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Effects of Feeding Different Levels of Baker's Yeast on Performance and Hematological Parameters in Broiler Chickens

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ABSTRACT

The effects of feeding baker's yeast performance of Cobb 500 broilers were studied. Four nearly isocaloric and isonitrogenous starter and finisher rations were prepared. 240 chicks with an average initial body weight of 42g were randomly divided into 12 groups contained 4 treatments with 3 replications for each treatment. Treatment rations were containing 0, 0.5, 1.5 and 2.5% of baker's yeast as T1, T2, T3 and T4 respectively. At the end of the trial, 3 males and 3 female chickens from each replication were slaughtered for carcass evaluation. The Crude Protein (CP) and Metabolizable Energy (ME) contents of baker's yeast were 48% and 3615 kcal/kg DM, respectively. The CP content of the rations during the starter and finisher phases were 22% and 20%, respectively. The ME content of the rations during the starter and finisher phases were 3100 kcal/kg and 3200 kcal/kg respectively. Feed intake during the starter phase and entire trial period was lower for T4, whereas during the finisher phase in control diet group showed the highest feed intake than the other supplemental groups. The highest daily body weight gain was recorded in broilers fed T4 rations during starter phase, finisher phase and entire experimental period. Feed conversion ratio of T4 and T3 groups was better than T2 and T1. T3 and T4 groups had higher eviscerated percentages. Blood parameters results showed that fed broilers yeast containing ration had higher WBC, PCV and Hb. Partial budget analysis indicated that the highest net income, marginal rate of return and chicks' sale to feed cost were obtained for T3 followed by T4. Baker's yeast can be an important feed additive, which can be included up to 2.5% of the total ration and improve the overall performance of broilers without compromising the hematological indices of broiler chickens.

Key words: Baker's yeast, Blood constituents, Broiler, Carcass and Growth

INTRODUCTION

Broiler production represents nearly 33% of global meat production and is a source of protein that plays an important role in human nutrition (FAO, 2010). Modern intensive poultry production produces market ready broiler chickens within six weeks of their age. This achievement arises from improved productivity via genetic selection, improved feeding and health management practices involving usage of antibiotics as therapeutic agents to treat bacterial diseases and as feed additives for growth promotion (Apata, 2009). One of the major challenges faced by the poultry industry in the developing world is improving efficiency of production. To meet this challenge and maintain the efficiency of feed utilization, series of attempts have been made by different researchers and organizations. These include incorporation of genetics selection, antimicrobials and other natural products, such as antibiotics as therapeutic agents to treat bacterial diseases and as feed additives for growth promotion, probiotics, vitamin supplements and antibodies to animal feeds and pelleting of feed, all decrease the time that an animal requires to reach market weight, reducing feed and overall cost (Kanwal et al., 2017). Two main groups of feed additives are the nutrient feed additives and non-nutrient feed additives. The nutrient feed additives are added in the feed to correct quantity of the deficient nutrients in the rations, such as vitamin mix, mineral mix and single or the mixture of amino acids. While the non-nutrient feed additives such as color and taste enhancers, appetizers, enzymes, yeast, growth promoters and probiotics are added in the feed to improve or to accelerate the rate of feed or nutrient utilization (Kemal et al., 2001).

Addition of Live yeast to animal feed has been known for improving the animals health symptoms

(Kanwal et al., 2017). For a long time, yeast products have been successfully included in feed as natural growth promoters for livestock and poultry production. Many types of yeast have been fed to animals either in the form of yeast fermented mash produced on farm, yeast by-products from breweries or distilleries and commercial yeast products (Kemal et al., 2001; Saied et al., 2011). Currently, in many parts of the world, food additives, such as probiotics and prebiotics are being experimented to alleviate the problems associated with the withdrawal of antibiotics from feed. Probiotic is defined as a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance (Fuller, 2000). It is a biological product, which stimulates the immunity system (Toms and Powrie, 2001), produces the digestive enzyme and increases its defensive activity against pathogenic bacteria and stops the implementation of those bacteria over the mucosa of the intestine (Rolfe, 2000).

Baker's yeast (*Saccharomyces cerevisiae)* is considered as one of the live microorganism probiotic that is used as feed additive. It can improve body weight gaining, feed efficiency, stimulate the immunity system and increase its defensive activity against pathogenic bacteria and also reduces feed cost by shortening the length of feeding (Fietto et al., 2004; Graff et al., 2008; Patane et al., 2017; Mohamed et al., 2015). Even though in Ethiopia incorporating yeast in ration specially baker's yeast is not widely used, it is one of the most widely available in Ethiopia. Therefore, the current experiment was conducted with the following objectives:

To evaluate the effects of feeding different levels of baker's yeast *(S. cerevisiae)* on feed intake, growth performance and carcass characteristics of broiler chicks; To assess the effects of baker's yeast on hematological indices of broiler chicks and to determine the economic profitability of using baker's yeast in the ration of broilers.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at Haramaya University poultry farm, Ethiopia, which is located at an altitude of 1980 meters above sea level and 515 km east of Addis Ababa. The area is located at latitude and longitude of 9^0 26' N and 42^0 3' E, respectively. The average annual rainfall of the area is 780 mm with an average minimum and maximum temperatures are 8^0C and 24^0C, respectively (Samuel, 2008).

Experimental feeds

Feed ingredients of the study were formulated using the common broiler feeds. The ingredients used for ration formulation were soybean meal, noug seed cake, corn grain, wheat short, vitamin premix, di-calcium phosphate, limestone, baker's yeast, salt, lysine and methionine. The food ingredients that are corn grain and noug seed cake were hammer milled at 5mm sieve size and mixed based on dry matter basis. Lysine, methionine, di-calcium phosphate and vitamin premix were added to the feed during mixing without hammer milling. Representative samples of food ingredients soybean meal, noug seedcake, corn grain and wheat short as well as additive which are baker's yeast were analyzed for chemical composition before ration formulation.

For the period of both starter and finisher phases, treatment rations containing baker's yeast at levels of 0%, 0.5%, 1.5%, and 2.5 % of the total ration were formulated for T1, T2, T3 and T4, respectively by using feed win software. The four treatment rations used in the study were formulated to contain approximately 22% and 20% CP and 3100 and 3200 kcal/kg ME for starter's and finisher's diet respectively. The starter phase was until the age of 3 weeks. The finisher phase was offered from fourth up to sixth weeks. The starter and finisher diets were formulated separately as indicated in tables 1 and 2.

Experimental design and treatments

Completely Randomized Design (CRD) with four treatments and three replicates was used in the study. Twelve pens were used for the two hundred and forty day old chicks and 20 chicks were randomly assigned to each pen (Table 3).

Table 1. Percentage of ingredients used in formulating starter ration of broiler chicken

Ingredients (%)	T1	T2	T3	T4
Corn grain	44.0	44.0	44.0	44.0
Wheat short	11.0	11.0	10.5	10.0
SBM	25.0	25.0	25.0	25.0
NSC	17.5	17	16.5	16.0
BY	0.0	0.5	1.5	2.5
Lime stone	1	1	1	1
Common salt	0.5	0.5	0.5	0.5
VP	0.4	0.4	0.4	0.4
DCP	0.3	0.3	0.3	0.3
Lysine	0.1	0.1	0.1	0.1
Methionine	0.2	0.2	0.2	0.2
Total	100.00	100.00	100.00	100.00
ME(kcal)	3038.23	3043.71	3054.7	3062.37
CP (%)	21.7	21.82	21.98	22.06

SBM= soybean meal; NSC= noug seed cake; BY= baker's yeast; VP= vitamin premix; DCP= di-calcium phosphate; ME= metabolizable energy; CP= crude protein.

Table 2. Percentage of ingredients used in formulating finisher ration of broiler chicken

Ingredients (%)	T1	T2	T3	T4
Corn grain	55.0	55.0	55.0	55.0
Wheat short	8.0	7.5	7.5	7.0
SBM	22.0	22.0	22.0	22.0
NSC	12.5	12.5	11.5	11.0
BY	0.0	0.5	1.5	2.5
Limestone	1	1	1	1
Salt	0.5	0.5	0.5	0.5
VP	0.4	0.4	0.4	0.4
DCP	0.3	0.3	0.3	0.3
Lysine	0.1	0.1	0.1	0.1
Methionine	0.2	0.2	0.2	0.2
Total	100	100	100	100
ME(kcal)	3100.51	3104.34	3112.01	3123
CP %	19.47	19.93	20.00	20.03

SBM= soybean meal; NSC= noug seed cake; BY= baker's yeast; VP= vitamin premix; DCP= di-calcium phosphate; ME= metabolizable energy; CP= crude protein.

Table 3. Experimental design

Treatment	No of Replication	Starter Phase			Finisher Phase		
		Chicks/ Replication			Chicks/ Replication		
		R1	R2	R3	R1	R2	R3
T1	3	20	20	20	18	19	17
T2	3	20	20	20	18	19	19
T3	3	20	20	20	20	18	20
T4	3	20	20	20	19	19	18

Management of experimental chicks

The experimental house was cleaned and disinfected 3 weeks before the chicks' arrive. The pens were washed and sprayed with commercial disinfectant labeled for use in the poultry farm. The feeding and drinking troughs were properly cleaned, dried and disinfected before chicks' arrival. 240 day old chicks with 42 g average weigh (Cobb 500, commercial broiler strains) were purchased from Debre Zeit Elere Farm, Ethiopia. For these chicks, 12 pens were used and their floors were covered with disinfected wood shaving. Each pen was also equipped with a 250-watt infrared heat bulb. Feeding was twice a day at 08:00 and 16:00 hours *ad libitum*. Watering was also given *ad libitum* by washing the watering troughs properly. The chicks were vaccinated against common diseases in the area. Other health precautions and disease control measures were taken throughout the study period.

Chemical analysis of food ingredients. The chemical analyses of experimental feeds were done at Haramaya University Nutrition Laboratory by taking representative samples. Samples were taken from each food ingredients. Each ingredient was analyzed for their nutrients composition of DM, CP, EE, CF and total ash using the Weende or Proximate analysis method of the AOAC (1995). Metabolizable energy (ME) content of the feed ingredients as well as experimental diets was determined by using indirect method of Wiseman (1987) as follows: ME (kcal/kg DM) = 3951 + 54.4 EE - 88.7 CF - 40.80 Ash

Feed intake. Daily feed consumption was determined as the difference between the feed offered and refused. Feed offered and refusals were weighed and recorded every day in the morning. Mean daily Feed intake per bird was computed as;

$$\text{Mean daily feed intake} = \frac{\textbf{Mean total feed intake}}{\textbf{No of experimental days}}$$

Body weight gain. Body weight gain was assessed every week by weighing the chicks with sensitive balance. The body weight gain of birds was computed by subtracting mean initial weight from the mean final weight. Daily body weight gain (ADG) was determined as a difference between mean final and mean initial body weights divide by the number of experimental days.

Feed conversion ratio. The mean feed conversion ratio was determined by dividing the average daily feed intake (DFI) with a mean daily body weight gain (DBWG).

Carcass measurements. At the end of the experiment, six broilers were randomly picked from each replication for carcass evaluation. The birds were slaughtered after being starved for about 12 hours and weighed. After slaughtering, bleeding and de-feathering dressing percentage (DP%) was calculated as

$$\mathbf{DP\%} = \frac{\textbf{Carcass weight}}{\textbf{Live weight}} \times \mathbf{100}$$

Eviscerated percentage was calculated by removing the viscera, head, shank, trachea and lungs but with giblets (heart, liver, and gizzard) and skin and expressed as percent of live weight. Abdominal fat was determined by weighing the fat trimmed from proventriculus up to cloacae. Its percentage was calculated as the proportion of slaughter weight and multiplied by hundred. Breast meat weight was measured individually and equated with percent live weight. Drumstick and thigh together were measured and expressed as percent of the live weight. The edible offal (heart, liver and gizzard), kidney and spleen were weighed after separated from the visceral and their percentages were determined in relation to slaughter weight. The length and weight of small intestine, ceaca, proventriculus and crop were measured using a centimeter tape and sensitive balance.

Hematological parameter analysis. At the end of experiment period, six broilers were randomly selected from each replicate of each treatment groups and blood samples were taken from the bronchial vein with a syringe on a tube containing anticoagulant (heparin solution) for analysis of hematology parameters (Hemoglobin, Packed Cell Volume, Total white blood cell and red blood cell). Hemoglobin (Hb) was determined from samples before spinning in centrifuge by the method of Acid hematin. Packed cell volume (PCV) was determined by spinning blood filled capillary tubes in a centrifuge at 1200 revolutions per minute (rpm) for 5 minutes and reading on hematocrit reader. Total white blood cell (WBC) and red blood cell (RBC) counts were determined by using hemocytometer. The hematological parameters were determined as described by Dacie and Lewis (1991). At the time of slaughter, gastrointestinal tract and organs were examined for any pathological symptoms and gross lesions were recorded when observed.

Mortality. Mortality was recorded as it occurred and was determined for each treatment as a percentage of the total mortality at the end of the whole experiment.

Partial budget analysis

The net profits from broiler were calculated based on the cost of feed that each bird consumed from the respective treatments and the other costs. To estimate net benefit of baker yeast feeding, the partial budget was analyzed by consideration of the whole feed expense according to the principles developed by put (Upton, 1979). The partial budget analysis involves calculation of the variable cost and benefits. Partial budget measures the chicken cost, feed and others if any and the profit after the experiment, or differences between gains and losses for the proposed change.

Total variable cost includes the cost of feeds and other costs. The selling prices of broilers were determined by using the average current market price of broiler carcass per kilogram. Total return (TR) was considered as the difference between sale and purchase price in the partial budget analysis. The net income (NI) was expressed by subtracting total variable cost (TVC) from total return (TR). NI =TR - TVC The change in net income (ΔNI) was expressed as the difference between the changes in total return (ΔTR) and total variable cost (ΔTVC). The marginal rate of return (MRR) measures the increase in net income (ΔNI) related with each additional unit of expenditure (ΔTVC) as follows;

$$\mathrm{MRR} = \frac{\Delta \mathrm{NI}}{\Delta \mathrm{TVC}}$$

The sale of chicks to cost of feed ratio was calculated as additional parameter to evaluate profitability and use efficiency of the rations as;

$$\frac{\text{Sales of chick's (Birr)}}{\text{Cost of feed (Birr)}}$$

Ethical approval

This research was carried out as a part of Master of Science in Agriculture (Animal production) research after the approval of competent authority of the director of research and post graduate study, Haramaya University, Ethiopia.

Statistical analysis

Data of the experiment was subjected to ANOVA using the General Linear Model (GLM) procedure (SAS, 2008). When the analysis of variance revealed significant differences, treatment means were compared using Least Significant Difference (LSD) test (P<0.05). The model used for data analysis was;

Yij = μ + Ti + eij

Where,

Yij = is an observation (experimental unit)

μ = Overall means

Ti = Treatment effect

eij = Random error term

RESULTS AND DISCUSSION

Chemical composition of experimental diets

The results of laboratory analysis for the different feed ingredients are shown in table 4. Among all ingredients, yeast contains the highest protein value and with respect to the total protein content, it seems to be good protein feed additive for poultry. Even though the total protein composition of a given feed is important, the quality of the essential amino acids and their composition determine to a considerable extent its nutritive value in poultry ration (Sukanya et al., 2017).

The rations CP and ME contents were almost in line with in the recommended levels of 22% and 20% and ME value of 3100 and 3200 kcal/kg for broilers during the starter and finisher phases, respectively on tables 1 and 2 (Leeson and Summers, 2005).

Feed consumption

The average daily feed intake of the four groups of chicks during the starter, finisher phases as well as the whole growth period are shown in table 5. Average daily and total intake of feed during the starter phase was not affected (P>0.05) by dietary treatment. But in finisher phase and entire experimental period average and total feed intake had significant difference (P<0.05). During finisher phase, total feed intake was higher for T1 than T3 and T4 but similar with T2 and average feed intake also high in T1 and T2 than T3 and T4. For the whole experimental period, total feed intake for all treatment groups was significantly different (P<0.05) and at the level of supplemental yeast increases, the birds consume less feed. In terms of total feed intake, the present results showed that chicks fed a diet containing 0% baker's yeast (T1) consumed more quantity of feed than the yeast containing treatment groups. The present study is in agreement with those of Adebiyi et al. (2012) and Nihar et al. (2016), who reported the lowest fed intake in all chickens given probiotic and highest in the control group. In addition, Shoeib and Madian (2002) also described low feed intake in the chickens fed on probiotic as compared to the control group.

Table 4. Chemical composition of feed ingredients

Ingredients	Chemical composition							
	DM (%)	CP (%DM)	EE (%DM)	CF (%DM)	ASH (%DM)	ME (kcal/kg DM)	Ca (%DM)	P (%DM)
Corn grain	89.07	10.28	3.1	5.72	6.08	3364.22	0.04	0.25
WS	90.02	15.36	3.3	12.34	4.60	2848.28	0.15	0.71
SBM	94.22	38.84	2.7	7.42	5.45	3217.37	0.37	0.32
NSC	90.89	30.76	7.2	15.74	10.55	2516.10	0.35	0.83
BY	94.46	48.0	2.94	3.29	5.01	3614.71	0.12	1.40

DM= Dry Matter; CP= Crude Protien; EE= Ether Extract; CF= Crude Fiber; P= Phosphorus; Ca= Calcium; ME= Metabolizable Energy, WS= Wheat short; SBM= Soybean meal; NSC= Noug seed cake; BY= Baker's yeast.

Table 5. Feed and nutrient intake of broilers fed diets with different levels of supplemental baker's yeast during the starter phase (1-21 days), finisher phase (22-45 days) and the whole growth period (1-45 days)

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
Starter phase						
Feed intake (g/bird)	978.55	962.22	960.47	947.35	9.85	NS
Feed intake (g/bird/day)	46.6	45.82	45.73	45.11	0.47	NS
Finisher phase						
Feed intake (g/bird)	3377.09^{a}	3355.16^{ab}	3314.69^{bc}	3292.65^{c}	9.35	*
Feed intake (g/bird/day)	140.71^{a}	140.03^{a}	138.11^{b}	137.19^{b}	0.36	*
Whole period						
Feed intake (g/bird)	4355.64^{a}	4317.38^{b}	4275.16^{c}	4240^{d}	4.38	*
Feed intake (g/bird/day)	96.41^{a}	95.04^{ab}	95.9^{a}	94.22^{b}	0.35	*

^{abcd} Means within a row with different superscript letters are significantly different (P<0.05); NS = non-significant; SEM = Standard error of the mean; SL = Significance level; FI= Feed Intake; T1 = diet containing 0% of baker's yeast; T2 = diet containing 0.5% of baker's yeast; T3 = diet containing 1.5 of baker's yeast; T4 = diet containing 2.5% of baker's yeast.

Body weight gain

The growth rate of the experimental chicks during the starter, finisher and the whole growth period are presented in table 6. In this experiment chicks fed 2.5% baker's yeast (*Saccharomyces cerevisiae*) supplementation in ration were significantly (P<0.05) increase the body weight gaining compared with other groups. Meanwhile, chicks fed 2.5% baker's yeast has higher feed conversion efficiency compared with the other dietary treatments (control and 0.5% baker's yeast). No negative effects were exerting on the addition of at all inclusion levels on internal body organs as compared with control.

At the end of starter phase, final body weight of bird was greater for T4 as compared to T1 and T2 but, similar with T3 groups. Results showed that the final body weight of birds during finisher phase and at the end of whole experimental period had higher body weight for T4 than T1 but, similar to other yeast containing treatment groups. Average daily body weight gain during the starter phase and the whole experimental period was significantly affected by treatment (P<0.05). The obtained results confirmed the previous findings of several researchers (Zhang et al., 2005; Paryad and Mahmoudi, 2008) that yeast supplementation in broiler ration had a significant effect on body weight gain and feed conversion ratio.

Gudev et al. (2008) and Patane et al. (2017) also reported that *Saccharomyces cerevisiae* improved feed/gain ratio and body weight gain. The present study revealed that baker's yeast supplementation had a positive effect on the body weight of broiler chickens in T4 for the whole trail period. This may be explained as one of the critical roles of probiotic yeast in the metabolic function is promoting a healthy or pathogen free gastrointestinal tract environment for the proper functioning of endogenous enzymes to break down the energy nutrients of the experimental rations and the competition between probiotic microorganism and pathogenic microorganisms for energy and nutrients are reduced. Then energy and nutrients are efficiently absorbed in Gastrointestinal tract of broilers. This in turn may have improved body weight and feed conversion efficiency of the chicks fed yeast added rations as compared to the chicks fed control or non-yeast added diets.

Table 6. Body weight change of broilers fed diets with different levels of supplemental baker's yeast during the starter phase (1-21 days), finisher phase (22-45 days) and the whole growth period (1-45 days)

Items	Treatments				SEM	SL
	T1	T2	T3	T4		
Starter Phase						
Initial wt (g/bird)	43.28	42.76	42.58	42.37	0.71	NS
Final wt (g/bird)	478.63^{b}	494.36^{b}	495.56^{ab}	527.67^{a}	7.1	*
Total weight gain (g/bird)	435.35^{b}	451.77^{b}	452.46^{b}	485.3^{a}	7.02	*
ADG (g/bird/day)	20.73^{b}	21.51^{b}	21.54^{b}	23.11^{a}	0.33	*
FCR (g feed/g gain	2.25^{a}	2.13^{ab}	2.12^{ab}	1.95^{b}	0.04	*
Finisher Phase						
Initial wt (g/bird)	478.63^{b}	494.36^{b}	495.56^{ab}	527.67^{a}	7.1	*
Final wt (g/bird)	1784.72^{b}	1802^{ab}	1849.09^{ab}	1863.85^{a}	16.68	*
Total weight gain (g/bird)	1306.09	1307.64	1353.53	1336.17	16.68	NS
ADG (g/bird/day)	54.42	54.48	56.4	55.67	0.69	NS
FCR (g feed/g gain	2.59	2.57	2.45	2.46	0.03	NS
Whole Period						
Initial wt (g/bird)	43.28	42.76	42.58	42.37	0.71	NS
Final wt (g/bird)	1784.72^{b}	1802^{ab}	1849.09^{ab}	1863.85^{a}	16.68	*
Total weight gain (g/bird)	1741.44^{b}	1759.41^{ab}	1806^{ab}	1821.48^{a}	16.61	*
ADG (g/bird/day)	38.7^{b}	39.1^{ab}	40.13^{ab}	40.47^{a}	0.37	*
FCR (g feed/g gain)	2.5^{a}	2.45^{ab}	2.37^{bc}	2.33^{c}	0.02	*

[abc] Means within a row with different superscript letters are significantly different (P<0.05); NS = non-significant; SEM = standard error of the mean; SL = Significance level; ADG = Average daily body weight gain; g = gram; T1= diet containing 0% of baker's yeast; T2 = diet containing 0.5% baker's yeast; T3 = diet containing 1.5% baker's yeast; T4 = diet containing 2.5% of baker's yeast; wt = weight.

Feed conversion ratio

Feed conversion ratio of broilers during the starter, finisher phases and entire growth period of the experiment are presented in Table 6. Results of the experiment indicated that there was significant difference (P<0.05) in feed conversion ratio in broilers fed the starter rations. During finisher phase feed conversion ratio showed insignificant difference (P>0.05) among treatments. Feed conversion ratio (FCR) expressed as feed to gain and during whole growth period feed conversion ratio was showed significant difference (P<0.05) and the value was being greater for T1 and T2 than T3 and T4. A significant improvement in FCR was recorded in the supplemental yeast containing treatment groups. Yeast acts by reducing the feed conversion ratio, resulting in an increase in daily life weight gain. Birds that have a low FCR are considered as efficient users of feed. So attributable to this FCR of birds in T4 (2.5% baker's yeast) and T3 (1.5% baker's yeast) were low and efficiently feed utilizers than other groups.

The result is in agreement with Leeson and Summers (2006) who written 2-4 feed conversion ratios for poultry.

Zhang et al. (2005) had also reported significant improvement in feed/gain ratio. In addition, Bansal et al. (2011) and Hana et al. (2015) reported significant and better feed conversion efficiency on probiotic supplementation in the diet of commercial broiler chicks. In the present study, this improvement of feed conversion ratio in yeast supplemented groups might be due to the one beneficial effects of yeast in improvement of the intestinal lumen health and thereby increasing the absorption and utilization of the dietary nutrients.

Carcass parameters

Results of the present study indicated that the average slaughter weight was not significantly differ ($P>0.05$) among the treatment groups (Table 7). However, significant difference ($P<0.05$) was observed in dressed and eviscerated carcass weight and percentage. In breast meat percentage, drumstick-thigh, abdominal fat, thigh, wing and drumstick weight and percentage there was no significant difference ($P>0.05$) among treatments. But, there was significant difference in breast meat weight for T4 compared to other treatments. Breast meat often has a higher economic value than meat from other parts of the poultry carcass (Sasidhar, 2006 and Eltazi et al., 2014). The author also reported that the main concern of people producing broilers is unnecessary accumulation of carcass fat, particularly in the abdominal area, as this fat is not accepted by consumers it becomes a waste to the processor. Even if the statistical results showed insignificant difference in abdominal fat weight and percentage among treatments, it was a bit higher for the groups kept on the control group than T2, T3 and T4.

Table 7. Carcass yield characteristics of broilers fed different level of supplemental baker's yeast from 1-45 days of the period.

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
Slaughter wt (g)	1881.42	1877.08	1944.17	1966.25	46.4	NS
Dressed carcass wt (g)	1599.14^{b}	1616.77^{b}	1750^{a}	1747.95^{a}	36.08	*
Dressing percentage (%)	85.02^{c}	86.36^{c}	90.02^{a}	88.85^{ab}	0.65	*
Eviscerated wt(g)	1278.14^{ab}	1269.88^{b}	1378.54^{a}	1388.08^{ab}	33.42	*
Eviscerated percentage (%)	67.93^{ab}	67.66^{b}	71.43^{a}	70.13^{ab}	0.8	*
Drumstick -thigh wt (g)	348.42	350.77	362.71	367.33	9.1	NS
Drumstick -thigh (%)	18.53	18.68	18.89	18.45	0.28	NS
Breast meat wt (g)	457.46^{b}	452.15^{b}	497.08^{ab}	505.33^{a}	14.0	*
Breast meat (%)	24.29	24.1	25.56	25.71	0.49	NS
Abdominal fat wt (g)	36.69	32.59	31.53	31.08	2.7	NS
Abdominal fat (%)	1.95	1.74	1.62	1.57	0.11	NS
Thigh wt (g)	188.87	189.99	195.63	198.33	5.9	NS
Thigh (%)	10.05	10.12	10.19	9.96	0.23	NS
Wing wt (g)	71.31	71.84	74.75	77.75	1.48	NS
Wing (%)	3.79	3.82	3.84	3.96	0.07	NS
Drumstick wt(g)	159.55	160.77	167.08	169	4.72	NS
Drumstick (%)	5.82	8.56	8.7	8.49	1.24	NS
Liver wt (g)	35.33^{b}	30.3^{b}	43.93^{a}	46.87^{a}	1.89	*
Liver (%)	1.87^{bc}	1.61^{c}	2.26^{ab}	2.38^{a}	0.1	*
Heart wt (g)	9.87^{b}	9.08^{b}	10.77^{ab}	13.2^{a}	0.64	*
Heart (%)	0.52^{b}	0.49^{b}	0.55^{ab}	0.67^{a}	0.03	*
Gizzard wt (g)	28.0	30.33	32.0	33.33	1.25	NS
Gizzard (%)	1.47	1.62	1.64	1.67	0.05	NS
Kidney wt (g)	10.68^{c}	11.1^{bc}	13.13^{ab}	13.87^{a}	0.51	*
Kidney (%)	0.57^{b}	0.59^{ab}	0.67^{ab}	0.7^{a}	0.03	*
Spleen wt (g)	2.0^{b}	1.83^{b}	2.83^{ab}	3.33^{a}	0.34	*
Spleen (%)	0.11	0.09	0.15	0.17	0.02	NS

[abc] Means within a row with different superscript letters are significantly different ($P<0.05$); NS = non-significant; SEM = standard error of the mean; SL= Significance level; g = gram; wt= weight; T1 = diet containing 0% of baker's yeast; T2 = diet containing 0.5% of baker's yeast; T3 = diet containing 1.5% of baker's yeast; T4 = diet containing 2.5% of baker's yeast; wt = weight.

In study, Kalavathy et al. (2003) found that supplementation of *S. cerevisiae* reduces ($P < 0.05$) abdominal fat pad. Similarly, Anjum et al. (2005) and Safalaoh (2006) also reported that supplementation of yeast had produced low level ($P<0.05$) of abdominal fat pad. This result is similar with several studies that reported lowering of abdominal fat by yeast supplementation than non-supplementation (control group), indicating the fact that baker' yeast enhance efficient energy usage.

Baker's yeast (*S. cerevisiae*) affect significantly spleen weight, liver, heart and kidney weight and percentage, crop length, caeca and small intestine weight. The results agreed with that of Ivanov (2004); Penkov et al. (2004); Dimcho et al. (2005) and Onwurah and Okejim (2014) reported more improvements in liver, and heart of broilers, mules and ducklings by supplementing diets with probiotics. However, it is in contrast with the findings by Hussein and Selim (2018) who reported that dietary probiotic supplementation did not increase the liver weights of broiler chickens. As indicated on Table 8 entire mass of the small intestine in T3 and T4 groups were heavier than the weights of intestine from other experimental groups. Gao et al. (2008) also noted that yeast culture inclusion at a level of 0.25% increased ($P<0.05$) small intestine weight in broilers. This result is in contrast with the findings by Alcicek et al. (2004), who reported that dietary supplementation of probiotics lowered the weight of the small intestine. Finally, non-significant differences were seen in spleen percentage, gizzard, crop, proventriculus weight and percentage and caeca and small intestine length. In addition, there was no significant effect of the probiotic on the weights of organs like crop and gizzard (Çınar et al., 2009).

Table 8. Non-edible offal components of broilers fed different level of supplemental baker's yeast from 1-45 days of the period.

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
Crop weight (g)	8.58	8.3	11.27	11.43	1.13	NS
Crop length (cm)	13.79^{b}	16.34^{a}	15.83^{ab}	15.79^{ab}	0.45	*
Proventriculus weight (g)	9.66	11.88	10.16	10.66	1.48	NS
Proventriculus length (cm)	9.87	12.15	9.14	7.58	1.21	NS
Caeca weight (g)	12.66^{b}	14.38^{ab}	18.75^{a}	19.5^{a}	1.3	*
Caeca length (cm)	27.45	25.21	29.42	29.12	1.15	NS
Small intestine weight (g)	60.67^{c}	66.33^{bc}	101.75^{a}	85.75^{ab}	5.32	*
Small intestine length (cm)	177	168	196.67	180.22	7.15	NS

^{abc} Means within a row with different superscript letters are significantly different ($P<0.05$); NS = non-significant; SEM = Standard error of the mean; SL = Significance level; cm = centimeter; g = gram; T1 = diet containing 0% of baker's yeast; T2 = diet containing 0.5% of baker's yeast; T3 = diet containing 1.5 of baker's yeast; T4 = diet containing 2.5% of baker's yeast.

Hematology evaluation

The values obtained for all hematological parameters of broilers fed graded levels of baker's yeast in ration (Table 9) showed that Hb (10.96 - 12.5 g/dl) and PCV (32.42 - 35.63%) were within normal range of 6.0-13.0 g/dl and 29 - 38% for Hb and PCV, respectively (Nworgu, 2007). Hematological constituents reflect the physiological state of the animals to its internal and external environment (Chowdhury et al., 2005). RBC was also within the range of 1.0-3.0 ($x10^6/mm^3$) and no reduction in total WBC were recorded in chicks of all treatment groups with or without yeast at its four graded levels within the normal range of 1.099.06 x $10^3/mm^3$ reported by Douglas et al. (2010). These indices could have contributed to the better performance of the broilers at both phases. The use of baker's yeast had no significant effects on RBC for all treatment groups, but differences between treatments were significant for Hb and PCV ($P < 0.05$). All yeast fed chicks in compare to control diet had more WBC. The yeast can stimulate immune system of chick's body so, it affects WBC. Mohamed et al. (2015) reported a positive correlation between dietary levels of *S.cerevisiae* with the haematological indices like, RBC, WBC and PCV in rabbit and broiler chickens. The results agreed with Shareef and Al-Dabbagh (2009) that reported there was no reduction in total white blood cells and hemoglobin with supplemental yeast fed to broilers.

Normal hematological values reveal the nutritional status of animal. Thus, the normal values observed in the present study indicate the adequacy of nutrients for the birds. Oladele et al. (2001) reported that linked lower values of these parameters to inadequate nutrition. It also implies that the immune systems of the chicks are adequate. Even though Hb, PCV and RBC values are within the normal range, the higher values observed in broilers consumed ration containing yeast as compared to the control diet suggest that yeast improved nutrient utilization and assimilation in to the blood stream for use by the birds and enhanced blood formation due to availability of essential nutrients.

Mortality

Rate of mortality recorded from the experimental chicks are shown in table 9. During the trial period there was no observable sign of morbidity recorded but mortalities occurred fortuitously within the first 2 weeks of the study. May be due to stress and mechanical injury during transportation. Mortality percent of broilers during experimental period was 10.00, 6.67, 6.67 and 3.33 (SEM = 2.89) for T1, T2, T3 and T4, respectively and there was no significant difference (P>0.05) in mortality percentage among the treatments. But numerically the highest mortality rate was seen in T1 and the lowest mortality rate was observed in T4. All mortalities occurred during the first phase of feeding trail and it was not reported in all groups of this experiment during the second phase. This observation could be in accordance with that mention yeast is used to stimulate the animal's immune system, thereby further reducing the risk of disease (Laegreid and Bauer, 2004). Also several workers (Shashidhara and Devegourda, 2003; Goa et al., 2008) reported that (*Saccharomyces cerevisiae*) improved the efficiency of immune system of broilers. Similar findings were obtained by Świątkiewicz et al. (2014) who found positive effect of dietary (*Saccharomyces cerevisiae*) on mortality rate of broiler. In addition to Karaoglu and Durdag (2005) reported that, the use of probiotic (*Saccharomyces cerevisiae*) in the broiler diet reduced or prevented the mortality.

Table 9. Effect of graded levels of baker's yeast fed in ration of broiler on haematological indices and mortality rate during 1-45 days of age.

Parameters	Treatments				SEM	SL
	T1	T2	T3	T4		
Hemoglobin (g/dl)	10.96^{b}	12.06^{ab}	12.17^{a}	12.5^{a}	0.24	*
Packed cell volume (%)	32.42^{b}	34.63^{ab}	34.94^{ab}	35.63^{a}	0.7	*
RBC(10^6/mm^3)	1.76	2.09	2.07	2.17	0.89	NS
WBC (10^4/mm^3)	2.23^{b}	2.44^{a}	2.40^{ab}	2.46^{a}	0.56	*
Mortality %	10	6.67	6.67	3.33	2.89	NS

^{abc} Means within a row with different superscript letters are significantly different (P<0.05); NS = non-significant; SEM = Standard Error of the Mean; SL= Significance level; RBC= red blood cell; WBC = white blood cell; g/dl= gram per deciliter; T1= diet containing 0% of baker's yeast; T2 = diet containing 0.5% of baker's yeast; T3 = diet containing 1.5% of baker's yeast; T4 = diet containing 2.5% of baker's yeast.

Table 10. Partial budget analysis for broilers fed different levels of baker's yeast during 1-45 days of age.

Variables	Treatment			
	T1	T2	T3	T4
Purchase price/bird (birr)	20	20	20	20
Price/kg of carcass (supermarket)	140	140	140	140
Selling price/bird (birr)	178.94	177.78	193.00	194.33
Feed cost/bird (birr)	26.96	27.07	28.6	30.93
Other cost/bird (birr)	1.15	1.15	1.15	1.15
TVC/bird (birr)	28.11	28.22	29.75	32.08
TR (birr)	158.94	157.78	173	174.33
NR (birr)	130.83	129.56	143.25	142.25
ΔNR	0.00	-1.27	13.69	-1
ΔTVC	0.00	0.11	1.53	2.33
MRR	0.00	-11.54	8.95	-0.43
Chicks sale/feed cost	6.64	6.57	6.75	6.28

ETB = Ethiopian Birr, TR= total return, NR= net return, ΔTVC = change in total variable cost, ΔNR = change in net return; MRR = marginal rate of return; T1= diet containing 0% of baker's yeast; T2 = diet containing 0.5% of baker's yeast; T3 = diet containing 1.5% of baker's yeast; T4 = diet containing 2.5% of baker's yeast.

Partial budget analysis

Differences in feed cost, chick sale and chick's sale to feed cost ratio were noticed among the treatment groups (Table 10). The highest net income and marginal rate of return were obtained for T3 ration followed by T4. Therefore, T3 appeared to be economical in economic parameters used in the study. The chicks' sale to feed cost ratio was estimated as additional parameter to see the importance of inclusion baker's yeast on ration of broilers during both starter and finisher phases. The birds in T3 score highest chicks' sale to feed cost than T1, T2 and T4. The lower ratio of chick's sale to feed cost was resulted from higher price of baker's yeast and low body weight gain. Therefore, the results of this study indicated that ration containing 1.5% addition of baker's yeast is potentially profitable than the other levels of inclusion in the ration under the condition of the present experiment.

CONCLUSION

In conclusion, baker's yeast can be an important feed additive, which can be included up to 2.5% of the total ration and improve the overall performance of broilers without compromising the hematological indices of broiler chickens. Generally, the present study can be a gate-way for further researches on how to use baker's yeast as an efficient protein feed additive in poultry ration.

DECLARATIONS

Competing interests

The authors declare that they have no conflict of interest.

Author's contributions

This manuscript is part of Kassech Mulatu MSc Thesis, where Negassi Ameha and Meseret Girma were advisors of her. Meseret Girma prepared of the manuscript. All authors read and approved the manuscript.

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