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Research Article
Effect of Probiotic (*Saccharomyces cerevisiae*) Supplemented Poultry Diet on the Lymphoid Organs, Hematology and Production Parameters of Broiler Chickens

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Abstract
Objective: The aim of the study was to evaluate the effect of poultry diet supplemented with *Saccharomyces cerevisiae* on lymphoid organs, weight gain and hematology of broilers. **Materials and Methods:** A total of 60 day-old broiler chicks (Ross 308) were randomly divided into two groups (A- control and B- probiotic) of 30 birds each. Each group was further subdivided into 3 replicates of 10 birds each. Birds were fed *ad libitum*. At the 6th week, 2 birds from each replicate were randomly selected and 3 mL of blood was collected from the right jugular vein for haematological analysis. The thymus, spleen and ileum was collected for histopathology. The weight gain, feed intake and feed conversion ratio were also determined. **Results:** Birds in group B showed increased proliferation of cells in the thymus, spleen and Peyer's patches. The absolute heterophil count of birds in Group A (11.577×10^3 µL) was significantly ($p<0.05$) lower than that of Group B (22.38×10^3 µL), while the heterophil-lymphocyte ratio of birds in group B was lower (1:1) than that of group A (control) (1:3). Group A (control group) had a significant ($p<0.05$) lower live body weight (3.0 kg) than Group B (3.5 kg). **Conclusion:** It is possible that probiotics contributed to an increase in the lymphoid organs, absolute heterophil count, weight gain and feed conversion efficiency. Based on the findings of this study, probiotic inclusion level of 1 g per kg of broiler feed was recommended for improved immunity, productivity and profit in broiler chicken.

Key words: Broilers, hematology, lymphoid organs, production parameters, *Saccharomyces cerevisiae*

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Poultry is a key sub-sector in the Nigerian livestock industry. In 2019, the Central Bank of Nigeria (CBN) reported that the poultry sub-sector as the most capitalized component of all the livestock sectors with a current net worth value of N1.6 trillion which represents 25% of the agricultural Gross Domestic Product (GDP) contribution to the Nigerian economy[1]. Specifically, broiler production has a resource of 104,247,960 birds which account for 48.72% of the Nigerian livestock production[1]. This underscores the position of poultry farming in the livestock industry. The poultry industry provides employments and means of livelihood for the teeming Nigeria populace and source of animal protein[2].

Despite these benefits, the Nigerian poultry industry has been dimed as highly volatile due to myriads of challenges confronting the sector. These challenges include poor growth rate, high price of inputs such as feeds, high prevalence of pest and diseases, poor management skills, infrastructural deficits, lack of credit facilities, lack of functional regulatory bodies to ensure compliance with best industrial practice among others[3]. The cumulative impact of these constraints has limited the development of the sector and poultry products are almost always inadequate in supply relative to its demand. Omolayo[4], emphasized that the low supply of broiler products relative to its high demand can also be attributed to low returns on investment and poor resource management, therefore it is imperative to increase productivity level through efficient use of resources.

In Nigeria, two key challenges affecting poultry production is the high cost of feed and diseases. Feed accounts for about 70-80% of the total cost of production[5]. Birds are monogastrics and compete with humans for most of their feed materials. This makes it expensive and unavailable most of the times, hence, increasing cost of production. In order to maximize profit, farmers now sought to reduce the total cost of production, which led to the need for feed additives. Feed additives increase quality, digestibility, palatability and nutrient availability of the feed[6]. They also improve animal's growth performance, immunity and gut health if chosen wisely[7]. Additives in feed improve feed conversion efficiency, reduce the stress, maximize the profit and lower the cost of poultry production[6].

There are still great losses in poultry production due to diseases, despite ever-improving prevention programs. They also pose serious public health risk as some of these diseases are zoonotic (avian influenza, Newcastle disease, colibacillosis, ectoparasites) and some are not zoonotic but have economic significance (Gumboro disease, Marek's disease, coccidiosis)[8]. Strategies such as, vaccination, chemotherapeutic prophylaxis and curative treatment and biosecurity has been employed to manage these diseases but, these are still very capital intensive and still add to increase the cost of production. Use of feed additives is an alternative that can improve production and immune status of the birds while mitigating the high cost of production[9]. Anti-microbials, probiotics, prebiotics, arsenicals, estrogen preparations are examples of feed additives. Arsenicals and estrogen preparations are highly carcinogenic. While the development of antimicrobial resistance has discouraged the use of antimicrobials and has made the use of probiotics and prebiotics popular and best choice.

Probiotic (*Saccharomyces cerevisiae*), a yeast, among all these natural alternative growth promoters used in animal and poultry production, is one of the most prominent. The yeast has been reported to improve feed conversion efficiency, weight gain, egg lay[10,11] and modulates the immune system of the host[12]. Addition of yeast in feed reduces the population of gut pathogens by decreasing the growth of destructive microbes[13]. Through enzymatic action, yeast aids digestion and produces lactic acid that makes the gastrointestinal tract acidic, thereby reducing the number of pathogenic microbes. Yeast is a good source of protein (40-45%) and other essential nutrients[10]. Increased digestibility and nutrient utilization in animals receiving yeast has been established[11]. Yeast Contains Mannan Oligosaccharides (MOS), a natural feed additive in yeast cell wall that encourages the growth of beneficial bacteria and at the same time it discourages the growth of bad bacteria in the gut[14]. Santin *et al.*[15], reported the growth-enhancing effect of yeast cell wall (0.1 and 0.2%) in broilers.

The mechanism of how *Saccharomyces cerevisiae* improves immunity has not been fully evaluated. There is paucity of information in available literature on the effect of *Saccharomyces cerevisiae* on immune organs. The aim of the study was to evaluate the effect of poultry diet supplemented with *Saccharomyces cerevisiae* on the histology of lymphoid organs (thymus, spleen and Peyer's patches), hematology and weight gain of broilers.

MATERIALS AND METHODS

Study location: The experiment was carried out from April 25th to June 6th, 2023 and the chicks were reared in the poultry house of the Department of Animal Health and Production, Faculty of Veterinary Medicine, University of Nigeria, Nsukka.

Table 1: Nutrient composition of experimental diet

	Broiler starter diet (given for the first four weeks)		Broiler finisher diet (given for the remaining 2 weeks)	
Feed ingredients	Group A (control group)	Group B (supplemented group)	Group A (control group)	Group B (supplemented group)
Metabolizable energy (Min)	2950 kcal/kg	2950 kcal/kg	3150 kcal/kg	3150 kcal/kg
Crude protein (Min)	22.0%	22.0%	18.0%	18.0%
Crude fat (Min)	4.0%	4.0%	5.0%	5.0%
Crude fiber (Max)	5. 0%	5.0%	5. 0%	5.0%
Moisture (Max)	14.0%	14.0%	14.0%	14.0%
Calcium (Min)	0.95%	0.95%	0.85%	0.85%
Average phosphorous (Min)	0.4%	0.4%	0.42%	0.42%
Lysine (Min)	0.4%	0.4%	1.05%	1.05%
Methionine (Min)	0.55%	0.55%	0.46%	0.46%
Probiotics (*S. cerevisiae*)	0 g	1 g/kg	0 g/kg	1 g/kg

Experimental animals: A total of 60 day-old broiler chicks (Ross 308), procured from Agrited® in Ibadan, Oyo State, Nigeria were used for this study. These animals were kept on deep litter housing system in a well-aerated poultry house. They were fed experimental diet and fresh drinking water were provided *ad libitum*. The house, feeders and drinkers were thoroughly cleaned and disinfected prior to stocking of the chickens. The birds were handled in accordance with the guidelines of the Institutional Animal Care and Use Committee of the Faculty of Veterinary Medicine, University of Nigeria Nsukka. An approval was obtained for the use of the birds for the study (Approval Reference Number: FVM-UNN-IACUC-2024-03/146).

Experimental design and management of experimental animals: On arrival, the birds were weighed to determine their day 0 weight. Birds were randomly divided into two groups-A and B (n = 30) and each group was further sub-divided into three replicates of ten birds each. Group A: Fed plain diet (control group) and Group B: fed probiotics supplemented diet (1 gm of probiotic/kg of feed). The birds were brooded for three weeks. The brooding temperature was provided by gas stove and maintained at 29-31°C for the first one week and was reduced by 1 to 3°C on weekly basis up to the 3rd week of life. The birds were vaccinated against Infectious Bursal Disease (IBD) and Newcastle Disease infections. The birds were fed broiler starter diet for the first four weeks and switched to finisher diet for the remaining period. The yeast, *Saccharomyces cerevisiae* MG 865964 strain was used as feed supplement for birds in group B. The feed intake was measured daily, while the weight of the birds was measured weekly. At the end of the experiment (day 56), the birds were euthanized and the intestine (ileum), spleen and thymus were harvested for histological examination.

Experimental diet: Table 1 shows the formulation of the experimental diet as indicated by the Manufacturer.

Data collection

Tissue processing for histopathological examination: The birds were humanely euthanized by cervical dislocation[16] and the thymus, spleen and intestine (ileum) were carefully harvested for histological examination. The thymus, spleen and a segment of the ileum was collected, fixed in 9 mL of 10% neutral buffered formalin[17]. The samples were trimmed and placed in accurately labelled cassettes for dehydration. The tissue specimens were immersed in a series of ethanol solutions of increasing concentration (from 60-100%) until pure, water-free (absolute) ethanol was reached for a specified period of time (15 min in each ethanol concentration). The tissue specimens were removed from the ethanol and immersed in xylene. It was immersed in three different xylene jars for a period of 20 min in each. The tissues were then infiltrated with paraffin wax (embedding agent) in a beaker placed in a hot air oven for 6-8 hrs. After the tissues had been dehydrated, cleared and infiltrated with embedding material, it was placed in leuckhart moulds/blocks (metallic angle) for cooling. The paraffin blocks were sectioned using a rotatory microtome with 5 micro-metre thickness. The sectioned tissues were placed in a warm water bath and picked up from the water bath and placed on a glass microscopic slide in a hot air oven for 15 min to help the sections adhere to the slides. The slides were then labelled with a non-removable ink. To remove wax from the slides, they were dipped ten times in xylol before staining and then rinsed in graded concentrations of alcohol (65-95%) to remove xylol. The slides were stained with Hematoxylin and eosin stain and allowed to dry. The stained section on the slide was covered with a thin piece of cover slip. Then the slides were dried in hot air oven for 15 min[17,18].

Hematology: After proper restraint, 3 mL of blood was collected from the right or left jugular vein of each bird using a 5 mL hypodermic needle and syringe and quickly and gently

dispensed into sample bottles containing Na-EDTA. The sample bottles were gently rocked to mix the blood with Na-EDTA to prevent coagulation.

Determination of the Packed Cell Volume (PCV): The packed cell volume was determined by the microhematocrit method[19]. A microcapillary tube was nearly filled with the anti-coagulated blood sample and sealed at one end with plasticine. It was centrifuged at 10,000 rpm for 5 min using a microhaematocrit centrifuge. The PCV was read after centrifugation as a percentage using a microhaematocrit reader.

Determination of haemoglobin concentration: The haemoglobin concentration of the blood samples was determined by the cyanmethemoglobin method[20]. Only 3 mL of Drabkin's haemoglobin reagent was added to a clean test tube. Then 0.02 mL of the blood sample and standard (containing 16 g/dL haemoglobin) was added to the reagent and mixed properly. The mixture was allowed to react for 20 min and the haemoglobin concentration was read using a Diatek® Semi-automated Blood Biochemistry Analyzer (Diatek Instruments, Wuxi, China), set at the Haemoglobin Concentration Program Mode. The results (g/dL) were printed out.

Red blood cell count (erythrocyte count): The erythrocyte count was done following the haemocytometer method[21]. Blood (0.02 mL) was pipetted from the blood sample and added to 4 mL of the Natt and Herrick's avian blood cell count fluid in a clean test tube to make a 1:200 dilution of the blood sample. The diluted sample was loaded onto a Neubauer counting chamber and red blood cells (erythrocytes) on the five central squares were counted using a light microscope at x40 objective. The number of cells counted for each blood sample was multiplied by 10,000 to obtain the red blood cell count per microlitre of blood.

Total white blood cell count (total leukocyte count): The total white blood cell count was determined by the haemocytometer method[21]. Blood (0.02 mL) was pipetted from the blood sample and added to 4 mL of the Natt and Herrick's avian blood cell count fluid in a clean test tube to make a 1:200 dilution of the blood sample. The diluted sample was loaded onto a Neubauer counting chamber and white blood cells on the four corner squares were counted using a light microscope at x10 objective. The number of cells counted for each blood sample was multiplied by 500 to obtain the total white blood cell count per microlitre of blood.

Differential white blood cell (leukocyte) count: A thin smear of the blood sample was made on a grease free slide and allowed to air-dry. The smear was later stained following the Leishman technique, using Leishman stain. The stained slides were examined under oil immersion at x100 objective of the light microscope using the meander counting method[21]. Each cell type was identified and counted using the differential cell counter. The result of each cell was expressed as a percentage of the total count and converted to the absolute value per microlitre of blood[21].

Production parameters

Weight gain: Live weight of the birds were measured weekly to determine the weekly weight gain (kg/bird).

Feed conversion ratio: The Feed Conversion Ratio (FCR) was calculated by dividing the total feed intake by the final weight of the birds.

$$\text{FCR} = \frac{\text{Total feed intake}}{\text{Final weight of the bird}}$$

Data analysis: The data obtained from the experiment were subjected to student t-test using the SPSS computer programme version 29.0. Means were compared using least significant difference (LSD) test. Significance level was set at $p<0.05$. Results was presented in tables and figures.

RESULTS

Histopathology of the lymphoid organs

Histopathology of the thymus: The thymus of birds in group A (control) showed the normal architecture-pale medulla and dark cortex (Fig. 1). While the thymus of birds in group B (supplemented) showed significant lymphocytic proliferation in the cortex reducing the area of the medulla (Fig. 1).

Histopathology of the spleen: The spleen of the control birds (Group A) showed normal architecture of the white pulp interspersed with the red pulp (Fig. 2). However, in the supplemented group (Group B), there is proliferation of lymphocytes in the white and red pulps (Fig. 2).

Histopathology of the ileum: The histology of the ileum of birds in the supplemented group (B) had significant higher number of cells in the Peyer's patches when compared with the control group (A) (Fig. 3).

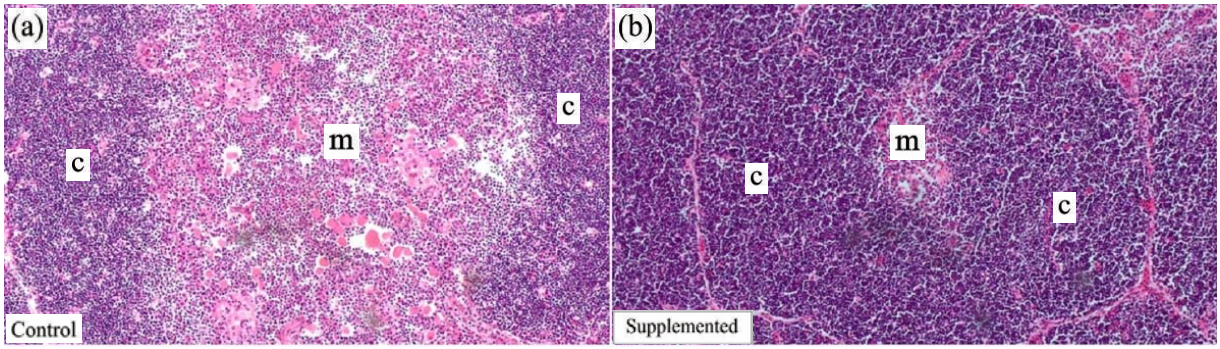

Fig. 1(a,b): Photomicrograph of the thymus of broilers fed probiotics supplemented diet (group B) and control diet (groups A) showing the medulla (m) and cortex (c). H&E: x200 magnification

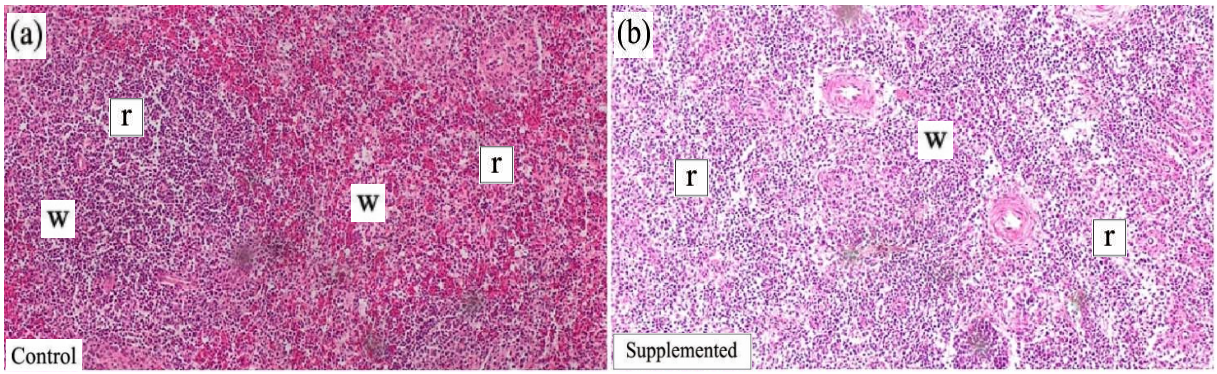

Fig. 2(a,b): Photomicrograph of the spleen of broilers fed probiotics supplemented diet (group B) and control diet (groups A) showing the red pulp (r) and white pulp (w). H & E: x200 magnification

Table 2: Erythrocytic parameters of broiler fed probiotics supplemented diet supplemented (group B) and the control (group A)

Parameters	Control group	Probiotic group	p-value
	----------Mean±SEM----------		
Packed cell volume (%)	24.133±1.020[a]	26.833±1.475[a]	0.215
Hb concentration (g/dL)	7.380±0.460[a]	8.180±0.540[a]	0.324
RBC count (x10^{6}µl)	2.817±0.183[a]	3.380±0.373[a]	0.271

[a]No significant difference (p>0.05) across groups (in rows)

Hematology

Packed cell volume: PCV of the control (A) and probiotic supplemented birds (B) did not differ (p>0.05) significantly (Table 2).

Hemoglobin concentration: The mean hemoglobin concentration of birds in the control group (A) and birds in the probiotic supplemented group (B) did not differ (p>0.05) significantly (Table 2).

Red blood cell count: The mean RBC count of birds in the control group (A) and birds in the probiotic supplemented group (B) did not differ (p>0.05) significantly (Table 2).

Total white blood cell count: The mean total WBC count of birds in the control group (A) and birds in the probiotic supplemented group (B) did not differ (p>0.05) significantly (Table 3).

Absolute heterophil count: The birds in the probiotics supplemented group (B) had significantly (p<0.05) higher absolute heterophil count than those of the control birds (A) (Table 3).

Absolute lymphocyte count: The mean absolute lymphocyte count of birds in the control group (A) and birds in the probiotic supplemented group (B) did not differ significantly (p>0.05) (Table 3).

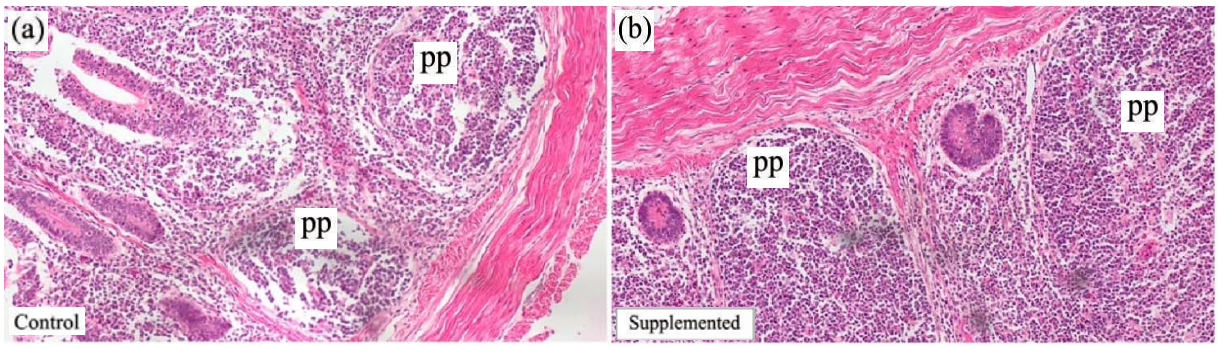

Fig. 3(a,b): Photomicrograph of the ileum of broilers fed probiotics supplemented diet (group B) and control diet (groups A) showing the Peyer's patches (pp). H&E: x200 magnification

Table 3: Leukogram of broiler fed probiotics supplemented diet (group B) and the control (group A)

Parameters	Group A (control)	Group B (supplemented)	p-value
	Mean±SEM		
Total WBC count (×10³ µL)	57.000±6.384[a]	67.667±2.455[a]	0.231
Absolute heterophil count (×10³ µL)	11.577±1.327[a]	22.383±2.278[b]	0.023
Absolute lymphocyte count (×10³ µL)	42.253±6.928[a]	39.393±4.066[a]	0.744
Absolute eosinophil count (×10³ µL)	2.500±0.547[a]	4.077±0.464[a]	0.095
Absolute monocyte count (×10³ µL)	1.603±0.589[a]	1.820±0.276[a]	0.762
Heterophil-lymphocyte ratio	1 : 3	1 : 1	

[a,b]Significant difference (p<0.05) across groups (in rows)

Table 4: Body weight of broilers fed probiotics supplemented diet (group B) and the control (group A)

Experimental period	Group A (control)	Group B (supplemented)	p-value
	Mean±SEM		
Week 1	0.181±0.004[a]	0.182±0.003[a]	0.690
Week 2	0.471±0.016[a]	0.525±0.008[b]	0.011
Week 3	0.927±0.021[a]	1.036±0.016[b]	0.000
Week 4	1.508±0.042[a]	1.641±0.031[b]	0.015
Week 5	2.148±0.049[a]	2.324±0.041[b]	0.008
Week 6	3.002±0.039[a]	3.524±0.050[b]	0.000

[a,b]Indicate significant difference (p<0.05) across groups (in rows)

Absolute eosinophil count: The mean absolute eosinophil count of birds in the control group (A) and birds in the probiotic supplemented group (B) did not differ (p>0.05) significantly (Table 3).

Absolute monocyte count: The mean absolute monocyte count of birds in the control group (A) and birds in the probiotic supplemented group (B) did not differ significantly (Table 3).

Heterophil-lymphocyte ratio: The ratio of heterophil to lymphocyte was lower in the group B (supplemented) than those of the birds in group A (control) (Table 3).

Body weight: On the first week of life, Body weights of broilers in both groups were not significantly different (p>0.05) (A-control and B-supplemented) (Table 4). However, from the second to the sixth week, the body weight of birds in group B (supplemented) was significantly higher than those of the birds in group A (control) (Table 4).

Production parameters: The initial weight of the birds in both groups were the same at day 0 (Table 5). However, at the end of the sixth week, the birds fed probiotic supplemented diet (group B) weighed more than the birds fed control diet (group A) (Table 5). Although the birds in group A (control), consumed more feed than group B (supplemented) (Table 5), the feed conversion ratio and efficiency of birds in group B was higher and lower, respectively, than those in group A (Table 5).

DISCUSSION

This study revealed that birds fed *Saccharomyces cerevisiae* (SC) supplemented diet at 1 g/kg (probiotic group)

Table 5: Initial weight, final weight, weight gained, total feed intake, feed conversion ratio and feed conversion efficiency of broiler fed diet supplemented with *S. cerevisiae*

	Mean	
Production parameters	Group A (control)	Group B (supplemented)
Initial weight (kg)	0.181	0.182
Final weight (kg)	3.002	3.524
Weight gained (kg)	2.821	3.342
Total feed intake (kg)	1.430	1.373
Feed conversion ratio	0.507	2.434
Feed conversion efficiency	1.973	0.412

had an improved immune response and better production attributes- higher weight gain with low feed intake and better feed conversion efficiency, than birds fed bland diet (control group).

The hypercellularity of the lymphoid organs characterized by proliferation of lymphocytes in the cortex of the thymus, red and white pulps of the spleen and Peyer's patches in the ileum seen in the probiotic treated group, could be the mechanism of immunomodulatory effect of *Saccharomyces cerevisiae*. As this fungal organism induces antigenic stimulation, leading to the proliferation and differentiation of immune cells in the lymphoid organs thereby, conferring immuno-competency to the animal.

This significant increase in lymphocytes is in agreement with the findings of Balcells *et al.*[22], who reported an increased proliferation of T-lymphocytes in obese and ageing mice administered probiotics *Lactobacillus caseia*. Mucosal lymphocyte proliferation and differentiation confer mucosal adaptive immunity and maintain healthy gut integrity, preventing opportunistic infections by normal flora and invading microbes. This result is supported by the findings of Kazue *et al.*[23], who reported that probiotic reduced pH of intestinal mucosa and also stimulated release of cytokines. Those cytokines induce the secretion of Immunoglobulin A on the intestinal mucosa, then IgA release mucins which forms a physical barrier against pathogens. Also, Dalloul *et al.*[24], found similar effects of probiotics on the intestinal immune system of broiler chickens treated with a commercial probiotic product (Primalac) containing *L. acidophilus*, *L. casei*, *E. faecium* and *Bi. bifidum* and infected with coccidian oocyst. A higher population of Intestinal Intraepithelial Lymphocytes (IEL) was observed compared with control birds.

As part of feeding trials, blood is used to assess the clinical and nutritional health status of animals and the hematological parameters such as Packed Cell Volume (PCV), hemoglobin concentration, red Blood Cell Count (RBC), White Blood Cell count (WBC) and differential white blood cell count were routinely measured.

There was no significant difference in the erythrocytic parameters (PCV, Hb, RBC count) of both the probiotic and control group. This finding corresponds to the report of Aguihe *et al.*[25], who found that the probiotic supplementation did not affect blood constituents comprising PCV and hemoglobin concentrations. In contrast, the findings disagree with Cetin *et al.*[26], who observed that the probiotic supplementation caused statistically significant increase in hematological parameters. The difference may be attributed to the type and number of species of organism used as probiotics.

Birds in the probiotic group had a higher but not significant total white blood cell count, absolute lymphocyte count, absolute eosinophil count, absolute monocyte count and absolute basophil count when compared with the control group. But the absolute heterophil count was significantly ($p<0.05$) higher than that of the control group. This is probably due to antigenic stimulation by *Saccharomyces cerevisiae* leading to increased lymphocyte proliferation and differentiation[27,28]. This enhances the immune status of birds and increase their resistance to infection[29]. The increased WBC count observed in birds fed probiotic is in line with the findings of Aguihe *et al.*[30], who reported that when poultry diet is supplemented with probiotic, haematological profiles showed an increase in total leucocyte count and marked increase in percentage of heterophils.

The heterophil-lymphocyte ratio decreased in the probiotic group when compared to the control group. This decrease in the ratio is due to the mobilization of lymphocytes from blood to the tissues (thymus, spleen and intestine) as a result of the antigenic stimulation that led to proliferation of lymphocytes in the tissue.

Probiotics exert their action by maintaining or re-establishing the conditions of eubiosis in the digestive tract, thus, maintaining a normal microbial flora and balanced gastrointestinal tract. The results showed that probiotic supplementation had no effect on body weight of broilers on the first week of age. This may be due to the time it took for

the organism to re-establish the conditions of eubiosis in the digestive tract and thus a balanced gastrointestinal tract could be set and maintained. However, from the second to sixth week, the body weight of birds in the supplemented group was significantly ($p<0.05$) higher than those of the control group. This result is in agreement with Abdel-Hafeez *et al.*[31] and Smolentsev *et al.*[32], who observed that probiotic supplementation in broiler feed increased the body weight gain of the broilers.

In this study the significant improvement in growth rate/weight gain in the probiotic group can be associated with improved feed conversion ratio and efficiency compared with the control group which had a high feed take with high feed conversion ratio and low feed conversion efficiency. Probiotic may have contributed to increased digestibility, increased villus height, which increases absorption of nutrients from the intestine[33].

The birds in group A (control), though they consumed more feed compared to group B (supplemented) but , they had less weight gain and poor feed conversion efficiency. This could be due to the fact that probiotics are natural rich source of proteins, minerals, B-complex vitamins and 1, 3-1, 6 D-glucan and Mannanoligosaccharide. When the organism dies in the GIT, the host enzymes digests it and utilize it for the synthesis of protein for the body system thereby increasing weight gain and nourishing the body[34]. Therefore, probiotic reduces the cost of production and maximizes profit. These findings are supported by previous studies conducted by Smolentsev *et al.*[32]. However, it contradicts with a previous study conducted by Adebiyi *et al.*[35], who reported no significant differences ($p>0.05$) in body weight between control and yeast supplemented birds. This might be due to the kind of strain of *Saccharomyces* used (alive or dead, enriched or non-enriched or less concentrated).

CONCLUSION

In lymphoid organs, probiotics might have increased lymphocyte proliferation. It had no effect on the red blood cells but caused a significant increase in the absolute heterophils count. It may have contributed to increased weight gain, feed conversion ratio and feed conversion efficiency.

RECOMMENDATION

Based on the findings of this study, probiotic *Saccharomyces cerevisiae* at inclusion levels of 1g per kg of broiler feed was recommended to improve immunity, productivity and profit in broiler chicken.

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