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Full Length Research Paper

Effect of different levels of supplemental yeast (*Saccharomyces cerevisiae*) on performance, blood constituents and carcass characteristics of broiler chicks

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The effect of feeding different levels of yeast *Saccharomyces cerevisiae* (*SC*) on growth performance, blood constituents and carcass characteristics of Ross broiler chicks was studied. An experiment of 42 days duration was conducted with a flock of 240 one day-old chicks. There were 4 dietary treatments each consisting of 6 replicates with 10 chicks in each replicate. The treatments were containing 0% (control), 0.5, 1.5 and 2% yeast (*Saccharomyces cerevisiae*) respectively. Data were collected for body weight, daily gain, feed intake and feed conversion ratio during the experimental period (0 – 42 d of age). At the end of the experiment carcass yield and percentage of breast, legs, liver, heart, gizzard and abdominal fat were recorded. On day 42, concentration of proteins, lipids in serum, WBC (white blood cells) and heterophil to lymphocyte ratio (H/L) in chick's blood were evaluated. Results showed that chicks fed 1.5% yeast had higher (P<0.05) body weight gain (BWG), feed intake (FI) and the better (P<0.05) feed conversion ratio (FCR). Feeding ration containing 1.5 and 2% yeast reduced (P<0.05) plasma cholesterol and triglycerides concentration, while that containing 1.5% and 2% yeast increased (P<0.05) plasma HDL level. Chicks fed 1.5% *S. cerevisiae* had the higher (P<0.05) total plasma protein, albumin and globulin concentration. The inclusion of 1.5% of yeast improved (P<0.05) all of the carcass characteristics parameters. It is concluded that dietary *S. cerevisiae* could improve the performance, blood constituents and carcass characteristics of broiler chicks.

Key words: Broiler chicks, *yeast*, growth, blood constituents, carcass.

INTRODUCTION

One of the major challenges faced by the poultry industry in the developing world is about improving efficiency of production. To meet this challenge and maintain the efficiency of feed utilization, series of attempts have been made by researchers. These include incorporation of antimicrobials and other natural products, such as yeasts to animal feeds (Kung, 1992; Muihead, 1992). Live yeast addition to animal feed has been known to improve the nutritive quality of feed and performance of animals (Glade and Sist, 1988; Martin et al., 1989). Yeast from malted grain fermentation constitutes a natural concentrate mixture of essential nutrients minerals and vitamins. *Saccharomyces cerevisiae (SC)* yeast has biologically valuable proteins, vitamin B-complex, important trace minerals and several unique "plus" factors. Many other beneficial factors identified such as ability to enhancement of phosphorus availability (Glade and Biesik, 1986; Brake, 1991; Moore et al., 1994) and utilization by animals (Thayer et al., 1978; Erdman, 1989; Pagan, 1990), reduction in cases of disease infection (Line et al., 1997) in addition, improvement of feed efficiency (Day, 1997; Onifade and Babatunde, 1996). Santin et al. (2001) reported that manna oligosaccharides and fruct- oligosaccharides in the cell wall of yeast assist the balance of the

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Table 1. The chemical composition basal diet.

Ingredient (%)	Starter (1-28 d)	Finisher (29-42 d)
Corn	59.26	64.63
Soybean meal (44%)	20.52	18.92
Corn gluten meal	9.43	7.17
Rapeseed meal	5.00	3.00
Soybean oil	2.00	3.00
Tricalcium phosphate	1.78	1.27
Limestone	0.88	1.08
Salt	0.40	0.16
DL-Methionine	0.34	0.16
L-Lysine HCl	0.19	0.17
Vitamin premix2	0.10	0.10
Mineral premix3	0.10	0.10
Total	100.00	100.00
Calculated composition		
ME (kcal/kg)	3100	3200
CP (%)	21.50	19.00
TSAA (%)	0.80	0.72
Ca (%)	1.00	0.90
Available P (%)	0.45	0.35
Methionine (%)	0.50	0.38
Lysine (%)	1.10	1.00

the gastro-intestine by maintaining or reestablishing the conditions of eubiosis in the digestive tube, Some authors (Hayat et al., 1993, Bradley and Savage, 1993) have attributed the increase in mineral retention and better bone mineralization of broilers supplemented with manna oligosaccharide probiotic.

However, there are still conflicting reports on the beneficial effect of yeast inclusion in poultry diets. Hayat et al. (1993) suggested that the beneficial effects of *Saccha-omyces* dried yeast in feeds may be influenced by the birds genome and recom-mended further studies. In spite of these series of studies on the effect of yeast inclusion in poultry diets no one has come out with the specific effect of *SC* in different levels on growth performance, blood constituents or carcass characteristics of broiler chicks.

This work therefore, has the objective of evaluating the effects of feeding different levels of supplemental y*east (S. cerevisiae)* on growth performance, blood constituents and carcass characteristics of Ross broiler chicks.

MATERIALS AND METHODS

Birds, housing and feeding

An experiment with 240 day-old commercial *Ross* male broiler chicks was conducted from 1 - 42 d of age. Chicks were weighed and the average of weight was recorded as day-old weight. They were assigned into 4 treatment groups. Each group was divided into 6 equal replicates and 10 chicks per each replicate. The chicks were housed in floor pens (1.25 x 2 m) each. Starter diets containing 22.33% crude protein (CP) and 2975.6 kcal/kg ME were offered *ad-libitum* from 1 - 28 d of age. Then a finisher diet contains 18.4% crude protein and 3174.35 kcal/kg ME were offered *ad-libitum* from 29 - 42 d of age. All diets were formulated to cover the nutrient requirements of chicken (NRC, 1994). Ingredients and the composition of the experimental diets are shown in Table 1. First group served as a control (0% yeast), while, the other groups fed diets with 0.5, 1.5, and 2.0% of y*east* respectively. The chemical composition of yeast is presented in Table 2. Standard management practices of commercial broiler production were applied. Chicks were vaccinated against New-castel disease (ND) and Infectious Bronchitis (IB) in mixed vaccine at 7 and 21 d of age and against Infectious Bursal disease (IBD) at 13 d of age. Anticoccidial compounds were used as a preventive dose from 22 - 29 days of age. Individual body weight was determined weekly and similarly, feed consumption was recorded for the corresponding periods

Table 2. The chemical composition of *Saccharomyces cerevisiae*.

Composition	
Dry matter%	93
ME(kcal/kg)	1990
Crude protein%	44.4
Crude fat%	1
Crude fiber%	2.7
Ca%	0.12
P%	1.4

and the mean of each pen was obtained. Feed conversion was calculated according to following formula: feed conversion = feed intake / body weight. Mortality was recorded daily for adjusting data in the end of experiment and post mortem examination was conducted.

Blood samples

At 42 days old, blood samples were taken from the brachial vein with a syringe rinsed with a heparin solution. Whole blood samples (0.5 ml) were used instantly to measure ratio of leukocytes to lymphocytes and hetrophil to lymphocytes. Then 2 ml of each sample centrifuged to harvest the plasma and was stored at 20 until 0° C assayed.

Blood constituents assay

Total plasma cholesterol was assayed by a JENWAY, 6105µ v/v spectrophotometer with commercial Kits (Bio Mereuxas, France). Triglycerides were also assayed by using the same spectrophotometer with commercial Kits (Triglyceride-GPO method) Biolabosa, France. Triglyceride was determined after enzymatic hydrolysis with lipase. Indicator was quinoneimine formed from hydrogen peroxide, 4-aminoantiyring and 4-chlorophenol under catalytic influence of peroxidase. High density lipoprotein (HDL) was obtained using commercial Kits (Labkit, Chemelex, SA, Barcelona). Plasma total proteins were analyzed by using commercial Kits (Biuret Method, Chemelex, SA, Barcelona). The total protein determination is that protein gives an intensive violet blue complex with copper salts in an alkaline media. Iodine was included as antioxidant the intensively of color formed is proportional to the total protein concentration in the sample. Commercial kits also used for albumin determination (Bromocresol green test, Labkit, Chemelex, SA, Barcelona).

Total WBC was counted as described by Haddad and Mashaly (1990). Briefly, 490 µ / of brilliant crassly blue dye leukocytes were counted using a hemocytometer. One drop blood was smeared on the glass slide. The smears were fixed and stained using Hema-3 (Fisher Science). One hundred leukocytes were counted on one slide for each bird and heterophil to lymphocyte ratio was calculated.

Carcass characteristics

Dressing percentage

At the end of the experiment 4 chicks from each replicate within each treatment (24 chicks/treatment) were randomly selected and weighed to obtain live body weight, then slaughtered by a sharp knife for complete bleeding and feather was plucked. Head, viscera and shanks were removed. Carcass was left for one hour to remove excess water and allowed for over night in refrigerator at 4 ± 2°C and weighed. Dressing percentage was calculated without giblets using the following equation:

$$\text{Dressing percentage} = \frac{\text{Carcass weight}}{\text{Live body weight}} \times 100$$

Carcass was then portioned, breast and legs were obtained and weighed. The data on abdominal fat and organ weight that is, heart; liver and gizzard were also recorded at this stage. Abdominal fat comprised leaf fat surrounding the cloacae and abdominal muscles excluding fat surrounding the gizzard. Data from these measurements were used to calculate the percentage of part to the carcass weight. Breast and leg meat were chemically analyzed for moisture, crude protein (CP) and total lipids according to AOAC, 1990 and the values were expressed on dry matter basis. Heart, gizzard and liver were weighed and the weight of each part was calculated as percentage of the carcass weight.

Statistical analysis

All data were analyzed by analysis of variance (ANOVA) procedures (Steel and Torrie, 1980) appropriate for a completely randomized design by the GLM procedure of SAS (1995). When the effect of yeast on performance, blood constituents and carcass characteristics was the main effect. The level of statistical significance was preset at P≤0.05.

RESULTS

Growth performance

Table 3 presents the mean ± SE of body weight gain, feed intake and feed conversion ratio of broiler chicks fed different levels of yeast at 42 days of age. Results showed that chicks fed 1.5% yeast had the higher (P<0.05) body weight gain and improved (P<0.05) feed conversion ratio compared with the control group or other dietary treatments. Meanwhile, chicks fed 1.5% *S. cerevisiae* had higher (P<0.05) cumulative feed consumption compared with the other dietary treatments (control, 0.5 and 2% *SC).*

Blood constituents

The results of plasma total protein, total plasma cholesterol, albumin, globulin, HDL, triglycerides, total WBC, and heterophil to lymphocyte ratio are summarized in Table 4. The present results showed that chicks fed 1.5% yeast had the higher (P<0.05) total plasma protein values compared with the other dietary treatments. On the other hand, chicks fed 1.5% yeast recorded the higher (P<0.05) albumen and globulin concentration compared with all other dietary treatments.

Nevertheless, the present results showed that feeding broiler chicks 1.5% *S. cerevisiae* reduce (P<0.05) plasma cholesterol and triglycerides compared with broiler chicks fed control, 0.5 and 2% *S. cerevisiae*. Meanwhile, chicks fed ration containing 1.5% *S. cerevisiae* recorded the higher (P<0.05) high density lipoproteins. In addition, both 1.5 and 2% *S. cerevisiae* yeast significantly (P<0.05) increased WBC and decreased hetrophil to lymphocytes ratio of chicks.

Carcass characteristics

The effect of feeding different levels (0, 0.5, 1.5 and 2%) *S. cerevisiae* on dressing percentage, breast, leg, abdominal fat and some internal organs percentage (liver,

Table 3. Effect of different levels of yeast (Saccharomyces cerevisiae) on growth performance of male broiler chicks

Items	Yeast supplement (%)				SEM	Significance level
	control	0.5	1.5	2		
0–3 wk						
BW gain, g/bird	611[a]	612[a]	617[b]	615[b]	2.75	*
Feed intake, g/bird	1.12[a]	1.12[a]	1.14[b]	1.12[a]	0.01	*
Feed conversion ratio	1.72[a]	1.70[a]	1.62[bc]	1.65[b]	0.04	*
4–6 wk						
BW gain, g/bird	1083[a]	1084.5[a]	1095.2[bc]	1086.5[b]	5.43	*
BW gain, g/bird	2290[a]	2291[a]	2299[bc]	2294[b]	4.04	*
Feed intake, g/bird	2.11[a]	2.10[a]	1.95[bc]	1.98[b]	0.08	*
Feed conversion ratio	5.35[a]	5.36[a]	5.45[b]	5.49[c]	0.07	

[a b c]: Means with different superscript in the same row differ significantly
*: P<0.05.
SEM: Standard error of a mean.

Table 4. Means of blood constituents of broiler chicks fed rations contain different levels of yeast (*Saccharomyces cerevisiae*)

Items	Yeast supplement (%)				SEM	Significance level
	control	0.5	1.5	2		
Total plasma cholesterol (mg/dl)	151.55[a]	150.14[a]	138.11[bc]	148.02[b]	6.07	*
Triglycerides (mg/dl)	78.36[a]	76.80[a]	72.92[b]	72.58[b]	2.86	*
HDL (mg/dl)	67.89[a]	69.49[b]	72.76[bc]	72.25[bc]	2.30	*
Total plasma proteins (mg/dl)	3.19[a]	3.83[bc]	4.00[bc]	3.64[b]	0.35	*
Albumin (mg/dl)	1.36[a]	1.46[b]	1.61[bc]	1.59[bc]	0.12	*
Globulin (mg/dl)	1.63[a]	1.78[b]	1.89[bc]	1.86[bc]	0.17	*
WBC (unit/mm^3)	22164[a]	22240[b]	22308[c]	22349[d]	81.09	*
Hetrophil / lymphocytes ratio	0.820[a]	0.753[b]	0.708[c]	0.691[d]	0.06	*

[a b c]: Means with different superscript in the same row differ significantly
*: P<0.05.
SEM: Standard error of a mean.

Table 5. Effect of different levels of yeast (Saccharomyces cerevisiae) on carcass characteristics of male broiler chicks

Items	Yeast supplement (%)				SEM	Significance level
	control	0.5	1.5	2		
Dressing %	69.50[a]	69.57[a]	71.64[b]	71.8[b]	1.26	*
Breast%	14.75[a]	15.00[a]	16.01[b]	15.54[b]	0.56	*
Legs%	15.43[a]	15.61[a]	16.08[b]	16.17[b]	0.36	*
Liver%	3.27[a]	3.29[a]	3.42[bc]	3.34[b]	0.07	*
Heart%	0.713[a]	0.716[a]	0.72[b]	0.72[b]	0.004	*
Gizzard%	2.67[a]	2.68[a]	2.75[b]	2.76[b]	0.05	*
Abdominal fat%	2.38[a]	2.37[a]	2.31[b]	2.32[b]	0.04	*

[a b c]: Means with different superscript in the same row differ significantly
*: P<0.05.
SEM: Standard error of a mean.

heart and gizzard) are summarized in Table 5. Results of the present experiment showed that the inclusion of 1.5% and 2% *S. cerevisiae* improved (P<0.05) the measured parameters. However, feeding broiler chicks rations con-

Table 6. Effect of different levels of yeast (Saccharomyces cerevisiae) on chemical composition of breast and leg meat of broiler chicks

Items	Yeast supplement (%) control	0.5	1.5	2	SEM	Significance level
Breast meat						
Dry Matter%	25.24 [a]	25.31 [b]	25.46 [c]	25.46 [c]	0.11	*
Crude Protein%	22.15 [a]	22.18 [b]	22.34 [c]	22.32 [c]	0.96	*
Ether Extract%	2.02 [a]	2.01 [a]	2.00 [a]	1.96 [b]	0.03	*
Leg meat						
Dry Matter% Crude	24.22 [a]	24.27 [b]	24.33 [c]	24.35 [c]	0.06	*
Protein% Ether	20.34 [a]	2291 [a]	2299 [bc]	2294 [b]	4.04	*
Extract%	5.35 [a]	5.36 [a]	5.45 [b]	5.49 [c]	0.07	*

[a b c]: Means with different superscript in the same row differ significantly
*: P<0.05.
SEM: Standard error of a mean

tains 2% yeast (*S. cerevisiae*) gave numerically the higher dressing, leg and gizzard percentage while, 1.5% *S. cerevisiae* gave numerically the higher breast percenttage. Moreover, chicks fed ration contains 1.5% *S. cerevisiae* had significantly the higher liver percentage. On the other hand, chicks fed ration contain 1.5 and 2% *S. cerevisiae* had significantly the less abdominal fat percentage.

Table 6 represents the chemical composition of breast and leg meat of broiler chicks fed different dietary treatments (control, 0.5, 1.5 and 2% *S. cerevisiae*). The tabulated results showed that breast meat of broiler chicks fed rations contains 1.5 and 2% *S. cerevisiae* had the higher (P<0.05) dry matter, crude protein and ether extract percentage, compared with control and 0.5% *S. cerevisiae*. Moreover, leg meat of chicks fed rations contains 1.5 and 2% *S. cerevisiae* had the higher (P<0.05) dry matter, crude protein and ether extract percentage. Meanwhile, leg meat of chicks fed rations containing 2% *S. cerevisiae* had the higher (P<0.05) ether extract percentage compared with control, 0.5 and 1.5% *S. cerevisiae.*

DISCUSSION

Growth performance

Results of the present study showed that the inclusion of 1.5% *S. cerevisiae* yeast in broilers ration improved body weight gain, feed intake and feed conversion ratio. The obtained results confirmed the previous findings of several researchers (Zhang et al., 2005; Angel et al., 2005; Nilson et al., 2004; Santin et al., 2003). Also in agreement with our study, Onifade et al. (1999) reported that *SC* improved feed/gain ratio and BW gain. Valdivie (1975) reported that feed/gain ratio of broiler chicks from 0 to 9 wk of age improved significantly as the *SC* level in the diets increased. Improved intestinal lumen health was observed in *SC* fed male pullets (Bradley et al., 1994) as well as in 1-week old male broilers fed *SC* yeast (Santin et al., 2001). Several workers (Valdivie, 1975; Oyofo et al., 1989; Newman, 1994; Spring et al., 2000) reported that *SC* improved the efficacy of the immune system, improved intestinal lumen health, and increased digestion and absorption of nutrients, which resulted in better performance. As mentioned above in the present study, feeding 1.5% yeast to chicks improved BWG, FCR and FI but chicken fed greater level of yeast (2%) had similar BWG and FI to control or 1.5% yeast. These results suggest that yeast increased these parameters at an optimum level and its effect will reduce exceed of this optimum level that probably refer to digestive tract activity. It seems that the feed digestion will alter by adding more yeast and the bird growth will alter too.

Blood constituents

The present results showed that broiler chicks fed ration contains 1.5% *S. cerevisiae* had significantly the lower plasma cholesterol and triglycerides, the higher of plasma total protein, albumin, globulin, HDL, total WBC, and lower heterophil to lymphocyte ratio. Our observations corroborated data published by some authors (Gudev et al., 2008; Kannan et al., 2005; Onifade et al., 1999; Onifade, 1997; Mohan et al., 1996; Panda et al., 2000; Rao et al., 1981; De Smet et al, 1998; Abdulrahim et al., 1996) who stated that there was a decrease in plasma cholesterol for chicks fed diets contains yeast and different probioticsc**.**

Probiotics could contribute to the regulation of serum cholesterol concentrations by deconjunction of bile acids. Since the excretion of deconjugated bile acids is enhanced and cholesterol is its precursor, more molecules are spent for recovery of bile acids (De Smet et al.,

1994). As a result of increased synthesis of this acids, it is expected the level of serum cholesterol to be reduced. Klaver and Van Der Meer (1993) suggested that co-precipitation with bile acids might be of importance for decreasing of serum cholesterol concentrations.

Serum concentrations of albumin, globulin, total protein and, HDL were significantly affected by the treatments. Serum total protein and albumin have been reported to be directly responsive to protein intake and quality (Eggum, 1989). Diet containing 0.5, 1.5 and 2% *yeast* increased serum HDL concentration. With increasing level of *SC* in experimental diet, serum LDL and cholesterol concentration were not significantly increased. On the other hand, in chickens fed diet containing 1.5% *SC* serum cholesterol concentration decreased compare with control group ($P<0.05$). Reduction in circulating cholesterol with supplemental yeast was remarkable and agrees with the results of other researchers (Onifade et al, 1999; Onifade, 1997) that the addition of innocuous micro-organisms including yeast to diet of rabbit and broiler chickens decreased serum cholesterol, triglycerides and phospholipids. In our experiment, all yeast-fed chicks in compare to control diet had a more WBC and lower H/L ratio by the higher populations of lymphocytes than control diet. The same trend of lymphocyte populations may be indicative of higher activity of humeral immune responses in chicks fed yeast supplemented diets. Onifade et al. (1999) and Onifade (1997) reported a positive correlation between dietary levels of SC with the hematological indices like RBC, WBC and PCV in rabbit and broiler chickens. They suggested that theses correlations may be an additional mechanism growth promotion by supplemental yeast. The yeast can stimulate immune system of chicks body so, it affects WBC.

Carcass characteristics

The present results suggested that the inclusion of different levels *S. cerevisiae* in broiler chicks rations affect significantly all carcass characteristics parameters measured (dressing percentage, breast, leg, liver, heart, gizzard, and abdominal fat percentage). The present findings were in agreement with previous findings (Zhang, 2006; Kannan et al., 2005; Panda et al., 1999; Onifade et al., 1998; Jin et al., 1998). The other researchers (Dimcho et al., 2005; Penkov et al., 2004; Ivanov, 2004) reported more improvements in liver, gizzard and heart of broilers, mules and ducklings by supplementing diets with probiotics.

In recent study, Kalavathy et al. (2003) found that supplementation of *S. cerevisiae* reduces ($P<0.05$) abdominal fat pad. Similarly, Yusrizal and Chan (2003) reported that supplementation of beta fructans as a probiotic from chicory had produced low level ($P<0.05$) of abdominal fat pad.

The same trends of results were also noticed with edible organs. Zhang1 et al. (2006) demonstrated that the addition of *SC* into the control diet significantly lowered the shear force in raw drumstick meat ($P<0.05$).

Also, there are trials showing that enrichment of diets with yeast could favorably improve the quality of edible meat from broilers. For example, edible meats from broiler chicks fed a diet containing chromium-enriched SC exhibited increased tenderness (Bonomi et al., 1999) and increased water holding capacity (Lee et al., 2002).

Although the information provided in these papers contributes to the elucidation of the mode of action of the probiotics and their efficacy, information about the effects of them on key broiler carcass characteristics, such as leg and breast yield and the incidence of broken legs, wings, and clavicles, is not available. There exists, therefore, a paucity of data detailing the effect of the level of probiotic supplementation during the finisher and withdrawal stages of broiler production on commercial processing parameters.

Unfortunately, from the viewpoint of broiler chicks carcass characteristics and chemical composition breast and leg meat, there is a scarcity in information in the literature about these parameters. Angel et al. (2005) reported that feeding the direct fed microbial (DFM) resulted in lower tibia ash than that of birds fed the control diet, but the addition of DFM to low nutrient diets overcame this negative effect. In addition to, Pillai et al. (2006) study on *Escherichia coli* phytase with chicks stated that tibia ash increased linearly ($P<0.01$) with increasing phytase levels, regardless of phytase source. Mutus et al. (2006) reported same results who studied the effect of dietary probiotic supplementation on tibial bone characteristics and strength in broilers. However, it can be concluded that feeding *S. cerevisiae* yeast improved chemical composition of breast and leg meat of broiler chicks. More studies required in this field to confirm the present results.

Conclusion

Broiler chicks fed 1.5% yeast had the higher ($P<0.05$) BWG, FI, total plasma protein, plasma cholesterol and triglycerides compared with the control group or other dietary treatments. Also, the inclusion of 1.5 and 2% *S. cerevisiae* improved the measured carcass characteristics.

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