Response and Economic Efficiency of Broiler Chickens fed graded levels of Baker's Yeast (*Saccharomyces cerevisiae*) supplement

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Abstract

Two hundred and fifty-five day-old Ross White strain broiler chicks were used to evaluate the Response and economic efficiency of broiler chickens fed graded levels of baker's yeast (*saccharomyces cerevisiae*) supplement during the harmattan season in the northern guinea savannah zone of Nigeria. There were five treatment groups for both starter and finisher phases. The experiment lasted for eight weeks. Each treatment group had three replicates with 17 birds per replicate and fifty-five birds per group in a completely randomized design (CRD). Treatments 1, 2, 3, 4 and 5 contained 0.0, 0.5, 1.0, 1.5 and 2.0% SC respectively. Results of the starter phase showed significant ($P < 0.05$) differences in terms of final weight gain and feed conversion ratio (FCR). Treatment groups fed the control diet (0.0%), 0.5% and 1% SC had the best final body weight and body weight gain during the starter phase. The FCR was significantly ($P < 0.05$) higher in the treatment group fed 0.5% SC during the starter phase. Mortality was higher (11.76%) in the control group compared to other treatment groups in the starter phase. During the finisher phase, treatment group fed 1.0% SC had significantly ($P < 0.05$) higher final body weight, body weight gain and FCR. Apparent digestibility of crude protein, crude fibre, ether extract, ash, dry matter and nitrogen free extract were better in treatment groups containing SC. The economic efficiency results of this study indicated that the birds fed 1.0% SC were more profitable compared to those fed the control diet. The net profit of the treatment group fed 1.0% SC was N 650.01 compared to the control (N554.35). This study concluded that the optimum inclusion level of Baker's yeast (*Saccharomyces cerevisiae*) in the diet of broilers starter was 0.5% and 1.0% for finisher diet for improved performance in terms of weight gain and feed conversion ratio (FCR). It is suggested that broiler chicken farmers should be encouraged to include Baker's yeast in the diet of broiler chickens for improved weight productivity and better feed utilization.

Keywords: Baker's Yeast (SC), Season, Probiotics, Northern Guinea Savannah

Introduction

Poultry production faces several challenges (climatic conditions, changes of feed, microbial load and stress during rearing) disturbing the normal functioning of the birds. The Gastro Intestinal Tract may be influenced resulting in impaired absorption of nutrients which can lead to reduced performance and increased mortality (Grashorn, 2010).

In the past, antibiotics were supplemented in diets for increased feed efficiency and an

improved growth rate but with the ban on antibiotics as growth promoters in feed, farmers lost an effective tool to help birds to realize their performance capacity (Grashorn, 2010). Meanwhile many alternative substances belonging to different groups of additives have been tested for their potentials to replace antibiotics. Probiotics seem to be the most promising ones as they are of natural origin and are generally regarded as safe.

The development of favourable microflora

in the gut of poultry can be enhanced by inclusion of probiotics as reported by Krehbiel *et al.*, (2003). Stress due to intensive production conditions creates imbalance of intestinal microflora and also lower the body defence mechanisms (Taksande *et al.*, 2009). Birds may get stressed from different factors such as overcrowding, unfavourable ambient temperature, feed intake and vaccination (Taksande *et al.*, 2009). Samar *et al.* (2014) reported that broiler birds kept in heat stress conditions during summer months (36°C and 75% relative humidity (RH)) presented about 35% lower weight as compared to those in thermo neutral condition (25°C and 67% RH). Chickens reared under low temperatures are also characterised by reduced growth rate, high feed intake and poor feed conversion ratio (Deaton *et al.*, 1996; Pan *et al.*, 2005).

Based on the peculiarities of the different seasons on performance of broiler chickens, researches into feed additives and their potential beneficial effects; this study was designed to evaluate the effect of *Saccharomyces cerevisiae* as probiotic on the growth performance, apparent nutrient digestibility and economic efficiency of broilers chickens during the harmattan season in the Northern Guinea Savannah.

Materials and methods

Experimental site

The study was conducted at the National Agricultural Extension and Research Liaison Services, Skill Acquisition Farm, Ahmadu Bello University, Zaria, located within the Northern Guinea Savannah Zone of Nigeria at latitude 11° 09' 06" N and longitude 7° 38' 55" E, at an altitude of 706m above sea level (GPS 2014). The area has an average annual rainfall of 1100mm, which starts from late April or early May to mid-October. The peak of rainy season is

between June and September, followed by the harmattan period of cool and dry weather which lasts from November to January. This is then followed by hot – dry weather from February to April. The mean maximum temperature varies from 26°C to 35°C depending on the season, while the mean relative humidity during harmattan period and wet season are 21% and 72% respectively (Akpa *et al.* 2002).

Source of experimental birds/materials

A total of two hundred and fifty five (255) day old commercial broiler chicks of Ross White strain were purchased from a reputable hatchery. The Bakers yeast (Vahine brand) was purchased in Samaru market in Zaria.

Experimental diets

Five experimental diets (at both Broiler starter and finisher phases) were formulated to meet the nutrient requirement of broilers (Tables 1 and 2). Diet 1 serves as the control while diets 2, 3, 4, and 5 contained 0.5, 1.0, 1.5 and 2.0% of commercial dry yeast, respectively.

Experimental design and management of birds

Two hundred and fifty five (255), day old broiler chicks were allotted to five treatments (0.0, 0.5, 1.0, 1.5 and 2.0) consisting 17 chicks per replicate and three replicates per treatment during the starter phase. *Saccharomyces cerevisiae* was included at 0.5, 1.0, 1.5 and 2.0% of the total diet while the control had no SC. The design of the experiment was a completely randomized design (CRD). The birds were reared in deep litter system with feed and water provided *ad libitum* during the experimental period (8 weeks). The chemical composition of *Saccharomyces cerevisiae* was also determined and all the diets were formulated to meet the nutrient requirements of the broiler chickens (NRC, 1994). During the finisher phase, the birds

Table 1: Composition of broiler starter diets containing varying levels of *Saccharomyces cerevisiae* (SC)

Ingredients (Unit)	Levels of inclusion of SC (%)				
	0.0	0.5	1.0	1.5	2.0
Maize	50.66	50.63	50.60	50.55	50.52
Groundnut cake	25.31	24.81	24.31	23.82	23.32
Soya cake	12.59	12.59	12.59	12.59	12.59
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm oil	3.69	3.72	3.75	3.79	3.82
Limestone	0.90	0.90	0.90	0.90	0.90
Bone meal	2.75	2.75	2.75	2.75	2.75
Common Salt	0.30	0.30	0.30	0.30	0.30
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.25
Bakers yeast (SC)	0.00	0.50	1.00	1.50	2.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
ME (Kcal/kg)	3008	3007	3007	3006	3005
Crude protein (%)	23.31	23.32	23.30	23.31	23.30
Ether extract (%)	8.11	8.12	8.12	8.13	8.14
Crude fibre (%)	3.70	3.68	3.66	3.65	3.63
Calcium (%)	1.28	1.28	1.28	1.28	1.28
Lysine (%)	1.24	1.23	1.22	1.22	1.21
Methionine (%)	0.35	0.34	0.34	0.34	0.34
Available P (%)	0.57	0.57	0.58	0.58	0.59
Feed cost/kg(N)	100.84	103.28	105.71	108.18	110.48

P=Phosphorus; ME=Metabolizable Energy; **Biomix premix supplied per kg of diet: Vit. A, 10,000iu; Vit.D₃, 2000 iu; Vit E, 23 mg; Vit. K, 2mg; Vit.B₁, 1.8; Vit. B₂, 5.5mg; Niacin, 27.5mg; Pantothenic acid, 7.5mg; Vit. B₁₂, 0.015mg; Folic acid, 0.75mg; Biotin, 0.06mg; Choline chloride, 300mg; Cobalt, 0.2mg; Copper, 3mg; Iodine, 1 mg; Iron, 20 mg; Manganese, 40 mg; Selenium, 0.2 mg; Zinc, 30mg; Antioxidant, 1.25mg.

were adjusted for seven days then randomized and adjusted for weight. Fifteen birds were used per replicate in the finisher phase. Vaccines against Newcastle and Gumboro diseases were given following the vaccination schedule of Veterinary Teaching Hospital of Ahmadu Bello University, Zaria. Anti-stress was given to the birds after each vaccination.

Data collection

Measurement of growth performance

Feed intake and body weight of the birds were recorded weekly. Body weight gain was calculated as the difference between

the final weight and the initial weight. Feed conversion was calculated as the ratio between feed intake and weight gain.

Digestibility trial

A nutrient digestibility trial was carried out at the starter (3rd week) and finisher (7th week) phases of the experiment. After three days adjustment period, two birds were selected randomly from each replicate pen making a total of six (6) birds per treatment. The birds were housed in individual cages with wire bottoms. Trays were placed under each cage for faecal collection. The birds were given a known amount of feed for seven days and water was also given

Table 1: Composition of broiler finisher diets containing varying levels of *Saccharomyces cerevisiae* (SC)

Ingredients (Unit)	Levels of inclusion of SC (%)				
	0.0	0.5	1.0	1.5	2.0
Maize	57.52	57.52	57.52	57.52	57.52
Groundnut cake	11.67	11.17	10.67	10.17	9.67
Soya cake	20.00	20.00	20.00	20.00	20.00
Fish meal	3.00	3.00	3.00	3.00	3.00
Palm oil	2.81	2.81	2.81	2.81	2.81
Limestone	1.10	1.10	1.10	1.10	1.10
Bone meal	2.80	2.80	2.80	2.80	2.80
Common Salt	0.30	0.30	0.30	0.30	0.30
Premix**	0.30	0.30	0.30	0.30	0.30
Lysine	0.30	0.30	0.30	0.30	0.30
Methionine	0.20	0.20	0.20	0.20	0.20
Bakers yeast (SC)	0.00	0.50	1.00	1.50	2.00
Total	100.00	100.00	100.00	100.00	100.00
Calculated Analysis					
ME (Kcal/kg)	3045	3044	3042	3041	3039
Crude protein (%)	21.02	21.00	21.01	21.00	21.01
Ether extract (%)	7.21	7.18	7.16	7.13	7.11
Crude fibre (%)	3.66	3.65	3.63	3.62	3.60
Calcium (%)	1.35	1.35	1.35	1.35	1.35
Lysine (%)	1.25	1.24	1.23	1.22	1.21
Methionine (%)	0.35	0.35	0.35	0.35	0.35
Available P (%)	0.57	0.57	0.58	0.59	0.59
Feed cost/kg(₦)	94.51	96.86	99.21	101.56	103.91

P=Phosphorus; ME=Metabolizable Energy; **Biomix premix supplied per kg of diet: Vit. A, 10,000iu; Vit.D₃, 2000 iu; Vit E, 23 mg; Vit. K, 2mg; Vit.B₁, 1.8; Vit. B₂, 5.5mg; Niacin, 27.5mg; Pantothenic acid, 7.5mg; Vit. B₁₂, 0.015mg; Folic acid, 0.75mg; Biotin, 0.06mg; Choline chloride, 300mg; Cobalt, 0.2mg; Copper, 3mg; Iodine, 1 mg; Iron, 20 mg; Manganese, 40 mg; Selenium, 0.2 mg; Zinc, 30mg; Antioxidant, 1.25mg.

throughout the experiment. Feed consumed was measured by weighing the left over feed daily and subtracting from amount of feed provided. Faeces were collected for 7 days and mixed thoroughly. Contaminants were carefully removed, and the faeces were sun dried then samples were analysed for proximate composition (Dry matter, Nitrogen, Ether extract, Crude fibre Ash and Nitrogen free extract) in the Biochemical Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria, using the methods described by A.O.A.C (1990). The percentage apparent digestibility was calculated using the equation below:

$$\text{Apparent Digestibility (\%)} = \frac{\text{Nutrient intake} - \text{Nutrient output} \times 100}{\text{Nutrient Intake}}$$

Where; Nutrient intake (g) = Feed intake x Nutrient in diet; Nutrient output (g) = Faecal output x Nutrient in faeces.

Determination of economic viability

The economic benefits of the various diets were determined using the following indices:

- Total expenditure (N /bird) = fixed cost + total variable cost
- Net profit (N /bird) = income - expenditure
- Mean feeding cost (N /bird) = cost of feed x mean feed intake

- iv. Total Expenses (N /bird) = mean feeding cost + cost of chick + other expenses
 v. Other expenses (N /bird) = expenses spent on drugs, Vaccines etc
 vi. Mean yield cost (N /bird) = cost of chicken/kg live weight x mean final weight/bird

Statistical analysis

Data obtained from all the studies were subjected to the analysis of variance (ANOVA) using the general linear model procedure of (SAS, 2001). Significant differences among treatment means were compared using the Duncan's Multiple Range Test in the SAS, version 9.0 package. Model used for the study is as shown below:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Y_{ij} = Dependent variable

μ = Overall mean

T_i = fixed effect of treatment at varying levels of probiotic inclusion

e_{ij} = random residual effect

Results

Growth performance of broiler chickens fed graded levels of baker's yeast (Saccharomyces cerevisiae) supplement (0-4wks) during the harmattan season

The performance parameters of broiler starter chicks fed diets containing graded levels of SC are presented in Table 3. The final weight, body weight gain and daily weight gain were significantly ($P < 0.05$) higher in treatment groups fed 0.0, 0.5, and 1.0% SC compared to the other treatments. Total feed intake was significantly ($P < 0.05$) higher (2061.76g) in the birds fed the control (0.0% SC) diet. The feed conversion ratio (FCR) was significantly ($P < 0.05$) better (1.61) in treatment group fed 0.5% SC compared to other treatments but similar to the treatment group fed 1% SC. The highest percentage mortality (11.76%) was recorded in the control group.

Table 3: Growth performance of broiler chickens fed graded levels of baker's yeast (*Saccharomyces cerevisiae*) supplement (0-4wks) during the harmattan season

Parameters	Levels of SC inclusion (%)					SEM
	0.00	0.5	1.0	1.5	2.0	
Initial body weight (g/b)	44.12	44.12	44.12	44.13	44.12	0.03
Final body weight (g/b)	1152.94 ^a	1168.63 ^a	1160.79 ^a	1035.29 ^c	1100.00 ^b	17.83
Body weight gain (g/b)	1108.82 ^a	1124.51 ^a	1116.67 ^a	991.17 ^c	1055.88 ^b	17.83
Av daily gain (g/b)	39.60 ^a	40.16 ^a	39.88 ^a	35.40 ^c	37.71 ^b	0.64
Total Feed Intake(g/b)	2061.76 ^a	1812.25 ^b	1840.58 ^b	1710.49 ^c	1896.28 ^b	42.47
Feed Intake(g/d)	73.63 ^a	64.72 ^b	65.74 ^b	61.09 ^c	67.72 ^b	1.52
FCR	1.86 ^a	1.61 ^c	1.65 ^{bc}	1.73 ^c	1.80 ^{ab}	0.04
Mortality (%)	11.76 ^a	7.8 ^b	3.92 ^b	0.00 ^c	3.92 ^b	1.97

^{abc}: Means with different superscripts along same rows show significant differences ($P < 0.05$)

SEM: Standard Error of Means; FCR= Feed conversion ratio

Growth performance of broiler chickens fed graded levels of baker's yeast (Saccharomyces cerevisiae) supplement (5-8wks) during the harmattan season

Table 4 shows the result of the growth parameters of birds fed graded levels of SC during the finisher phase. Significant ($P < 0.05$) differences were observed in the

feed intake, final body weight, body weight gain, average daily weight and FCR. The final body weight, body weight gain, average daily weight and FCR were significantly ($P < 0.05$) better in treatment group fed 1% SC compared to other treatment groups. Total feed intake was significantly ($P < 0.05$) higher (3426.04g) in

the control (0.0% SC) compared to other dietary treatment groups. No mortality was

recorded during the finisher phase.

Table 4: Growth performance of broiler chickens fed graded levels of baker's yeast (*Saccharomyces cerevisiae*) supplement (5-8wks) during the harmattan season

Parameters	Levels of SC inclusion (%)					SEM
	0.00	0.5	1.0	1.5	2.0	
Initial body weight (g/b)	1875.02	1875.04	1875.05	1875.02	1875.03	0.02
Final body weight (g/b)	3357.08 ^b	3327.08 ^{bc}	3533.33 ^a	3297.92 ^c	3325.00 ^{bc}	17.19
Body weight gain (g/b)	1482.08 ^b	1452.08 ^{bc}	1658.33 ^a	1422.92 ^c	1450.00 ^{bc}	17.19
Av daily gain (g/b)	52.93 ^b	51.86 ^{bc}	59.23 ^a	50.82 ^c	51.79 ^{bc}	0.62
Total Feed Intake(g/b)	3426.04 ^a	3341.30 ^c	3393.76 ^b	3351.05 ^c	3388.54 ^b	15.08
Feed Intake(g/d)	122.36 ^a	119.33 ^c	121.21 ^b	119.68 ^c	121.02 ^b	0.54
FCR	2.31 ^a	2.30 ^a	2.05 ^b	2.36 ^a	2.34 ^a	0.04
Mortality (%)	0.00	0.00	0.00	0.00	0.00	0.00

^{abc}: Means with different superscripts along same rows show significant differences ($P < 0.05$)

SEM: Standard Error of Means

FCR= Feed conversion ratio

Effect of inclusion of Saccharomyces cerevisiae (SC) in broilers starter diet on apparent digestibility during the harmattan season

The result of the effect of inclusion of SC on apparent digestibility in broiler starter diet is presented in Table 5. All parameters measured (Dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract) differed significantly ($P < 0.05$) across the dietary treatments. Crude protein and dry matter digestibility's were significantly ($P < 0.05$) higher in treatment group fed 1% SC compared to other treatments. No significant ($P > 0.05$)

difference in the crude fibre digestibility between treatment groups fed 0.5 and 1% SC. Ash and Nitrogen free extract (NFE) digestibility's were significantly ($P < 0.05$) higher in treatment group fed 1% SC but similar to the one fed 0.5% SC. Ether extract digestibility was significantly ($P < 0.05$) higher in treatment groups fed 1.0 and 2.0% SC compared to the control and 0.5% SC, but similar to treatment groups fed 1.5% SC. Treatment groups fed 1% SC and 0.5% SC had better retention values compared to other treatment groups. The least retention values were recorded in the control treatment (0.0% SC)

Table 5: Effect Saccharomyces cerevisiae on apparent nutrient digestibility of broilers (0-4 weeks) during the harmattan season

Parameters	Levels of SC inclusion (%)					SEM
	0.00	0.5	1.0	1.5	2.0	
Dry matter (%)	68.63 ^c	77.18 ^b	80.86 ^a	73.80 ^b	73.50 ^b	2.19
Crude protein (%)	82.88 ^d	90.05 ^b	92.18 ^a	85.57 ^c	85.73 ^c	0.77
Crude Fibre (%)	63.93 ^d	82.62 ^a	82.14 ^a	68.54 ^c	77.66 ^b	1.75
Ether extract (%)	89.29 ^c	91.50 ^b	93.71 ^a	92.20 ^{ab}	93.09 ^a	0.70
Ash (%)	76.60 ^b	79.57 ^{ab}	82.71 ^a	77.17 ^b	78.48 ^b	1.83
NFE (%)	55.38 ^d	72.55 ^{ab}	74.05 ^a	61.84 ^c	68.85 ^b	2.37

^{abc}: Means with different superscripts along same rows show significant differences ($P < 0.05$)

SEM: Standard Error of Means

NFE= Nitrogen free extract

Effect of inclusion of *Saccharomyces cerevisiae* (SC) in broilers finisher diet on apparent digestibility during the harmattan season

Table 6 shows the result of the effect of inclusion of SC on the apparent digestibility in broiler finisher diet during harmattan season. The dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract differ significantly ($P < 0.05$) along various treatment groups. Treatment group

fed 1.0% SC had significantly ($P < 0.05$) higher (93.48%) crude protein digestibility but similar to treatment group fed 0.5% SC. Treatment groups fed 0.5 and 1.0% SC were significantly ($P < 0.05$) higher in terms of crude fibre (CF) and nitrogen free extract (NFE) digestibility. Ether extract digestibility was significantly higher in treatment group fed 1.0% SC but similar to the treatment groups fed 0.5 and 1.5% SC.

Table 6: Effect of *Saccharomyces cerevisiae* on apparent nutrient digestibility of broilers (5-8 weeks) during the harmattan season

Parameters	Levels of SC inclusion (%)					SEM
	0.00	0.5	1.0	1.5	2.0	
Dry matter (%)	66.12 ^c	85.51 ^a	78.36 ^{ab}	71.19 ^{bc}	74.76 ^b	3.75
Crude protein (%)	81.46 ^c	89.90 ^{ab}	93.48 ^a	87.75 ^b	88.78 ^b	1.99
Crude Fibre (%)	75.11 ^b	85.06 ^a	83.21 ^a	80.43 ^{ab}	74.36 ^b	2.96
Ether extract (%)	84.00 ^c	94.26 ^{ab}	95.54 ^a	92.40 ^{ab}	90.81 ^b	2.38
Ash (%)	68.63 ^c	88.89 ^a	77.85 ^b	78.12 ^b	76.13 ^b	3.60
NFE (%)	51.09 ^b	79.73 ^a	78.68 ^a	86.30 ^a	61.08 ^b	6.66

^{abc}: Means with different superscripts along same rows show significant differences ($P < 0.05$)

SEM: Standard Error of Means

NFE= Nitrogen free extract

Economic efficiency of inclusion of *saccharomyces cerevisiae* (SC) in diets of broilers during the harmattan season

The economic analysis of inclusion of SC in the diet of broilers during the harmattan season is shown in Table 7. The analysis

indicates that treatment group fed 1.0% SC had the highest net profit of N 650.71 followed by treatment group fed 0.5% SC (N578.46). The control treatment had net profit of N554.35 while the least (N 475.74) net profit was in treatment group fed 2.0% SC.

Table 7: Economic analysis of inclusion of *Saccharomyces cerevisiae* in the diet of broilers during the harmattan season

Parameters	Levels of SC inclusion (%)				
	0.00	0.5	1.0	1.5	2.0
Cost of feed (₦/bird)	195.35	200.14	204.92	209.74	214.39
Mean feed Intake (g/bird)	5487.80	5153.55	5234.34	5061.54	5284.82
Mean feeding cost (₦/bird)	1072.04	1031.43	1072.62	1061.61	1133.01
Cost of chicks (₦/bird)	130.00	130.00	130.00	130.00	130.00
Other expenses (₦/bird)	90.00	90.00	90.00	90.00	90.00
Total Expenses (₦/bird)	1292.04	1251.43	1292.62	1281.61	1353.01
Mean final weight (g/bird)	3357.08	3327.08	3533.33	3297.92	3325.00
Cost of chicken/Kg live weight (₦)	550.00	550.00	550.00	550.00	550.00
Mean yield cost (₦/bird)	1846.39	1829.89	1943.33	1813.86	1828.75
Net profit (₦/bird)	554.35	578.46	650.71	532.25	475.74

Discussion

The overall result showed that inclusion of SC in broiler diets at 0.5% during the starter phase and 1.0% during the finisher phase gave the best performance in terms of body weight gain. This finding agrees with the work of Farhad (2011) who reported that probiotic significantly increased body weight gain in the birds fed diets supplemented with different levels of probiotic than the control group. Shareef and Al-Dabbagh (2009) reported that body weight gain, feed conversion ratio and feed intake significantly increased when SC was added at a rate 2.0% as compared with other treatments. The best weight gain recorded in treatment groups fed 0.5 SC during the starter phase and treatment group fed 1% SC during the finisher phase could be due to digestive tract activity whereby SC in the gut inhibit the growth of pathogenic microbes by increasing acidity of the intestinal contents thereby providing a pathogenic free intestinal medium for proper functioning of endogenous enzymes to breakdown the nutrients of the experimental rations; thus in turn improve body weight gain and feed conversion ratio as reported by Altaf-Ur- Rahman *et al.* (2007). The growth performance may also be linked to the better nutrient digestibility. The reduction in the body weight observed in treatment groups fed 1.5 and 2.0% SC in both the starter and finisher phases similar to the findings of Payrad and Mahmoudi (2008) who reported that the inclusion of 1.5% SC in broiler rations improved body weight gain, feed intake and feed conversion ratio at an optimum level which reduced as it exceeded the optimum level. The lower feed intake observed in the SC treatment groups in both the starter and finisher phases could be due to better utilization and absorption of nutrients as confirmed by apparent digestibility of the

nutrients. Likewise the better FCR recorded for treatment groups fed 0.5% SC during the starter phase and 1% SC during the finisher phase of the experiment 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 finding is similar to that reported by Talebi *et al.* (2008) that the addition of probiotic to broiler chicken diet significantly decreased FCR.

The overall mortality was low except for the control group which had higher mortality compared to the treatment groups fed SC. The lowest mortality recorded in the treatment group supplemented with SC could be due to the stimulation of the immune system by the SC as reported by Paryad and Mahmoudi (2008). Lower mortality was also recorded by Awad *et al.* (2009) when broiler chickens were fed probiotic at 3%. No mortality was recorded in the finisher phase of the experiment and this could be due to better development of the immune system as the birds get older. The digestibility values of all the parameters were numerically increased due to supplementation of SC in both the starter and finisher phases of the experiment. The results of these findings corroborated that of Fioramonti *et al.*, (2003) who reported that the addition of probiotics have effect in the physiological functions of the gastrointestinal tract, such as digestion and absorption which could have led to the improvement in the apparent digestibility observed in the SC treated groups. Ahmed (2004) also reported an increase of crypt cells proliferation of small intestines with the use of probiotics as compared to the control and this could have led to the high digestibility coefficient as observed in the SC treated groups.

There was considerable cost benefit of

including SC in the diets of broilers compared to the control group. The differences in economic efficiency showed that diets that contained SC had the best values compared to the control. Inclusion of SC at 1% gave the highest net profit while the least net profit was in treatment fed 2% S.C. The better economic efficiency recorded in treatment group fed 1.0% SC could be due to better absorption and utilization of the nutrients which lead to improvement in feed conversion ratio. This is also reported by Mandal *et al.* (1996) who found that the use of probiotics in broiler chickens is financially profitable.

Conclusion

Inclusion of *Saccharomyces cerevisiae* (SC) in the diet of broiler chickens improved their growth performance, digestibility and economic efficiency during the harmattan season.

Recommendation

- i. It is recommended that broiler chicken farmers should include 0.5% Baker's yeast in broiler starter diet and 1.0% Baker's yeast in finisher diet for improved weight productivity during the harmattan season.
- ii. More research should be carried out on other feed additives to explore their beneficial effects based on seasonal fluctuations.

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