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CARCASS AND ORGAN CHARACTERISTICS OF FINISHING BROILERS FED DIETS CONTAINING PROBIOTICS (*Saccharomyces cerevisiae*)

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ABSTRACT

A five-week study was conducted to determine the effect of feeding varying levels of S. cerevisiae on carcass and organ characteristics of finishing broilers. One hundred and twenty 4-weeks old broilers of cobb strain were randomly assigned to four treatments (T1 = 0.6 g Saccharomyces cerevisiae (SC) kg^{-1} diet; T2 = 0.8 g SC kg^{-1} diet; T3 = 1.0 g SC kg^{-1} diet and T4 = 0.0 g SC kg^{-1} diet) with 30 birds per treatment and replicated twice with 15 birds per replicate in a completely randomized design. Feed and water were provided ad libitum to the birds in a deep litter system. In the end, data on growth, carcass and organ indices generated from the study were analyzed using one-way analysis of variance (ANOVA). Results showed no significant difference ($p > 0.05$) among the treatments in the birds' growth performance indices. However, significant differences ($p < 0.05$) were observed in the birds' values for liver weight, heart weight, shank length and thigh length with birds in T3 recording highest values of 61.30 g, 16.93 g and 12.00 cm for liver weight, heart weight and thigh length, respectively. It was thus concluded that finishing broilers fed 1.0 g of S. cerevisiae had superior carcass and organ characteristics than birds on the control and lower levels of inclusion.

Key words: animal protein, direct-fed microbials, fungi, chicken meat, yeast

INTRODUCTION

Poultry meat production still ranks as one of the most evolving industries in the world (Berri, 2001; 2007). Despite this status, it has not been able to meet the demand of the ever increasing human population, who depend directly on the meat for animal protein and consequently essential amino acids. In a bid to boost productivity, several dietary manipulations have been carried out on poultry, ranging from inclusion of growth promoters (Barreto *et al.,* 2008; Mokhtari *et al.*, 2010), hormones (Al-Dobaib and Mousa, 2009), organic acids (Ghazalah *et al.,* 2011), enzymes (Chuka, 2014; Hossain *et al.,* 2014), locally sourced additives (Onyimonyi *et al.,* 2012; Olabode *et al.,* 2013; Dim *et al.,* 2018), etc.

Because most of these growth enhancers are either carcinogenic or have a residual carryover effect with the attendant health implications in man (Al-Dobaib and Mousa, 2009; Camila *et al.,* 2012), it is therefore pertinent to search for their alternatives which will not only enhance growth of the birds but also ensure safe meat for the consuming populace. A popular alternative is the use of probiotics, which has been proven in poultry to compete and exclude bacterial pathogens in the gastrointestinal tract of the birds (Murry *et al.,* 2004; Abudabos *et al.,* 2013; Baldwin *et al.,* 2018), agglutinate harmful bacteria such as *Salmonella* (La Ragione and Woodward, 2003; Murry *et al.,* 2004), encourage complete absorption of nutrients by the birds' gut (Mountzouris *et al.,* 2010; Murshed and Abudabos, 2015), degrade fibrous resources in poultry feeds (Adejumo *et al.,* 2005; Oyedeji *et al.,* 2008) and also muster essential amino acids, vitamins and trace minerals required for the most favorable growth of the animal (Choi *et al.,* 2013; Zhang and Kim, 2014; Podolian, 2017).

Probiotics have been defined by several authors as live microorganisms that have beneficial effects on the host animal when administered (Ahmad, 2006; Ezema, 2013; Ritzi *et al.,* 2014; Aalaei *et al.,* 2019). Over the last decade, the use of probiotics in animal nutrition has gained so much attention and aroused growing research interest in the field of nutrigenomics. Microorganisms used in the formulation of probiotics are mostly of bacteria origin but can also be fungi-based. The use of fungi-based probiotics in the diets of food animals has been demonstrated to improve the quality of feed and performance of the animals (Shen, *et al.,* 2009; Berrin, 2011; Ezema, 2012; Chuka, 2014; Hassan and Mohammed, 2014).

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Saccharomyces cerevisiae (yeast) is a fungus that serves as an innate ingredient in human diets as bread or fermented beverage (Walker and Stewart, 2016; Shim *et al.,* 2007). It has shown to have probiotic effect when included in the diets of farm animals (Onwurah *et al.,* 2014; Ghazanfar *et al.,* 2015; Sharif *et al.,* 2018; Osita *et al.,* 2019). It has biologically valuable proteins (Choi *et al.,* 2013; Podolian, 2017), soluble fiber (Yamada and Sgarbieri, 2005), minerals, B-complex vitamins, and unique immuno-modulatory properties (Hana *et al.,* 2015). Different dietary inclusion levels of *S. cerevisiae* have been reported to have various effects on the performance of poultry species (Ghosh *et al.,* 2012; Reisinger *et al.,* 2012; Huff *et al.,* 2013; Onwurah *et al.,* 2014; Sharif *et al.,* 2018). This study was therefore aimed at ascertaining the dietary inclusion level of yeast (*S. cerevisiae*) that would support superior carcass and organ characteristics of finishing broilers in the tropics.

MATERIALS AND METHODS

Experimental Site and Ethical Approval

The study was situated in the poultry unit of the Department of Animal Science Teaching & Research Farm, University of Nigeria, Nsukka. In the report of Momoh *et al.* (2010), Nsukka was documented to be located in longitude 07^{o} 54 E and latitude 05^{o} 22 N, with annual rainfall range of 966-2098 mm, a mean daily temperature of 26.8 ^{o}C and relative humidity percentage values that ranges from 65-80% (Agbagha *et al.,* 2000). The experiment adhered strictly to the provisions of the Ethical Committee on the use of animals and humans for biomedical research of the University of Nigeria, Nsukka.

Experimental Diets

The percentage compositions of the experimental diets were presented in Table 1. Samples of the diets were analyzed for their proximate composition according to AOAC (2006) methods and presented in Table 2. Table 3 also presents the proximate composition of the *S. cerevisiae* used in the study.

Experimental Birds, Management and Duration

One hundred and twenty (120) four-week-old broilers (cobb strain) were randomly allocated to four groups of 30 birds each and replicated twice with 15 birds per replicate. They birds were brooded according to their respective groups from day-old to 28th day of age before commencing treatment trials. Broilers were randomly assigned to the experimental treatments thus: T1 = 0.6 g of *S. cerevisiae* kg^{-1} of feed, T2 = 0. 8 g of *S. cerevisiae* kg^{-1} of feed, T3 = 1.0 g of *S. cerevisiae* kg^{-1} of feed and T4 = feed without *S. cerevisiae*, using a completely randomized design (CRD). The birds received the test organism (*S. cerevisiae*) from 28 days of age till the termination of the study. Feed and water were supplied *ad libitum* to the birds. The birds were vaccinated against New Castle disease (Intraocular-Lasota), Gumboro disease (Intraocular) and fowl pox (Intraocular) at weeks one and three, two and four, and five, respectively. Prophylactic treatment against coccidiosis was also given to the birds using Embazin forte® (manufacturer's recommended dosage) at 2nd and 5th weeks of age. The study lasted for 5 weeks during which feed intake, weight gain, and feed conversion ratio (FCR) were properly recorded.

At the end of the feeding trials of the study, 2 birds per replicate were sampled for the carcass and organ yield for all the treatment groups.

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using the Statistical Package for Social Sciences (*SPSS*) version 20.0. Significantly different means were separated using Duncan's New Multiple Range Test (DNMRT) as described by Obi (2002).

Table 1: Percentage compositions of the experimental diets

	Starter	Finisher
Ingredients	%	%
Maize	51.0	53.0
Wheat offal	6.0	10.0
Palm kernel cake	5.2	5.5
Groundnut cake	21.0	15.0
Fish meal	1.8	1.5
Soy bean meal	10.0	10.0
Bone meal	4.0	4.0
Salt	0.25	0.25
Lysine	0.25	0.25
Methionine	0.25	0.25
Vitamin premix	0.25	0.25
Total	100	100
Calculated composition		
Crude protein (%)	23.08	20.1
Crude fibre (%)	4.02	5.28
Gross Energy (MCal/kg)	2.8	2.72

Each 2.5kg of Starter premix contains: vit. A, 10000000 IU; vit. D3, 2000000 IU; vit. E, 23000 mg; vit. K3, 2000mg; vit. B1, 1800mg; vit. B2, 5500mg; Niacin, 27500mg; pantothenic acid, 7500mg; vit. B6, 3000mg; iodine, 1000mg; iron, 20000mg; manganese, 40000mg; selenium, 200mg; zinc, 30000mg; antioxidant, 1250mg. One tonne of Finisher feed contains: vit. A, 10.00 g; vit. D_3, 5.00 g; vit. E, 50.00 g; vit. K, 3.00 g; vit. B_1, 2.00 g; vit. B_2, 6.00 g; vit. B_6, 3.00 g; vit. B_{12}, 15.00 mg; Biotin, 0.12 g; Nicotinic acid, 50.00 g; Folic acid, 1.50 g; Choline, 0.35 g; Methionine, 2514.00 g; Threonine, 361.00 g; Lysine, 1779.00 g; Iodine, 1.00 g; Selenium, 0.35 g; Iron, 40.00 g; Molybdenum, 0.50 g; Manganese, 100.00 g; Copper, 15.00 g; Zinc, 100.00 g

Table 2: Proximate compositions of the experimental diets

Composition	Starter	Finisher
Crude protein (%)	23.42	20.85
Ash (%)	5.33	6.13
Ether extract (%)	4.39	5.74
Crude fiber (%)	2.10	2.62
Moisture (%)	8.72	7.90
Nitrogen free extract (%)	56.04	56.76
Gross energy (kCal/g)	2940	2700

Table 3: Proximate composition of *S. cerevisiae*

Composition	Value
Dry matter (%)	92.87
Calcium (%)	0.11
Ether extract (%)	1.09
Crude fiber (%)	2.50
Phosphorus (%)	1.20
Metabolizable energy (kCal/kg)	1970
Crude protein (%)	41.00

RESULTS AND DISCUSSION

Growth Performance of Broiler Chickens Fed Diets Containing Varying Inclusion Levels of *Saccharomyces cerevisiae*

Table 4 shows the growth performance of broiler chickens on varying dietary inclusion levels of *S. cerevisiae.* Results showed non-significant ($p > 0.05$) differences among the treatment means for all the growth performance indices studied. The final body weight and average daily weight gain of T1 were observed to be highest numerically compared to other treatment groups. Too, T1 consumed more feed than others. With respect to FCR, T3 performed the best amongst the treatment groups. Each group recording values within the range published by Udeh *et al.* (2015) for broilers of same age. The non-significant difference in the growth performance of birds recorded in the current study suggests that *S. cerevisiae* plays little or no significant role in stimulating growth response in finishing broilers at the inclusion levels used in the present study. This result disagrees with several authors (Oyedeji *et al.,* 2008; Afsharmanesh *et al.,* 2010; Yalcin *et al.,* 2013; Chuka, 2014; Onwurah *et al.,* 2014; Yasar and Yegen, 2017) who recorded outstanding growth performances in poultry birds when fed *S. cerevisiae.* Although their reports indicated that the dietary administrations of *S. cerevisiae* were done with day-old chicks, the introduction of *S. cerevisiae* in the diets of the birds in the current study was done at the finishing phase of the birds. Similar to the present study, Ahmed *et al.* (2015) observed non-significant growth responses in broiler chicks fed varying inclusion levels of *S. cerevisiae*. Therefore, it can be argued that the additive (*S. cerevisiae*) had less time in the gastrointestinal tract of the birds under study during their growth phases, to efficiently colonize the gut and consequently stimulate positive growth response. Brummer *et al.* (2010) and Roto *et al.* (2015) had demonstrated the effects of *S. cerevisiae* on the gut morphology and micro-biota of broiler chickens, linking the early colonization of the probiotic organism in the gut to the improved performance observed in the birds.

Carcass and Organ Characteristics of Broiler Chickens Fed Varying Inclusion Levels of *Saccharomyces cerevisiae*

The carcass characteristics and organ weights of finishing broiler chickens fed varying inclusion levels of *S. cerevisiae* are presented in Table 5. Results indicated significant ($p < 0.05$) differences among the treatments with respect to liver and heart weights as well as shank and thigh lengths. However, non-significant ($p > 0.05$) differences were recorded in the birds' live, dressed and kidney weights. Despite the non-statistical significance, the dressed weight values of birds studied were within the range reported by Olawumi and Fagbuaro (2011) for commercial breeds of broilers in Nigeria. Ojedapo *et al.* (2015) also documented similar range of values for cobb broilers, at same age as birds from present study, while delineating the variation of broiler chickens in relation to genotype and age of slaughter on carcass indices. Birds on T3 had the highest liver weights which were statistically ($p < 0.05$) different from other treatment groups. Birds on the control group had the least liver weight among the treatment groups, clearly implicating the test organism in conditions leading to increased liver weights. These liver weight values (T3 and T4) were statistically similar to those of T1 and T2. However, liver weights of birds on T1 and T2 were statistically similar. The heart weights of birds on T3 were observed to be the highest and significantly ($p < 0.05$) different from other treatment groups whereas T4 (control) which was statistically similar to T1 had the least values. From the results, it can be suggested that the birds on *S. cerevisiae* experienced hepatomegaly as can be evidenced in their higher liver weight values than the control. This could be linked to possible intrinsic or extrinsic factors that leads to cardiac diseases. The high heart weight values observed in birds on *S. cerevisiae* inclusion suggests that the test additive might be implicated in myocardial hypertrophy. It could be that the *S. cerevisiae* produced "plus metabolites" that exacerbated stressor factors or central defects in the birds leading to myocardial hyperplasia, which can

Table 4: Growth performance of broiler chickens fed varying inclusion levels of *Saccharomyces cerevisiae*

Parameters	T1 (0.6 g)	T2 (0.8 g)	T3 (1.0 g)	T4 (control)	p-value
Initial body weight (g)	700.00	700.05	702.05	704.05	-
Final body weight (g)	2460.00	2400.00	2402.00	2404.00	0.10
Average daily weight gain, ADWG (g)	50.28	48.57	48.57	48.57	0.07
Total feed intake (g)	4400.00	4210.00	4200.00	4240.00	0.23
Average daily feed intake, ADFI (g)	125.71	120.28	120.00	121.14	0.19
Feed conversion ratio	2.50	2.48	2.47	2.49	0.44

Table 5: Carcass and organ characteristics of broiler chickens fed varying inclusion levels of *Saccharomyces cerevisiae*

Parameters	T1 (0.6 g)	T2 (0.8 g)	T3 (1.0 g)	T4 (control)	p-value
Live weight (kg)	2.46	2.40	2.40	2.40	0.10
Dressed weight (kg)	1.77	1.82	1.85	1.77	0.19
Liver weight (g)	53.67^{ab}	58.35^{ab}	61.30^{a}	47.87^{b}	0.04
Kidney weight (g)	2.38	2.80	2.50	2.47	0.06
Heart weight (g)	10.10^{c}	13.33^{b}	16.93^{a}	9.37^{c}	0.05
Shank length (cm)	7.33^{b}	7.67^{b}	7.33^{b}	9.67^{a}	0.02
Thigh length (cm)	10.00^{b}	11.00^{ab}	12.00^{a}	9.33^{b}	0.00

^{abc}means on the same row with different superscripts are significantly different at 0.05 probability level

also give rise to sudden myocardiopathy. The shank length value of T4 was the highest and statistically ($p < 0.05$) different from other treatment groups. Birds on T1 and T3 had the least values for shank length across the treatment means and were statistically ($p < 0.05$) similar with T2. However, the thigh length of T3 was the highest ($p < 0.05$) among the groups, despite having statistical ($p < 0.05$) similarity with T2. There was no statistical ($p < 0.05$) difference between T1 and T4 whereas they were similar to T2. Nevertheless, birds on the control group (T4) had the shortest thigh length when compared across the groups. In the current study, birds on the control group became visibly taller than the birds on the test additive (*S. cerevisiae*) owing to their higher shank length values. This suggests that *S. cerevisiae* could have played a negative role in calcium metabolism and of course, bone-mineralization. This negates the reports of Ghasemi *et al.* (2006) and Akhavan-Salamat *et al.* (2011) who had earlier documented improved mineral retention and bone mineralization in broilers fed yeast. Moreover, the increased thigh length values observed in birds on *S. cerevisiae* could be attributed to the role of the test additive in protein synthesis and muscle formation. Increased thigh length consequently translates to increased surface area for muscle coverage in the thigh region of the birds. Therefore, it can be suggested that the birds on *S. cerevisiae* had better bone density and muscle mass to fill up their improved thigh lengths. The carcass traits recorded in the present study are within the range reported by Singh and Pathak (2016) for cobb broilers while running a comparative carcass assessment of various indigenous chickens. Nonetheless, the reports of Paryad and Mahmoudi (2008), Onwurah *et al.* (2014) and Ahmed *et al.* (2015) concur with the findings of the present study as they recorded excellent carcass characteristics of broiler birds fed *S. cerevisiae.*

CONCLUSION AND RECOMMENDATION

From the results presented in the tables above, it can be concluded that the inclusion of *Saccharomyces cerevisiae* in the diets of finishing broilers at the levels used in the present study did not improve the growth performance indices studied. However, the dietary inclusion of *Saccharomyces cerevisiae* at 1.0 g kg^{-1} in the diet of finishing broilers supported significant organ weights of heart and liver and also maintained better carcass characteristics than the birds on the control group. The increased awareness of the general public on the consumption of organ meats over staple meats due to heart and other health implications, made the present study apt and of paramount significance. Thus, the use of *Saccharomyces cerevisiae* in broiler production should be encouraged at the dietary inclusion level of 1.0 g kg^{-1} starting from the first day of the birds' age in order to achieve maximum productive potentials in the birds.

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