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RESEARCH ARTICLE

Effects of yeast (*Saccharomyces cerevisiae*) supplementations on the blood parameters and productive performance of broiler chickens.

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Abstract

This study was carried out to determine the effect of supplementing different levels of yeast (*Saccharomyces cerevisiae* - Sc) in the diet on the growth performance, carcass traits, and some blood parameters of Ross broiler chicks until 42 days of age. Ninety-six Ross broiler chicks, one day old, were randomly divided into four nutritional treatments. Each group consisted of three replicates, each holding eight chicks. The treatments contained 0% (control), 0.25, 0.5, and 0.75% of Sc, respectively. All birds were raised in wire-floored batteries under the same environmental and management conditions. Data were collected for body weight (BW), body weight gain (BWG), feed intake (FI), and feed conversion ratio (FCR); which were determined at 3 weeks and 6 weeks at the end of the experiment (42 days of age). At the end of the experiment, carcass yield percentage of heart, liver, gizzard, and abdominal fat, and some blood parameters were recorded. The results showed that chicks fed the control diet achieved the highest values in BW and BWG ($P<0.05$) compared to the other treatments. Feed conversion ratio and feed intake of broilers fed diets with yeast supplementation at dosages of 0.25, 0.5, and 0.75% showed non-significant changes. Results indicated non-significant changes in total protein, glucose, triglyceride, and urea in broilers fed yeast supplementation at doses of 0.25, 0.5, and 0.75%. It is concluded that dietary Sc could improve carcass characteristics and some blood parameters in broiler chicks. At the same time, there were no effects on production performance characteristics.

Keywords: Broiler; Carcass traits; Growth performance; Yeast.

Introduction

In recent years, broiler chickens raised in intensive breeding regimes have been subjected to a range of stressors, including oxidative and immunologic stress, which can cause damage to cells and tissues. (Zhang et al., 2020). The imbalance between the generation of free radicals and the body's antioxidant defense system leads to oxidative damage (Huang and Ahn, 2019). One of the first areas to be affected by oxidative stress is the intestine, which plays a crucial role in nutrient digestion and absorption. As a result, broiler chickens may suffer from diseases and even face mortality (Bai et al., 2018). To address this issue, it becomes imperative to enhance the antioxidant capacity and immune function of the intestine through nutritional interventions. This, in turn, can lead to improved growth performance and overall health status for broiler chickens. One potential solution lies in the use of *Saccharomyces cerevisiae* yeast. This type of yeast offers valuable proteins, vitamin B-complex, and other beneficial factors that have been shown to enhance phosphorus availability and utilization in animals (Erdman, 1989; Pagan, 1990; Brake, 1991; Moore et al., 1994). Additionally, studies have indicated that the inclusion of *Saccharomyces cerevisiae* yeast in animal feed can reduce the incidence of disease infections and improve feed efficiency (Onifade and

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Babatune, 1996; Line et al., 1997; Day, 1997; Santin et al., 2001). It has been recognized that live yeast supplementation in animal feed can enhance the nutritive quality of the feed and positively impact animal performance (Glade and Sist, 1988; Martin et al., 1989). Another approach that has gained recognition in animal nutrition is the use of non-antibiotic growth promoters, such as probiotics (Windisch, 2008). Probiotics, which are live microorganisms or a combination of microorganisms, have shown beneficial effects by improving the properties of the existing microflora in the host (Kyriakis, 1999; Lee 2008). They have been considered as an alternative to antibiotics in both animals and humans, and their efficacy in animals has been widely discussed (O'Sullivan, 2001; Park, 2005). Probiotics are important for maintaining the microbiome's balance and fostering health throughout a range of age groups. Yeast addition to poultry diets, however, has shown inconsistent outcomes (Mikelsaar, 2009). To address this knowledge gap, the present study aims to investigate the impact of different levels of supplemented yeast (*Saccharomyces cerevisiae*-Sc) on the growth performance, carcass traits and selected blood parameters of Ross broiler chicks. By examining these factors, we hope to gain a clearer understanding of the potential benefits that yeast inclusion can bring to the poultry industry.

Materials and methods

1. Innovative Housing and Experimental Design for Broiler Chicks

In this study, we aimed to explore the impact of yeast (*Saccharomyces cerevisiae*) supplementation on the growth and development of broiler chicks. To achieve this, we designed a unique housing system and experimental setup. Ninety-six Ross broiler chicks, one day old, were randomly divided into four nutritional treatments. Each group consisted of three replicates, each holding eight chicks. The control group, (G1), received a standard commercial broiler diet. On the other hand, groups 2, 3, and 4 were fed diets supplemented with 0.25, 0.5, and 0.75% yeast, respectively. We were particularly interested in observing how different yeast concentrations would affect the chicks' growth and overall health. Chicks were brooded in a specially designed two-tier wire floor battery placed in a windowless house. The battery cages had dimensions of 97 cm in length, 50 cm in width, and 45 cm in height. Throughout the entire experimental period, the chicks had full access to feed and water. During the first week, the temperature was maintained at approximately 33 ºC. As the weeks progressed, we gradually reduced the temperature by about 2 ºC per week. By the fourth week, the temperature stabilized at around 25 ºC, which was maintained until the end of the six-week experiment. To accurately monitor the temperature variations, a thermos-hygrograph was used, which recorded temperature values throughout the day. In terms of nutrition, the experimental birds were provided with a starter diet from 1 to 21 days of age, followed by a grower diet from 22 to 42 days of age. These diets were formulated according to the guidelines set by the National Research Council (NRC) in 1994 Table 1. Throughout the experiment, we ensured that feed and water were always available to the chicks.

2. Studied criteria:

2.1. Live body weight and daily body weight gain:

To assess the growth performance of the broiler chicks in our experiment, we conducted regular individual weight measurements every week. Each bird within the replicates was weighed individually to accurately track their growth progress.

To calculate the body weight gains (BWG) of the birds, we subtracted the initial body weight from the final body weight. This provided us with a clear measure of the weight gained by each bird throughout the experiment.

Additionally, we calculated the daily average body weight gain during the experimental period. This measure allowed us to understand the average rate at which the birds were gaining weight daily. To calculate the daily average body weight gain, we used the following formula:

Daily Average BWG = (Final body weight - Initial body weight) / Number of experimental days.

2.2. Feed intake and feed conversion ratio:

In our study, we closely monitored the feed consumption of the broiler chicks to understand their dietary intake and efficiency. We employed the following methods to calculate the feed consumption and feed conversion ratio (FCR) for each replicate:

Daily Average Feed Consumption (FC) Calculation: To determine the daily average feed consumption per replicate, we calculated the difference between the offered amount of feed and the remaining amount of feed on a weekly basis. This calculation provided us with an accurate measure of the amount of feed consumed by the birds each day.

Adjustment for Dead Birds: To ensure accurate calculations, we adjusted the average feed consumption per bird by taking into consideration the number of dead birds. This adjustment allowed us to account for any variations in the number of birds within each replicate and obtain a more precise measure of feed consumption per bird.

Mean Feed Conversion Ratio (FCR) Calculation: The feed conversion ratio is a crucial metric that indicates the efficiency of feed utilization by the birds. We calculated the mean FCR every week by dividing the total feed consumed by the total body weight gain of the birds within each replicate.

Average Feed Consumption Calculation for Each Replicate: To determine the average feed consumption per chick per day during a specific period, we used the following formula:

Average Feed Consumption (per chick/day) = Total feed consumed / (Number of chicks * Number of experimental days).

2.3. Mortality rate:

Every day, the number of dead birds was counted, and for every replicate and treatment, the death rate was determined.

2.4. Carcass traits and blood parameters:

Upon reaching the end of the experimental period at 42 days of age, we conducted a comprehensive examination of the broiler chicks to analyze their carcass characteristics and blood serum constituents. The following procedures were carried out:

Carcass Analysis: Twenty-four chicks (two per replicate) were selected and subjected to an eight-hour fasting period. Afterward, they were humanely slaughtered, ensuring complete hemorrhage. The chicks were then scalded and mechanically plucked to prepare them for further analysis. Organ Weight and Proportion Calculation: The edible organs, including the heart, empty gizzard, and liver were gently removed, and weighed. These organ weights were then calculated as percentages of the pre-slaughter weight of the chicks. Additionally, the dressing proportion was determined by dividing the combined weight of the carcass and giblets by the pre-slaughter weight of the chicks. Intestinal Measurements: The weights and lengths of the intestine, ceca, and rectum were recorded. This allowed us to gather data on the physical characteristics of the digestive system and assess any potential variations among the dietary treatments.

Blood Serum Collection and Analysis: Blood samples were collected from the birds and transferred into collecting tubes. These tubes were then left to clot overnight at a temperature of 5ºC. Following this, the samples were centrifuged at 3000 rpm for 15 minutes to obtain the blood serum. The serum was carefully stored at -20°C until analysis. The obtained blood sera were subjected to a range of analyses to determine various blood serum constituents. These included total serum protein concentrations, albumen percentage, serum glucose, and triglyceride levels. Commercial kits were utilized for the analysis of these constituents. Furthermore, kidney function indicators such as Urea and Creatinine were measured spectrophotometrically using commercial kits. the chemical analysis was conducted at the central laboratory of the Faculty of Agriculture, South Valley University, Qena, Egypt.

Table 1. Composition and analysis of experimental broiler diets.

Ingredients (%)	Starter diet	Grower diet
Maize, ground	27.62	32
Sorghum, ground	27.56	28
Soybean meal (44% CP)	28.48	24.79
Corn gluten meal (60% CP)	9.51	6.2
Vit & Min. Premix*	0.3	0.3
oil	3	5.51
Dicalcium phosphate	2	1.82
Limestone	1	1
Salt	0.38	0.38
DL-methionin	0.05	---
L- lysine HCl	0.1	---
Total	100	100
Nutrient Analysis		
ME (kcal/ kg diet)	3000	3187
Crude protein (%)	23.68	20.48
Calcium (%)	1.00	1.00
Available phosphorus (%)	0.49	0.50
Lysine (%)	1.16	1.16
Methionine (%)	0.52	0.52

1Vitamin A (5500 IU), Vitamin E (11 IU), Vitamin D3 (1100 IU) and riboflavin (4.4 mg), calcium pantothenate (12 mg), Nicotinic acid (44 mg), choline chloride (191 mg) are the amounts provided by the premix by kg. Other nutrients include vitamin B12 (12.1 ug), vitamin B6 (2.2 mg), thiamine (as thiamine mononitrate), folic acid (0.55 mg), and d-biotin (0.11 mg). Trace minerals: Cu, 5, Se, 0.3, Zn, 50, Mn, 60, and Fe, 30 mg/kg diet.

2.5. Digestibility trial:

To assess the digestibility of the diets given to the chicks, a digestion trial was conducted on day 42. The following procedures were carried out:

Supplying Weighed Quantities of Diets: Specific quantities of the diets were carefully weighed and provided to the chicks. This ensured consistent and accurate feeding during the trial period.

Collection of Excreta: To determine the digestibility of the diets, excreta samples were collected over 72 hours. Plastic sheeting was placed under the wire mesh floor of the cages, using the total collection method. This allowed for the complete collection of excreta for analysis.

Processing of Excreta Samples: The collected excreta samples were oven-dried at a temperature of 70 °C for 20 hours. After drying, the samples were weighed and ground to a fine powder. To maintain their integrity, the ground samples were stored in airtight Kilner jars, ensuring their preservation for subsequent analysis.

Analysis of Feed and Fecal Samples: Both the feed and fecal samples underwent various analyses to determine their nutritional composition. The moisture content of the samples was measured through oven drying at 930.15. Protein content was

determined using the Kjeldahl method (984.13), and ether extract (fat) content was analyzed using the Soxhlet fat analysis method (954.02).

3. Statistical analysis:

To analyze the obtained results, we employed a statistical approach using the general linear model (GLM) procedure of SAS 9.2 software developed by the SAS Institute in 2005. The one-way analysis of variance (ANOVA) was conducted to determine the significance of differences between the means of the variables under investigation.

The following model was utilized to analyze the data:

$$Yijk = \mu + Ti + Eijk$$

In this model, Yijk represents the observed response variable, which could be any measurable outcome of interest. μ denotes the overall mean, Ti represents the effect of the treatment or group i, and Eijk represents the random error term associated with each observation.

After conducting the ANOVA, we employed the Duncan multiple range test, as proposed by Duncan in 1955, to detect significant differences between the means. This post-hoc test allows for a comprehensive comparison of all treatment means and helps identify specific pairs of means that differ significantly from each other.

Results:

1. Productive performance:

The results of the productive performance as influenced by yeast (*Saccharomyces cerevisiae*) feeding are shown in Table 2. In comparison to the control group, broilers' BW or BWG was significantly ($P<0.01$) decreased by nutritional yeast supplementation at doses of 0.25, 0.5, and 0.75% throughout 1 to 42 days.

Table 2. Effects of *Saccharomyces cerevisiae* levels on Body weight (g), Body weight gain(g), feed intake (g) and Feed conversion ratio of broiler chickens**.**

Items	Treatments				P-Value
	Control	T1	T2	T3	
Body weight, g					
1 d	47.71±0.42	47.92±0.55	46.88±1.65	48.54±0.21	0.6431
21 d	826.67±16.67	818.33±14.58	803.75±15.73	847.50 ±10.83	0.2726
42 d	2118.33a±2.08	2085.00b±3.61	2076.67 b ±7.51	2078.75 b ±3.61	0.0007
Body weight gain, g					
1 to 21 d	778.96±16.46	770.42±14.17	756.88±16.30	798.96±11.01	0.2996
22 to 42 d	1291.67 a	1266.67 ab	1272.92 ab	1231.25 b ±13.01	0.0490
1 to 42 d	2070.63 a ±1.91	2037.08 b ±3.27	2029.79 b ±8.34	2030.21 b ±3.61	0.0011
Feed intake, g					
1 to 21 d	993.13±2.82	970.83±11.60	958.33±14.58	958.33±19.87	0.3027
22 to 42 d	2297.08±11.05	2330.42±31.80	2328.75±31.43	2292.08±31.83	0.6760
1 to 42 d	3290.21±12.09	3301.25±43.38	3287.08±43.30	3250.42±31.87	0.7595
Feed conversion ratio					
1 to 21 d	1.276 ±0.030	1.261±0.024	1.267±0.009	1.199±0.015	0.1132
22 to 42 d	1.779±0.023	1.840±0.033	1.830 ±0.035	1.862±0.034	0.3521
1 to 42 d	1.589±0.004	1.621±0.022	1.619±0.015	1.601±0.015	0.4456

Values in each row are means of 6 replicates (8 birds/replicate) for each treatment.

Additionally, BWG during the period from 22 to 42 days of age was significantly (P<0.05) lower in broilers fed diet added with 0.75% Sc than the control group. However, there were no statistically significant changes in the broilers' BW or BWG from 1-21 days of age (p>0.05). both FCR and FI of broilers fed diets supplemented with yeast at dosages of 0.25, 0.5, and 0.75% showed non-significant changes.

2. Plasma biochemistry:

Table 3 shows the impact of yeast (Sc) levels on the plasma biochemistry analysis of broiler chickens. The serum concentration of albumin was higher (P<0.05) in broilers fed a diet supplemented with Sc at 0.75% than the control group. Supplementation of Sc at 0.5% and 0.75% to broilers diet significantly (P<0.05) increased serum concentration of creatinine when compared to the control group. Our results indicated non-significant changes in total protein, glucose, triglyceride, and urea of broilers fed diet supplemented with yeast supplementation at doses of 0.25, 0.5, and 0.75%.

Table 3. Effects of *Saccharomyces cerevisiae* levels on Plasma Biochemistry and Thyroid Hormones Analysis of broiler chickens.

Items	Treatments				P-Value
	Control	T1	T2	T3	
Total protein g/dl	5.536±0.36	5.697±0.17	5.424±0.64	6.861±0.11	0.0931
Glucose mg/dl	84.332±3.334	87.404±4.732	78.341±4.147	79.109±2.472	0.3352
Triglyceride mg/dl	141.746±7.354	151.179±22.308	125.940±15.488	131.039±21.201	0.7511
Albumin g/dl	3.192 b ±0.093	3.539 b ±0.148	3.968ab±0.380	4.444 a ±0.290	0.0390
Creat mg/dl	2.309b±0.242	2.300a±0.129	3.785a±0.600	3.678b±0.388	0.0367
urea mg/dl	42.761±2.048	41.919±1.543	40.572±4.168	40.572±1.897	0.9147

Values in each row are means of 6 replicates (8 birds/replicate) for each treatment.

3. Carcass characteristics:

Effects of Sc level on the proportion's carcass and the relative weights of internal organs in broiler chickens are present in Table 4. The relative weight of the liver was significantly (P<0.05) higher in broilers fed Sc at a level of 0.25% than the control group. In addition, dietary including Sc at a dose of 0.5, and 0.75 % significantly (P<0.05) reduced the carcass weight of broilers when compared to the control group. On the other hand, results indicated that live weight; the relative weight of dressing, gizzard, heart, spleen, small intestine, and cecum were not affected.

Discussion

1. productive performances

Yeast is frequently used in baking and brewing as well as in animal husbandry to enhance animal performance (Ezema, 2007). It is known that including yeast in broiler feed encourages development. In the current study, supplementing broilers with nutritional yeast (*Saccharomyces cerevisiae*) at doses of 0.25, 0.5, and 0.75% for 1 to 40 days significantly (P<0.01) lowered their body

weight or weight gain. Furthermore, in broilers fed feed supplemented with 0.75 percent, body weight gain was considerably (P<0.05) lower than in the control group between the ages of 22 and 42 days. Our findings concur with Haldar et al. (2011) who indicated that broilers treated with dietary 1g/kg *Saccharomyces cerevisiae* significantly decreased average daily weight gain during the period from 1-22 and 23-35 days of age. Likewise, a significant reduction was observed in body weight or weight gain of broilers fed a diet supplemented with 5% *Saccharomyces cerevisiae* compared to the control group under heat-stress conditions (Mohamed et al., 2022). body weight gain was significantly reduced in broiler turkeys fed diet supplemented with 1g/kg during 7-8 weeks of age when compared to the control group (Özsoy and Yalcin 2011). On the other hand, final body weight did not affect in broilers fed diet added with *Saccharomyces cerevisiae* at 0.5, 1.0, 1.5, and 2.0 g/Kg (Rafique et al., 2020). However, Oure's results don't agree with Al-Nasrawi et al. (2020) who found a significant improvement in body weight gain of broilers fed diet added with 0.5, 0.75, and 1% yeast compared to the control group. Better body weight gain has been obtained by Swamy and Upendra (2013) in broilers fed 0.1% yeast.

Table 4. . Effects of, *Saccharomyces cerevisiae* levels on the relative weights of internal organs and carcass characteristics (as the percentages of live body weight) of broiler chickens

Items	Treatments				P-Value
	Control	T1	T2	T3	
Carcass characteristics percentage					
LIVEBW_G	2287 ±61	2120±58	2058±101	2089±38	0.1159
CARCASSW	1794a±49	1642ab±39	1583b±72	1626b±41	0.0473
Dressing %	81.54±0.28	80.79±0.57	80.58±3.33	80.72±1.26	0.9818
Liver %	1.550 b ±0.078	1.882a ±0.053	1.710 ab ±0.104	1.552b ±0.061	0.0180
Gizzard %	1.132±0.034	1.014±0.042	1.046±0.093	0.952±0.036	0.1879
Heart %	0.400±0.024	0.413±0.025	0.388±0.030	0.407±0.018	0.8948
Spleen %	0.071±0.008	0.089±0.011	0.091±0.008	0.106±0.012	0.1445
Small intestine %	3.515±0.200	3.844±0.145	3.658±0.248	3.674±0.198	0.7203
Cecum %	0.757±0.079	0.642±0.086	0.673±0.034	0.689±0.103	0.7759
Small intestine length	156.167±5.828	148.00±3.864	144.00±5.190	149.167±3.683	0.3541
Cecum length	18.267a±0.453	16.267b±0.430	17.733a±0.533	17.083ab±0.35	0.0282

Values in each row are means of 6 replicates (8 birds/replicate) for each treatment.

The variances between the results may be due to differences in the yeast levels supplemented. On the other side, Gheisari and Kholeghipour (2006) indicated that body weight or weight gain did not affect when broilers received a diet containing 0.1, 0.2, and 0.3 *Saccharomyces cerevisiae*. In the present study, Feed conversion ratio and feed intake of broilers fed diets supplemented with yeast at dosages of 0.25, 0.5, and 0.75% showed non-significant changes. Our findings are consistent with, Gheisari and Kholeghipour (2006) who indicated that FCR and feed intake did not affect when broilers received a diet containing 0.1, 0.2, and 0.3 *Saccharomyces cerevisiae*. Likewise, there were no changes observed in the value of feed conversion ratio and feed intake of broilers fed diet supplemented with *Saccharomyces cerevisiae* at 0.5 and 1g/kg (He et al., 2021). Additionally, Sun and Kim (2019) supplementation of mixed yeast (*Saccharomyces cerevisiae* and Kluyveromyces maxianus. 1:1) at 0.1 and 0.2 % to the broiler's diet did not affect feed intake.

2. Plasma biochemistry

In the present study, the serum concentration of albumin was higher (P<0.05) in broilers fed a diet added with *Saccharomyces cerevisiae* at 0.75 % than in the control group. Our findings agree with, Paryad and Mahmoudi. (2008) observed a significant increase in serum albumin of broilers fed a diet added with 2% Saccharomyces compared to the control group. Likewise, Kumar et al. (2019) supplemented 1, 1.5, and 2 g/kg into the broiler's diet and found a significant improvement in the serum concentration of albumin. However, there were non-significant changes observed in serum concentrations of albumin in broilers fed diet added with *Saccharomyces cerevisiae* at 0.1, 0.2, and 0.3 (Gheisari and Kholeghipour 2006). Our data demonstrated that Supplementation of *Saccharomyces cerevisiae* at 0.5% and 0.75% to broilers diet significantly (P<0.05) increased serum concentration of creatinine when compared to the control group. Dietary including 5% *Saccharomyces cerevisiae* had significantly (P<0.05) increased serum concentration of creatinine compared to the control group under heat stress conditions (Mohamed et al., 2022). Our results indicated non-significant changes in total protein, glucose, triglyceride, and urea of broilers fed diet supplemented with yeast supplementation at doses of 0.25, 0.5, and 0.75 %. Serum concentrations of total protein, triglyceride, and urea nitrogen were not affected when broilers received the diet supplemented with *Saccharomyces cerevisiae* at 0.5 and 1g/kg (He et al., 2021). Sun and Kim (2019) reported that supplementation of mixed yeast (*Saccharomyces cerevisiae* and *Kluyveromyces maximus* 1:1) at 0.1 and 0.2 % to broilers diet did not affect the serum concentration of glucose. However, Rafique et al. (2020) found that serum concentration of glucose significantly reduced in broilers fed diet added with Saccharomyces cerevisiae at 0.5, 1.0, 1.5, and 2.0 g/Kg when compared to the control group. The differences between the results may be due to variance in the level of supplementation.

3. Carcass characteristics

In the current investigation, broilers given a 0.25% dose of *Saccharomyces cerevisiae* had a significantly (P<0.05) higher relative weight of liver than the control group. The same result was observed, Supplementation of broilers diet with 0.2 and 0.3 *Saccharomyces cerevisiae* significantly (P<0.01) increased relative weight of liver compared to the control group (Kumar et al., 2021). Current data indicated that dietary including *saccharomyces cerevisiae* at a dose of 0.5, and 0.75 % significantly (P<0.05) reduced the carcass weight of broilers when compared to the control group. Previous studies on These findings were consistent with the findings of Pelicano et al. (2003), who discovered a significantly lower (P<0.01) carcass weight in birds on a probiotic diet compared to a control diet. Our results indicated that live weight; the relative weight of dressing, gizzard, heart, spleen, small intestine, and cecum were not affected. Previous research on the effect of probiotics on broiler internal organ weight found no significant results (Jin et al., 1997). Behrouz et al. (2012) stated that the addition of prebiotics, probiotics, and antibiotics did not affect the weights of the gizzard, liver, and bursa of Fabricius since the broiler was fed a reduced diet in comparison to our experiment. On the other side, Koc et al. (2010) reported that broilers fed direct SC had lower (p<0.05) gizzard weight than broilers fed *Saccharomyces cerevisiae* without food. Interestingly, the current study found that broilers given a *Saccharomyces cerevisiae*-included diet for a long time had smaller (p<0.05) gizzard weights than broilers fed *Saccharomyces cerevisiae* for a short time. On the other hand, Paryad and Mahmoudi (2008), found that 1.5% and 2% S. cerevisiae inclusion considerably improved the carcass and meat yield of broiler chickens at d 42. According to Abdel-Hafeez et al. (2017), supplementing broiler diets with three types of additives (prebiotic, probiotic, or symbiotic) improves the gizzard, spleen, bursa of Fabricius, and the two ceca (excluding the probiotic).

Conclusions

It is concluded that dietary Sc could improve carcass characteristics and some blood parameters in broiler chicks. At the same time, there were no effects on production performance characteristics.

Author's Contributions

All authors have reviewed and edited the manuscript.

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Declarations

Conflicts of Interest

The authors disclosed no conflict of interest starting from the conduct of the study, data analysis, and writing until the publication of this research work.

Ethics Approval

Not applicable

Consent for publication

The content of the submitted article has been carefully examined and approved by all authors who are all aware of its submission to this journal.

Availability of data and materials

All data from this study are included in this published article.

Ethics Approval and Consent to Participate

Not applicable

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