were similar in birds on yeast supplementation diet but higher than those fed control diet. (23) reported that feed/gain ratio of broiler chicks from day 1 to 9 weeks of age improved significantly as the SC level in the diets increased. Birds fed 3% yeast supplemented based diet recorded the best feed conversion ratio (1.94), although birds fed diet containing

Table 1: Composition of experimental diets during the Starter phase containing varying levels of yeast

	Yeast inclusion level				
Ingredients (kg)	**T_1 (0%)**	**T_2 (1.5%)**	**T_3 (2.0%)**	**T_4 (2.5%)**	**T_5 (3.0%)**
Maize	54.0	54.0	54.0	54.0	54.0
Soya bean meal	25.0	23.5	23.0	22.5	22.0
Yeast	-	1.50	2.00	2.50	3.00
Full fat soya bean	17.27	17.27	17.27	17.27	17.27
Di-calcium phosphate	2.40	2.40	2.40	2.40	2.40
Lysine	0.08	0.08	0.08	0.08	0.08
Methionine	0.15	0.15	0.15	0.15	0.15
Limestone	0.60	0.60	0.60	0.60	0.60
Broiler premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Analysed Content					
Dry Matter	88.95	89.24	89.08	89.44	88.97
Crude protein	21.58	20.97	21.29	21.65	21.78
Crude Fibre	3.94	3.94	3.94	3.94	3.94
Ether Extract	3.57	3.68	3.64	3.55	3.73
Total Ash	6.57	6.71	6.49	6.89	6.38
Nitrogen free extract	53.60	53.80	53.87	53.32	53.03

ME: Metabolizable Energy; Vit. A: 1 0,000 iu; Vit. D_3: 2000 iu; Vit. E: 23 mg; Vit. K: 2 mg; Vit B_1: 1.8 mg; Vit. B_2: 5.5 mg; Niacin: 27.5 mg; Pantothenic acid: 7.5 mg; Vit B_{12}:0.015 mg; Folic acid: 0.75 mg; Biotin: 0.06 mg; Choline chloride: 300 mg; Cobalt: 0.2 mg; Copper: 3 mg; Iodine: 1 m g; Iron: 20 mg; Manganese: 40 mg; Selenium: 0.2 mg; Zinc: 30 mg; Antioxidant: 1.25 mg

Table 2: Composition of the Experimental diet during the finisher phase containing varying levels of yeast

	Yeast inclusion level				
Ingredients (kg)	**T_1 (0%)**	**T_2 (1.5%)**	**T_3 (2.0%)**	**T_4 (2.5%)**	**T_5 (3.0%)**
Maize	63.00	63.00	63.00	63.00	63.00
Soya bean meal	16.71	15.21	14.71	14.21	13.71
Yeast	-	1.50	2.00	2.50	3.00
Full fat soya	17.00	17.00	17.00	17.00	17.00
Di-calcium phosphate	2.00	2.00	2.00	2.00	2.00
Lysine	0.05	0.05	0.05	0.05	0.05
Methionine	0.14	0.14	0.14	0.14	0.14
Limestone	0.60	0.60	0.60	0.60	0.60
Broiler premix	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Analysed content					
Dry Matter	95.31	89.36	88.92	89.15	88.89
Crude protein	20.89	20.97	21.15	20.78	21.49
Crude Fibre	2.65	2.65	2.65	2.65	2.65
Ether Extract	3.61	3.66	3.59	3.63	3.72
Total Ash	6.66	6.28	6.93	6.85	6.37
Nitrogen free extract	54.33	54.12	53.37	53.67	53.43

ME: Metabolizable Energy; Vit. A: 10,000 iu; Vit. D_3: 2000 iu; Vit. E: 23 mg; Vit. K: 2 mg; Vit B_1: 1.8 mg; Vit. B_2: 5.5 mg; Niacin: 27.5 mg; Pantothenic acid: 7.5 mg; Vit B_{12}:0.015 mg; Folic acid: 0.75 mg; Biotin: 0.06 mg; Choline chloride: 300 mg; Cobalt: 0.2 mg; Copper: 3 mg; Iodine: 1 mg; Iron: 20 mg; Manganese: 40 mg; Selenium: 0.2 mg; Zinc: 30 mg; Antioxidant: 1.25 mg

Table 3: Effects of yeast Suppliementation on the Performance Characteris of Broiler Chicken

Parameters	T_1 (0%)	T_2 (1.5%)	T_3 (2.0%)	T_4 (2.5%)	T_5 (3.0%)	SEM±
Initial wt (g/b)	115.37	112.43	109.20	108.40	107.70	1.25
Final wt (g/b)	1329.00^{b}	2045.00^{a}	2090.50^{a}	2041.9^{a}	2152.00^{a}	98.95
TWG (g/b)	1233.70^{b}	1932.50^{a}	1981.30^{a}	1933.50^{a}	2044.80^{a}	99.57
DWG (g/b/d)	22.03^{b}	34.51^{a}	35.38^{a}	34.53^{a}	36.51^{a}	1.78
TFI (g/b)	3444.20^{b}	4100.00^{a}	3970.40^{a}	3779.00^{ab}	3854.6^{ab}	82.26
ADFI (g/b/d)	61.50^{b}	73.21^{a}	70.90^{a}	67.48^{ab}	68.83^{ab}	1.47
FCR	2.85^{a}	2.44^{b}	2.00^{b}	1.97^{b}	1.94^{b}	0.11

^{a,b,c} Means in the same row having different superscripts are significantly different($P<0.05$). TWG: total weight gain. DWG: Daily weight gain, ADFI: Average daily feed intake, FCR: Feed Conversion Ratio

SC were not significantly different. Better FCR values recorded for treatment groups fed yeast supplemented diet could be due to the better intestinal morphology and cell proliferation in terms of increased villi height and density which could lead to better utilization of the feed. This observation is similar to that findings reported by (24) that the addition of probiotics to broiler chicken diet significantly decreased FCR. The lowest numerical FCR value obtained in birds fed 3% yeast supplemented based diet was in accordance with the report of (25) who observed that the addition of yeast extract to broiler diets led to better feed conversion ratio. It is also in harmony with the findings of (26) who stated that birds fed ration supplemented with yeast consumed more feed, grew faster and had better body weight gain than birds fed without yeast. Moreover, the obtained results confirmed the previous findings of several researchers (7, 27; 28; 29). Presented in Table 4 are the haematological parameters of broiler chicken fed diet containing varying levels of yeast supplementation. Significance differences ($P<0.05$) were observed on all the haematological parameters except the haemoglobin, red blood cell, lymphocytes, mean cell volume and mean corpuscular haemoglobin. Birds fed ration with 3% yeast supplementation expressed significantly ($P<0.05$) highest packed cell volume (PCV) values compared to other dietary treatments. This findings was not in line with observed of (30) who reported that Hubbard broiler chicken fed 3% dietary yeast supplementation recorded the lowest PCV value whereas (26) claimed that dietary inclusion of yeast had no effects on PCV of broilers diet. Difference in the findings may be attributed to different inclusion levels or kind of yeast used, experimental conditions, geographical location, basal diet and different breeds or strain of broilers used. All yeast-fed chicks observed in this study compared to control diet had a more WBC and lymphocytes but lower heterophil values than control diet. The increase in lymphocyte activity is an indication of humeral immune responses in chicks fed yeast-supplemented diets. Positive correlation between dietary inclusion levels of SC with the hematological indices like RBC, WBC and PCV have been reported in rabbit and broiler chickens (22; 31). They suggested that these correlations may be an additional mechanism growth promotion by supplemental yeast. Yeast

can therefore stimulate the immune system of chicken as revealed by the WBC. However, most of the values obtained fell within the normal range of values recommended by (32) for broiler chicken. This may probably be as a result of the beneficial effects conferred on the birds by yeast which favours the haematological indices of the birds.

Table 4: Haematological Parameters of Broiler Chicken Fed Varying Levels of Yeast Supplementation

Parameters	T_1 (0%)	T_2(1.5%)	T_3 (2.0%)	T_4(2.5%)	T_5 (3.0%)	SEM±
PCV (%)	23.00^{c}	23.50^{c}	25.00^{c}	28.00^{b}	36.00^{a}	1.14
Haemoglobin (gb/l)	7.66	8.33	8.66	7.66	9.33	0.37
RBC (x10³µl)	1.68	1.96	2.30	1.96	2.38	0.16
WBC(x106µl)	16.75^{c}	18.35^{c}	17.70^{c}	31.30^{a}	27.05^{b}	1.39
Lymph. (%)	41.75	44.25	43.00	40.75	46.50	1.12
Heterophils (%)	22.00^{c}	41.00^{b}	52.00^{a}	14.00^{d}	13.00^{e}	3.56
Monocytes (%)	3.00^{c}	5.00^{a}	5.00^{a}	4.00^{b}	3.00^{c}	0.21
Eosinophil (%)	2.00^{d}	6.00^{a}	3.00^{c}	6.00^{a}	5.00^{b}	0.37
MCV(fl)	1541.70	1305.20	1165.10	1540.40	1606.20	89.97
MCH(pg/cell)	491.38	447.08	388.59	404.44	404.39	17.06
MCHC (%)	33.04^{ab}	35.22^{a}	34.08^{ab}	27.16^{bc}	25.79^{c}	1.24

^{a,b,c,} Means in the same row having different superscripts are significantly different (P<0.05),
PCV- Packed cell volume, RBC- Red blood cell, WBC- White blood cell, MCV-Mean Corpuscular Volume, MCH-Mean Corpuscular Haemoglobin, MCHC-Mean corpuscular Haemoglobin Concentration.

Table 5 shows the serum biochemical indices of broiler chicken fed yeast-supplemented diets. Significant differences (P< 0.05) were observed for all the parameters investigated except total protein, Globulin and glucose. Serum total protein is important in osmotic regulation, immunity and transport of some several substances within the birds system. Total protein was not significantly influenced (p>0.05) but the values were observed to increase across the dietary treatment as the yeast inclusion level increased. Serum concentration of albumin was significantly affected by the dietary treatments with the birds on dietary inclusion of 3% yeast recording the highest value (2.18 g/dl). Serum total protein and albumin have been reported to be directly responsive to protein intake and quality (33). The urea, AST and ALT values obtained in this study differed significantly (p< 0.05) across the dietary treatments with the birds on 3% yeast supplementation diet had the lowest values. AST activities take place in inflammatory and degeneration lesions of the liver. Low in ALT and AST was an indication that there were no traces of liver disease and rise in ALT and AST activity was noticed in liver and kidney disease (34). High level of urea could be as a result of high protein and energy diets while low level can result from liver disease. The result obtained in this study followed a similar trend that was reported by (35).

Table 5: Effect of yeast Supplementation on the Serum biochemical indices of Broiler Chicken

Parameters	Inclusion of yeast (kg)					
	T_1 (0%)	T_2 (1.5%)	T_3 (2.0%)	T_4 (2.5%)	T_5 (3.0%)	SME ±
Total Protein (g/dl)	3.32	3.44	3.48	3.72	3.89	0.13
Albumin (g/dl)	0.89^{d}	0.95^{d}	1.20^{c}	1.58^{ab}	2.18^{a}	0.11
Globulin (g/dl)	2.43	2.49	2.28	2.14	1.71	1.13
Glucose (mg/dl)	179.44	172.77	156.11	155.55	153.33	2.45
Urea (mg/dl)	3.15^{c}	3.97^{b}	3.33^{b}	2.43^{d}	1.80^{e}	0.17
AST (iu/L)	243.96^{a}	206.67^{b}	204.27^{d}	169.09^{d}	143.44^{c}	7.91
ALT (iu/L)	6.21^{b}	9.58^{a}	7.20^{b}	6.09^{b}	5.64^{b}	0.41

^{a,b,c,} Means in the same row having different superscripts are significantly different ($P<0.05$), AST- Apartate aminotransferase, ALT- Alanine aminotransferase,

Conclusions and Application

i. Based on the result of this study, yeast supplementation in the diets of broiler chicken is recommended for improved growth performance in term of total weight gain and feed conversion ratio
ii. The inclusion of yeast in the diet of Broiler chicken had no deleterious effect on their haematological and serum biochemical indices

References

1. Abdel-Azeem, F. (2002). Digeston, neomycin and yeast supplementation in broiler diets under Egyptian summer conditions. *Egypt Poultry Science.* 22 (1): 235-257.
2. Chen, K.L., Kho, W.L., You, S.H., Yeh, R.H., Tang, S.W. and Hsieh, C.W. (2009). Effects of *Bacillus subtilis* var. *natto* and *Saccharomyces cerevisiae* mixed fermented feed on the enhanced growth performance of broilers. *Poultry Science*; 88: 309-315.
3. Abed, E. L., Wahed, H. M., El Full, E. A., Osman, A. M. R. and Hataba, N. A. (2003). Effect of replacing soybean meal with graded levels of dried yeast on growth of Dandarawi and Golden Montazah chicks. *Egypt Poultry Science*, 23: 507-522.
4. Patterson, J. A. and Burkholder, K. M. (2003). Application of prebiotics and probiotics in poultry production. *International Journal of Poultry Science,* 82: pg. 627-631
5. Panda, A. K., Reddy, S. V., Rama Rao, M. V., Raju, L. N. and Paraharaj, N. K. (2000). Growth, carcass characteristics, immune- componence and response to Escherichia coli of broiler fed diets with various level of probiotics, *Archive fur Geflugelkunde* 64:152-156.
6. Stanley, V. G., Gray, C., Daley, M., Krueger, W. F. and Sefton, A. E. (2004). An alternative to antibiotics based drugs in feed for enhancing performance of broiler grown on *Elmeria spp*- infected. *Poultry Science.* 83: 39-44.
7. Nilson, A. J., Peralta, M. F. and Miazzo, R. D. (2004). Use of Brewer's yeast to replace part of the vitamin, mineral premix in finisher broiler diets. *XXII Worlds Poultry Congress, Istanbul.* Turkey. Pp. 35-37.
8. Churchil, R. and Mohan, B. (2000). Effects of supplementation of broiler rations with live yeast culture. Cheiron 29(1-2): 23-27.

9. Adejinmi, O. O., Adejinmi, J. O. and Adeleye, I. O. A. (2000). Studies on Haematology and Serum Biochemistry of Broiler Fed Fly Larvae Meal Diets. *Animal Production Investment* 3:169-179.
10. National Research Council (1994). Nutrient requirements of poultry 9th ed. National Academy Press, Washington. DC.
11. Jain, N. C. (1986). Schalm's Veterinary haematology (4th ed.) Philadelphia, U. S. A: Lea and Fabigor
12. Wintrobe, M. M. (1933). Macroscopic examination of the blood. American Journal of Medical Science, 185: 58-59.
13. Dacie, J. V. and Lewis, S. M. (1984). Practical haematology. 6th Edition Churchill living stone. Edinburg.
14. Brown, B. A. (1976). Haematology principle and procedure (2nd ed.) Philadelphia, U. S. A: Lea and Fabigor
15. Reinhold, J. G. (1953). Standard methods of clinical chemistry, M. Reiner (Ed). Volume 188, Academic Press.
16. Peter, T., Biamonte, G. T. and Donmas, B.T (1982). Protein in serum In: Selected method of chemical chemistry G. N. R. Faulkner and S. Meites (Eds) Animal Association of clinical chemistry.
17. Cooper, G. R. and Daniel, M. C. (1970). Standard methods in serum enzyme activities. Clinical chemistry Vol. 6: 159.
18. AOAC (2000). Official methods of analysis. Association of Official Analytical Chemists (17th edition). Arlington.
19. SAS. (2004). User's Guide: Statistics, version 9.1. SAS institute Inc. Cary, NC, USA. Seattle, Washington. Pp: 156-339.
20. Morgan, J. T. and Lewis, D. (1961). Nutrition of Pigs and Poultry William clowes and Son Limited, London.
21. McDonald, P., Edwards, R. H. and Greenhalgh, J. F. D. (1995). Animal Nutrition 5th edition, Longman Publishers Ltd., Singerpore, pp: 583-585.
22. Onifade, A. A., Obiyan, R. I., Onipede, E., Adejumo, O. A., Abu, O. A. and Babatunde, G. M. (1999). Assessment of the effects of supplementing rabbit diets with a culture of Saccharomyces cerevisiae using growth performance, blood composition and clinical enzyme activities. *Animal Feed Science Technology* 77: 25-32.
23. Valdivie, M. (1975). Saccharomyces yeast as a by-product from alcohol production on final molasses in diets for broilers. *Cuban Journal of Agricultural Science.* 9: 327–331.
24. Hosseini, S. (2011). The effect of utilization of different levels of Saccharomysec cerevisiae on broiler chicken's performance. Global Vet. 6: 233- 236.
25. Saied, J. M., Al-Jabary, Q. H. and Thilij, K. M. (2011). Effect of dietary supplement yeast culture on production performance and haematological parameters in broiler chicks. *International Journal of Poultry Science* 10:376-380.
26. Talebi, A., Amirzadeh, B., Mokhtari, B. and Gahri, H. (2008).Effects of a multistrain probiotic (Primalac) on performance and antibody responses to Newcastle diseases virus vaccination in broiler chickens. Avian Pathology 37 (5): 509-512.
27. Zhang, A. W., Lee, B. D., Lee, S. K., Lee, K. W., An, G. H., Song, K. B. and Lee, C. H. (2005). Effects of Yeast (*Saccharomyces cerevisiae*) Cell Components on Growth Performance, Meat Quality, and Ilea Mucosa

Development of Broiler Chicks. *Journal of Poultry Science.* 84:1015–1021.

28. Angel, R., Dhandu, A. S., Applegate, T. J. and Christman, M. (2001). Phosphorus sparing effect of phytase, 25-hydroxycholecalciferol, and citric acid when fed to broiler chicken. *Poultry. Science* 80 (Suppl. 1):133. (Abstr.).
29. Santin, E., Maiorka, A., Macari, M., Grecco, M., Sanchezi, J. C., Okada, T. M. and Myasaka, A. M. (2001). Performance and intestinal mucosa development of broiler chickens fed diets containing *Saccharomyces cerevisiae* cell wall. *Journal Applied Poultry Resources*. 10: 236-244.
30. Mohamed, E. A., Talha, E. A., Mojadid, A. and Dafaalla, E. A. (2105). Effect of Dietary Yeast (*Saccharomyces cerevisiae*) Supplementation on Performance, Carcass Characteristics and Some Metabolic Responses of Broilers. *Animal and Veterinary Sciences*. Special Issue: Poultry Welfare: Housing Systems and Feeding. 3: 5-10.
31. Onifade, A. A. (1997). Growth performance, carcass characteristics, organ measurements and hematology of broiler chickens fed a high fiber diet supplemented with antibiotics or dietary yeast. *Die Nahrung* 41: 370-374.
32. Mitruka, B. J. and Rawsley, H. M. (1977). Clinical Biochemical and Haematological Reference values in Normal experimental Animals, 2nd ed. Masson Publishing U.S.A. Inc: pg.186-187.
33. Murray, R. K., Granner, P. A., Mayer, P. A. and Rodwell, V. W. (2000) Harper's Biochemistry. 20th edition. McGraw-Hill; pp. 594–602Philip
34. Gao, J., Zhang, H. J., Yu, S. H., Wu, S. G., Yoon, I., Quigley, J., Gao, Y. P. and Qi, G. H. (2008) Effects of yeast culture in broiler diets on performance and immune modulatory functions. *Poultry Science*; 87:1377–1384.
35. Eggum, B. O. (1989). Protein Metabolism in Farm Animals. Evaluation, Digestion, Absorption, and metabolism. Oxford Science Publications, Deutscher Landwirtscafts Verlag, Berlin, pp: 1-25.