Journal homepage
www.ajas.uoanbar.edu.iq
Anbar Journal of Agricultural Sciences
(University of Anbar – College of Agriculture)

EFFECT OF ADDING YEAST (S. CEREVISIAE) TO THE DIET ON SOME PRODUCTION INDICATORS AND BLOOD BIOCHEMICAL PARAMETERS OF BROILERS

A. M. Mostafa [1]*   T. K. Dalla [1]   F. A. Abdalaziz [2]

[1] **Faculty of Agriculture Engineering, Tishreen University.**
[2] **College of Human Medicine, Tartous University.**

***Correspondence to:** Ammar M. Mostafa, Faculty of Agriculture Engineering, Tishreen University, Syria.
Email: ammarmostafa110@gmail.com

Article info

Received: 2024-05-31
Accepted: 2024-07-31
Published: 2024-12-31

DOI-Crossref:
10.32649/ajas.2024.184481

Cite as:
Mostafa, A. M., Dalla, T. K., and Abdalaziz, F. A. (2024). Effect of adding yeast (s. cerevisiae) to the diet on some production indicators and blood biochemical parameters of broilers. Anbar Journal of Agricultural Sciences, 22(2): 1324-1335.

Abstract

This study explored the effect of adding *S. cerevisiae* yeast to broiler diets on some of their production indicators and blood biochemical parameters. Ninety day-old chicks of broiler chickens (Ross-308) weighing 42 g on average were used in this study. The birds were randomly divided into three experimental groups of three replicates each (10 birds per replicate). The T1 group were fed a diet without any additives while the T2 and T3 groups received diets supplemented with 0.1% and 0.2% *S. cerevisiae* yeast, respectively. The T3 group performed the best with heavier body weights that increased at a rate of 4%. Its feed intake and feed conversion rates declined by 2% and 6%, respectively, and no dead birds were recorded in the group at $p \leq 0.05$. The results indicate that the concentrations of total protein, albumin, and globulin in blood serum increased by 13%, 17%, and 4%, respectively, while glucose and cholesterol levels decreased by 18% and 27%, respectively in the T3 group ($p \leq 0.05$).

Keywords: Food conversion, Yeast, Meat chicken, Serum, Body weight.

تأثير إضافة الخميرة (Saccharomyces cerevisiae) الى العليقة في بعض المؤشرات الإنتاجية، والمعايير الكيموحيوية لدم للفرّوج

عمار محمود مصطفى [1]* توفيق كامل دلّا [1] فهيم علي عبدالعزيز [2]

[1] كلية الهندسة الزراعية - جامعة تشرين

[2] كلية الطب البشري - جامعة طرطوس

***المراسلة الى:** عمار محمود مصطفى، كلية الهندسة الزراعية، جامعة تشرين، سورية.

البريد الالكتروني: ammarmostafa110@gmail.com

الخلاصة

أجريت التجربة لمدة 42 يوماً خلال الفترة 28/ 3/ 2024 – 8/ 5/ 2024، في مزرعة خاصة في منطقة صافيتا بمحافظة طرطوس، وذلك بهدف دراسة تأثير إضافة الخميرة *S. cerevisiae* الى عليقة فروج اللّحم في بعض المؤشرات الإنتاجية والمعايير الكيمياحيوية لمصل الدم. استخدم في هذه الدراسة تسعون صوصاً من دجاج اللحم سلالة (Ross-308) غير المجنس بعمر يوم واحد، وبمتوسط وزن 42 غم، وقد تم تقسيم الطيور بشكل عشوائي الى ثلاث مجموعات تجريبية بواقع ثلاث مكررات لكل مجموعة (10 طيور لكل مكرر): T1: تم تغذيتها على نظام غذائي من دون أي إضافات؛ وتم تغذية T2 وT3 بنظام غذائي مكمل بالخميرة *S. cerevisiae* بنسبة 0.1% و0.2% على التوالي. أظهرت المجموعة T3 تحسناً أفضلاً، إذ لوحظ وجود تحسن في وزن الجسم وزيادة وزن الجسم بمعدل 4%، وتدهور تناول العلف ومعامل التحويل الغذائي بمعدل (2%، 6%) على التوالي لطيور المجموعة T3 مقارنة مع المجموعتين (T1، T2) ($p \leq 0.05$). أيضاً لم يسجل لدى المجموعة T3 أي طيور نافقة مقارنة بالمجموعتين (T1، T2) ($p \leq 0.05$). تشير النتائج الى زيادة تركيز البروتين الكلي، الألبومين، والغلوبيولين في مصل الدم بمعدل (13%، 17%، 4%) على التوالي، بينما انخفض تركيز الجلوكوز، والكوليسترول بمعدل (18%، 27%) على التوالي لدى طيور المجموعة T3، مقارنة مع المجموعتين (T1، T2) ($p \leq 0.05$).

كلمات مفتاحية: تحويل غذائي، خميرة، دجاج اللحم، مصل الدم، وزن الجسم.

Introduction

The poultry industry is of much importance to the economic and production sectors, and in raising the standard of living for humans. In the face of food shortages, the demand for animal products, especially poultry, has increased due to its rapid growth, efficiency in feed conversion, short rearing period, and quality of its meat, which is characterized by its low fat content (4). Poultry meat is one of the most important sources of animal protein around the world, and the industry has made much progress in recent years. The productivity of poultry birds has increased tremendously due mainly to the efforts made in applied research in various fields of this industry (11). In recent years, the poultry industry has witnessed the use of multiple types of feed additives with the aim of enhancing meat and egg production and improving poultry health (22). The use of antioxidants in poultry nutrition has increased growth rates by maintaining the stability of the internal environment of the digestive canal, inhibiting the action of harmful free radicals, and thus inhibiting stress factors (12).

Probiotics, such as *S. cerevisiae* yeast, have been evaluated as potential feed supplements to enhance feed digestibility, reduce the number of pathogens, and improve animal performance and health. Yeast is also considered one of the most important additives that act as *S. cerevisiae*, due to its richness in selenium, which is essential for obtaining the mineral's antioxidant benefits (2 and 18). Carbohydrates are one of the main components of yeast, which belong to a group of oligosaccharides, consisting mostly of β-glucans and mannan-oligosaccharides (MOSs). It is estimated that yeast contains 85 to 90% of these sugars 1,3 -β-glucans (30-50%), 1,6-β-glucans (5-10%), mannoproteins (30-50%), and chitin (5.1-6%) (15). It also contains an excellent amount of protein necessary for body growth and tissue regeneration, especially in the growth stage, as well as the necessary substances it contains for the body, including fats, phosphorus, calcium, iron, vitamin A, vitamin B complex, and niacin. It is one of the richest sources of the B vitamin group, a vital compound required by the body, especially for the health of its nerves, and to increase the activity of the immune system and resistance to diseases, especially viral ones such as colds and influenza (18). In a recent study, 85 compounds considered effective for yeast were identified, including glycine, fructose, inositol, galactose, and sucrose (27).

The probiotic health benefits of *S. cerevisiae* in animal production are based on the following criteria: adhesion ability to intestinal cells, improved feed digestibility and promotion of beneficial microorganisms in the gut, enhanced digestive enzyme activity, enhanced immune stimulant, tolerance to high acidity, resistance to bile salts, and improved morphological structure of the intestine (20). Adding *S. cerevisiae* yeast in poultry feed causes a phenomenon called competitive exclusion of pathogenic bacteria. This removes significant amounts of harmful microorganisms and enhances defenses in the animal by producing antimicrobial agents, balancing the gut microbiota, stimulating the adaptive immunity of the host, and improving the morphological structure of the intestine, benefits that reflected in the health of poultry in general (6). Nutritional supplements containing whole yeast and yeast cell walls at a level of 1.5–2 g/kg can improve growth performance and meat productivity in broiler chickens (1). This may be attributed to the presence of selenium in yeast, which has a positive effect on growth through the role of thyroid hormones (13).

Fermentation enhances the nutritional value and availability of nutrients in feed ingredients, leading to improved poultry performance. It also positively affects intestinal microorganisms and morphology, antioxidant status, and immunity in poultry. Fermentation technology is critical to the sustainable poultry industry by improving feed quality, reducing environmental impacts, and enhancing poultry health (28). Therefore, this study investigated the effect on some production and biochemical indicators in the blood serum of broilers by adding two levels of *S. cerevisiae* yeast to their diets and to determine the best level of addition.

Materials and Methods

Experimental design, management, and care: Ninety day-old unsexed hybrid broiler chicks (Ross-308) were obtained from a private hatchery, weighed individually to record the initial weight, and then randomly distributed into three groups of 30 birds each, with three replicates for each group (10 birds per replicate). The experiment was conducted from 28 March to 8 May, 2024 on a private farm in the Safita area in Tartous Governorate, with the aim of studying the effect of adding *S. cerevisiae* yeast to the diet of broiler on some production indicators and biochemical parameters of blood serum.

The care barn was prepared as part of the necessary biosecurity procedures before the start of the experiment, and these procedures were applied with extreme precision during the experiment period. The semi-open system was used for breeding on a 5 cm thick mattress of sawdust, at a rate of 10 birds/m^2. The temperature in the barn was set at 33 - 35°C for the first two days, and reduced by 3 degrees per week until the end of the experiment, using thermometers to adjust the temperature. Lighting was provided for 24 hours during the first week, and then for 22 hours per day until the end of the experiment at 42 days of age for the birds.

Feeding system: The bird groups were provided with a balanced diet in two stages (starter and finisher) to meet their nutritional needs according to (29), and in accordance with the recommendations of the National Research Council (19), as shown in Table 1. The birds were randomly divided into three experimental groups as follows: the T1 group was fed an additive-free diet; while the T2 and T3 groups received diets supplemented with 0.1% and 0.2%, respectively of *S. cerevisiae* yeast.

Table 1: Components of feed mixtures used and chemical composition.

Ingredients	Starter (Days 1 - 21) %	Finisher (Days 22-42) %
Yellow corn	55.0	59.0
Soybean meal	39.2	34.68
Soy oil	2.0	2.5
Dicalcium phosphate	2.15	2.1
Calcium carbonate (limestone)	0.86	0.87
Free methionine	0.18	0.15
Iodized table salt	0.4	0.4
Choline chloride	0.1	0.1
Vitamin mixture*	0.1	0.1
Mineral mixture**	0.1	0.1
Total	100	100
Chemical composition		
Crude protein	22%	18%
Metabolizable energy	2850 Kcal/kg	2950 Kcal/kg

*The vitamin mixture in each 1 kg of ready-made feed included: 13,000 IU Vitamin A, 5,000 IU Vitamin D3, 80 mg Vitamin E, 4 mg Vitamin K3, 6 mg Vitamin B1, 8 mg Vitamin B2, 4 mg Vitamin B6, 0.02 mg Vitamin B12, 0.12 mg Biotin, 2 mg Folic Acid, 85 mg Nicotinamide, 22 mg pantothenic acid.

**The minerals mixture in each 1 kg of ready-made feed included: 120 mg manganese, 100 mg zinc, 40 mg iron, 20 mg copper, 1 mg iodine, 0.3 mg selenium.

Health and vaccination programs: Biosecurity procedures were applied during the trial period, and only farm employees were allowed to enter it after following strict biosecurity protocols every day. The birds were vaccinated against diseases as shown in Table 2.

Table 2: Vaccination schedule program.

Day	Vaccine	Route
7	Newcastle disease (Clone 30)	Drinking water
	Infectious bronchitis (H 120)	Drinking water
14	Gumboro (Gumboro. TM)	Drinking water
21	Newcastle disease (Clone 30)	Drinking water
32	Newcastle disease (Clone 30)	Drinking water

Production performance and mortality rate: The chicks were weighed individually in all repetitions of the groups after arriving at the farm, and the average live weight was calculated on days 1, 14, 28, and 42 after cutting off the feed for three hours using a sensitive electronic scale that weighed up to 5000 g. The various parameters were determined as follows:

1. Average weight gain during the stage (g) = Average body weight at the end of the stage (g) - Average body weight at the beginning of the stage (g);
2. Average bird feed intake = Amount of feed eaten (g)/number of birds in each repetition;
3. Feed conversion rate = Average bird feed intake (g)/average body weight gain (g); and
4. Bird mortality rate (%) = Number of dead birds during the experiment period/total number of birds x 100.

Biochemical indicators in blood serum: Blood samples were collected on day 42 from the wing veins of 9 birds for each group (3 birds for each replicate) using 3 or 5 ml syringes. The samples were emptied into sterile tubes (Vacotianor) and placed at an angle to increase serum separation. The tubes were then transported to the laboratory using a container cooled with ice and centrifuged at a speed of 3500 rpm for 5 minutes to obtain a clear serum. The serum was preserved in Eppendorf tubes and stored in a freezer at -15 to -20°C. The blood serums were subjected to a series of biochemical tests to determine the various blood components, which included: total protein, albumin, globulin, total cholesterol, and glucose. Commercial kits (Kit) were used to analyze these components (5, 9 and 17) at a private laboratory in Tartous Governorate.

Statistical analysis: SPSS V 25 was used to analyze the data, and a one-way analysis of variance (LSD) test was conducted to determine the variance between the groups in a completely randomized design. The significant differences were determined at the 5% level (7).

Results and Discussion

Productivity indicators: Table 3 shows the significant differences ($p \leq 0.05$) in the average body weight of the birds between the experimental groups at days 14, 28, and 42. The superiority of the T2 and T3 groups was observed and compared to the control group T1. The T3 group with 0.2% yeast added was found to be superior over the different rearing stages compared to the T2 group (0.1% added yeast), and the control group T1.

There were also significant differences ($p \leq 0.05$) in average weight gain among the experimental groups during the 1 - 14, 14 - 28, and 28 - 42 day periods, and during the entire rearing period (1 - 42 days). The T3 group (0.2% yeast added) was superior in terms of weight gain during the various periods compared to the T2 group (0.1% yeast added), and the control group T1.

As seen in Table 3, significant differences ($p \leq 0.05$) were recorded in average feed intake between the groups during the same periods. Average feed intake of the T2 birds increased compared to the T1 control group, while the intake of the T3 group was low compared to the other groups.

No significant differences ($p \geq 0.05$) were seen in feed conversion ratios in the T2 group (0.1% yeast added) and the control group T1, while major differences were found ($p \leq 0.05$) between the T3 group (0.2% yeast added) and the T2 and control groups over the study periods of 1 - 14 and 14 - 28 days. Also, significant differences ($p \leq 0.05$) were observed between the 3 groups during the 28 - 42 day-period and during the entire rearing period of 1 - 42 days. The results show lower feed conversion rates among birds in group T3 compared to the other groups during the various stages of rearing.

Mortality rates during the experiment period showed significant differences between the T3 group and the control group T1 ($p \leq 0.05$), while no significant differences appeared between the T2 and T3 groups. Also, no dead birds were recorded in the T3 group compared to the other groups.

Table 3: Broiler productivity at different breeding periods.

Time of Rearing	**Treatments****		
	T1	T2	T3
Body weight, g		mean ± SD	
Day 1	42.55 ± 1.04 ^{a}	42.28 ± 0.93 ^{a}	42.43 ± 1.08 ^{a}
Day 14	471.17 ± 4.07 ^{c}	486.02 ± 3.34 ^{b}	496.86 ± 4.39 ^{a}
Day 28	1476.47 ± 3.54 ^{c}	1505.09 ± 3.09 ^{b}	1524.42 ± 6.46 ^{a}
Day 42	2771.77 ± 6.61 ^{c}	2814.55 ± 5.78 ^{b}	2880.95 ± 7.73 ^{a}
Body weight gain, g		mean ± SD	
1 – 14 days	428.62 ± 3.03 ^{c}	443.75 ± 2.40 ^{b}	454.42 ± 3.32 ^{a}
14 – 28 days	1005.30 ± 0.54 ^{c}	1019.07 ± 0.25 ^{b}	1027.56 ± 2.08 ^{a}
28 – 42 days	1295.30 ± 3.08 ^{c}	1309.46 ± 2.70 ^{b}	1356.53 ± 1.30 ^{a}
1 – 42 days	2729.22 ± 5.57 ^{c}	2772.28 ± 4.84 ^{b}	2838.52 ± 6.66 ^{a}
Feed intake, g		mean ± SD	
1 – 14 days	539.97 ± 19.28 ^{c}	551.20 ± 20.08 ^{b}	517.77 ± 19.71 ^{a}
14 – 28 days	1587.66 ± 20.73 ^{c}	1602.50 ± 20.79 ^{b}	1576.15 ± 20.22 ^{a}
28 – 42 days	2627.39 ± 18.81 ^{c}	2643.24 ± 18.93 ^{b}	2568.59 ± 18.56 ^{a}
1 – 42 days	4755.02 ± 58.45 ^{c}	4796.94 ± 59.40 ^{b}	4662.52 ± 58.10 ^{a}
Feed conversion ratio %		mean ± SD	
1 – 14 days	1.260 ± 0.0361 ^{a}	1.242 ± 0.0386 ^{a}	1.139 ± 0.0351 ^{b}
14 – 28 days	1.579 ± 0.0214 ^{a}	1.573 ± 0.0208 ^{a}	1.534 ± 0.0166 ^{b}
28 – 42 days	2.028 ± 0.0098 ^{a}	2.019 ± 0.0105 ^{b}	1.893 ± 0.0119 ^{c}
1 – 42 days	1.742 ± 0.0179 ^{a}	1.730 ± 0.0184 ^{b}	1.643 ± 0.0167 ^{c}
Mortality rate %	10.00 ^{a}	3.33 ^{ac}	0.00 ^{c}

[a, b, c] Different horizontal letters indicate significant differences at the 5% level.
[**] *S. cerevisiae*: T1 (control) 0%; T2 0.1%; T3 0.2%.

Production indicators are important economic determinants of the efficiency of birds in converting feed into live weight. In this study, 4% improvements in average body weights and weight gain were noted in the T3 bird group which had 0.2% yeast added to their diets while for the T2 group (0.1% yeast added) it was 2% compared to the T1 control group. The average feed intake of the T3 group declined by 2% while it increased by 1% for the T2 group compared to the control. The feed conversion rate declined by 6% among birds in the T3 group and by 1% for the T2 group.

Earlier studies showed a decline in daily weight gain of the broilers when adding yeast at a rate of 1 g/kg feed (10), while *S. cerevisiae* yeast added at rates of 0.5, 1, 1.5, and 2 g/kg did not affect their live body weight (23). Another study showed that adding yeast at a rate of 0.1% and 0.2% did not affect feed intake (26). The findings of this study agree with (25) which showed an improvement in body weight and weight gain while average feed intake and feed conversion ratios declined compared to the control group when yeast probiotics were added to the diet. Another study also showed that nutritional supplements containing whole yeast and yeast cell walls at a level of 1.5-2 g/kg can improve growth performance and productivity of broiler chickens (1).

The improved production indicators from adding *S. cerevisiae* yeast to the diet in this study may be attributed to its containment of selenium (13 and 18), as it plays a major role in stimulating the work of hormonal-secreting cells in the small intestine, pancreas, and liver, which helps in the digestion process (8). The decline in the mortality rate when 0.1% yeast was added, and its absence at the 0.2% addition, may be due to the yeast's natural antioxidant properties for improving the immunity function in poultry, thereby reducing the incidence of diseases and lowering mortality rates (14). According to (30), feed supplements containing selenium help reduce the mortality rates of broiler chickens.

Differences between the results of this and other studies can be explained by the different types of birds, breeding periods, and amount of yeast added.

Biochemical indicators: Table 4 shows significant differences ($p \leq 0.05$) in the results of the studied blood indicators between the experimental groups. Except for globulin, no other significant differences ($p \geq 0.05$) were observed in the groups.

There were higher concentrations of total protein, albumin, and globulin in the birds of the T3 group whose diets were fortified with 0.2% yeast compared to the T2 group (0.1% yeast added) and the control group, while glucose and total cholesterol was lower in the T3 group compared to the T2 and T1 control groups.

Table 4: Results of some biochemical indicators of the broilers.

Biochemical indicators[*]	**Treatments**[**]		
	T1	T2	T3
Total protein (g/dl)	4.95 ± 0.006 [a]	5.11 ± 0.031 [b]	5.66 ± 0.046 [c]
Albumin (g/dl)	3.14 ± 0.035 [a]	3.27 ± 0.012 [b]	3.77 ± 0.078 [c]
Globulin (g/dl)	1.81 ± 0.038 [a]	1.84 ± 0.029 [a]	1.89 ± 0.082 [a]
Glucose (mg/dl)	222.17 ± 2.84 [a]	209.67 ± 1.44 [b]	188.83 ± 2.75 [c]
Total cholesterol (mg/dl)	153.50 ± 4.27 [a]	141.83 ± 2.52 [b]	121.33 ± 2.02 [c]

[a, b, c] Different horizontal letters indicate significant differences at the 5% level. [*] Values represent mean ± SD.
[**] *S. cerevisiae*: T1 (control) 0%; T2 0.1%; T3 0.2%.

Higher total protein, albumin, and globulin concentrations of 13%, 17%, and 4%, respectively were found in the blood serum of the T3 group of birds (0.2% yeast supplement), while they were 3%, 4%, and 2%, respectively for the T2 group (0.1% supplement) compared to the T1 control. The results showed that glucose and cholesterol concentrations declined by 18% and 27%, respectively in the T3 group and by 6% and 8% in the T2 group, compared to the control.

The concentration of albumin in the blood serum increased when *S. cerevisiae* yeast was added at a rate of 0.75% to broiler chicken feed, while non-significant changes occurred in total protein and glucose concentrations (21). Also, (16) noted that adding 1, 1.5, and 2 g/kg feed to broiler chickens produced obvious improvements in albumin concentrations in the blood serum, while (23) found a noticeable decline in glucose concentrations in the broiler chickens fed 0.5, 1, 1.5, and 2 g/kg of yeast supplements.

Improvements in the biochemical indicators from adding *S. cerevisiae* yeast to the feed mixture in this study may be due to its high protein content, in addition to minerals, especially selenium (13 and 18), which is associated with proteins and amino acids which have antioxidant properties (3). Also, the higher concentration of albumin in blood serum may improve the total protein percentage. This indicates an increase in the process of building protein and a decrease in the process of its catabolism (12), while the high concentration of globulin is directly proportional to both total protein and albumin.

The decline in the concentration of glucose in the blood serum could be due to the mineral components, especially selenium, in the *S. cerevisiae* yeast, which stimulate the B cells in the islets of Langerhans in the pancreas to secrete insulin, leading to the lower glucose concentrations (24).

Conclusions

This study showed that adding 0.2% of S. cerevisiae yeast to the diet of broiler chickens yielded better results than a 0.1% addition in the productive characteristics and biochemical parameters of their blood serum.

Supplementary Materials:

No Supplementary Materials.

Author Contributions:

Author 1: methodology, writing—original draft preparation; Authors 2 and 3: writing—review and editing. All authors have read and agreed to the published version of the manuscript.

Funding:

This research received no external funding.

Institutional Review Board Statement:

The study was conducted in accordance with the protocol authorized by the Ministry of Agriculture, the Ministry of Higher Education, Tishreen University, Faculty of Agricultural

Engineering, Department of Animal Production, Syrian Arab Republic.

Informed Consent Statement:

No Informed Consent Statement.

Data Availability Statement:

No Data Availability Statement.

Conflicts of Interest:

The authors declare no conflict of interest.

Acknowledgments:

The authors extend their thanks to the Head of the Animal Production Department, the Dean of the Faculty of Agricultural Engineering at Tishreen University, the laboratory personnel who contributed to the work, and everyone who contributed to the completion of this study.

Disclaimer/Journal's Note:

The statements, opinions, and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of AJAS and/or the editor(s). AJAS and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions, or products referred to in the content.

References

1. Ahiwe, E. U., Abdallh, M. E., Chang'a, E. P., Omede, A. A., Al-Qahtani, M., Gausi, H., ... and Iji, P. A. (2019). Influence of dietary supplementation of autolyzed whole yeast and yeast cell wall products on broiler chickens. Asian-Australasian journal of animal sciences, 33(4): 579. https://doi.org/10.5713%2Fajas.19.0220.
2. Arsène, M. M., Davares, A. K., Andreevna, S. L., Vladimirovich, E. A., Carime, B. Z., Marouf, R., and Khelifi, I. (2021). The use of probiotics in animal feeding for safe production and as potential alternatives to antibiotics. Veterinary world, 14(2): 319. https://doi.org/10.14202%2Fvetworld.2021.319-328.
3. Bagheri, M., Golchin-Gelehdooni, S., Mohamadi, M., and Tabidian, A. (2015). Comparative effects of nano, mineral and organic selenium on growth performance, immunity responses and total antioxidant activity in broiler chickens. International Journal of Biology, Pharmacy and Allied Sciences, 4(2): 583-595.
4. Bahri, S. I. S., Ariffin, A. S., and Mohtar, S. (2019). Critical review on food security in Malaysia for broiler industry. International Journal of Academic Research in Business and Social Sciences, 9(7): 869-876. http://dx.doi.org/10.6007/IJARBSS/v9-i7/6186.
5. Doumas, B. T., and Biggs, H. G. (1972). Standard methods of clinical chemistry. Academic Press, New York, 7: 175.
6. Elghandour, M. M. Y., Tan, Z. L., Abu Hafsa, S. H., Adegbeye, M. J., Greiner, R., Ugbogu, E. A., ... and Salem, A. Z. M. (2020). Saccharomyces cerevisiae as a probiotic feed additive to non and pseudo-ruminant feeding: a review. Journal of applied microbiology, 128(3): 658-674. https://doi.org/10.1111/jam.14416.

7. George, D., and Mallery, P. (2019). IBM SPSS Statistics 25 Step by Step. New York and London, 404. http://dx.doi.org/10.4324/9781351033909.
8. Gopi, M., Pearlin, B., Kumar, R. D., Shanmathy, M., and Prabakar, G. (2017). Role of nanoparticles in animal and poultry nutrition: modes of action and applications in formulating feed additives and food processing. International Journal of Pharmacology, 13(7): 724-731. http://dx.doi.org/10.3923/ijp.2017.724.731.
9. Habra, N., and Ibrahim, S. (2005). Laboratory Diagnosis (theoretical). Publications of the College of Veterinary Medicine, ALBaath University, pp. 268.
10. Haldar, S., Ghosh, T. K., and Bedford, M. R. (2011). Effects of yeast (Saccharomyces cerevisiae) and yeast protein concentrate on production performance of broiler chickens exposed to heat stress and challenged with Salmonella enteritidis. Animal feed science and technology, 168(1-2): 61-71. http://dx.doi.org/10.1016/j.anifeedsci.2011.03.007.
11. Hameed, H. M. (2020). Comparative study on the effect of β-mannanase, lysolecithin and probiotic on quail ration (*Coturnix coturnix*) on physiological and productive performance. Doctoral dissertation, University of Mosul. http://dx.doi.org/10.13140/RG.2.2.34373.47843.
12. Hamouda, M. (2023). The comparative effect of using nano-selenium and organic selenium on some blood components and a study of residual residues in oxidatively stressed broiler chickens. Doctoral dissertation, Hama University, pp. 206.
13. He, J., Zhang, K. Y., Chen, D. W., Ding, X. M., Feng, G. D., and Ao, X. (2013). Effects of vitamin E and selenium yeast on growth performance and immune function in ducks fed maize naturally contaminated with aflatoxin B1. Livestock Science, 152(2-3): 200-207. http://dx.doi.org/10.1016/j.livsci.2012.12.018.
14. Ibrahim, N. S., Sabic, E. M., Wakwak, M. M., El-Wardany, I. E., El-Homosany, Y. M., and El-Deen Mohammad, N. (2020). In-ovo and dietary supplementation of selenium nano-particles influence physiological responses, immunological status and performance of broiler chicks. Journal of Animal and Feed Sciences, 29(1): 46-58. http://dx.doi.org/10.22358/jafs/118209/2020.
15. Kumar, S., Yadav, S. P., Chandra, G., Sahu, D. S., Kumar, R., Maurya, P. S., ... and Ranjan, K. (2019). Effect of dietary supplementation of yeast (Saccharomyces cerevisiae) on performance and hemato-biochemical status of broilers. Indian Journal of Poultry Science, 54(1): 15-19. http://dx.doi.org/10.5958/0974-8180.2019.00002.3.
16. Mahmood, N. A., and S. M. Abdulateef. 2021. “Determining Some Undesirable Behavioral Traits and Their Impact on the Behavioral Performance of Broiler Chicks.” in IOP Conference Series: Earth and Environmental Science. Vol. 904. IOP Publishing Ltd
17. Mohammed, T., T. H., & H. Hamad, E. (2024). Effect Of Adding Natural Zeolite And Vitamin E To Laying Hans Diets On Some Productive Traits During The Summer Season. Anbar Journal Of Agricultural Sciences, 22(1), 501–516. https://doi.org/10.32649/ajas.2024.183746.

18. Mustafa, A. H. (2015). Different areas of use of yeast. Assiut Journal of Environmental Studies, (42): 10.
19. National Research Council, and Subcommittee on Poultry Nutrition. (1994). Nutrient requirements of poultry: 1994. National Academies Press.
20. Ogbuewu, I. P., Okoro, V. M., Mbajiorgu, E. F., and Mbajiorgu, C. A. (2019). Yeast (Saccharomyces cerevisiae) and its effect on production indices of livestock and poultry—a review. Comparative Clinical Pathology, 28: 669-677. https://doi.org/10.1007/s00580-018-2862-7.
21. Okasha, E. G., Hassan, H. A., and Ismail, Z. S. (2023). Effect of different levels of supplemental yeast (Saccharomyces cerevisiae) on productive performance, carcass traits and some blood parameters in broiler chickens. SVU-International Journal of Agricultural Sciences, 5(4): 130-140. https://doi.org/10.21608/svuijas.2023.247492.1315.
22. Pan, T., Liu, T., Tan, S., Wan, N., Zhang, Y., and Li, S. (2018). Lower selenoprotein T expression and immune response in the immune organs of broilers with exudative diathesis due to selenium deficiency. Biological trace element research, 182: 364-372. https://doi.org/10.1007/s12011-017-1110-3.
23. Rafique, K., Rahman, A., and Mahmood, M. (2020). Effect of dietary supplementation of different levels of saccharomyces cerevisiae on growth performance and hematology in broiler. Indian Journal of Animal Research, 54(1): 59-64. http://dx.doi.org/10.18805/ijar.B-695.
24. Saleh, A. A., and Ebeid, T. A. (2019). Feeding sodium selenite and nano-selenium stimulates growth and oxidation resistance in broilers. South african journal of animal science, 49(1): 176-183. http://dx.doi.org/10.4314/sajas.v49i1.20.
25. Śliżewska, K., Cukrowska, B., Smulikowska, S., and Cielecka-Kuszyk, J. (2019). The effect of probiotic supplementation on performance and the histopathological changes in liver and kidneys in broiler chickens fed diets with aflatoxin B1. Toxins, 11(2): 112. https://doi.org/10.3390/toxins11020112.
26. Sun, H. Y., and Kim, I. H. (2019). Dietary supplementation of mixed yeast culture derived from Saccharomyces cerevisiae and Kluyveromyces maxianus: effects on growth performance, nutrient digestibility, meat quality, blood parameters, and gut health in broilers. The Journal of Poultry Science, 56(2): 140-147. https://doi.org/10.2141%2Fjpsa.0180052.
27. Sun, Z., Wang, T., Demelash, N., Zheng, S., Zhao, W., Chen, X., ... and Qin, G. (2019). Effect of yeast culture (Saccharomyces cerevisiae) on broilers: A preliminary study on the effective components of yeast culture. Animals, 10(1): 68. https://doi.org/10.3390%2Fani10010068.
28. Supriya, R., Sravathi, V., Poloju Deepa, D. K., Vasavi, D. K. D., and Tripathi, P. (2023). Application of fermentation technology in poultry feed for the sustainable poultry industry: A review. International Journal of Veterinary Sciences and Animal Husbandry, 8(5): 7-14. https://doi.org/10.22271/veterinary.2023.v8.i5Sa.673.
29. Syrian fodder tables. (1987). Resolution 45/T. Ministry of Agriculture and Agrarian Reform, Damascus, Syrian.

30. Visha, P., Selvaraj, P., and Jayachandran, S. (2020). Nanoselenium as a growth promoting feed supplement in broiler chickens. Int J Curr Microbiol Appl Sci, 9(5): 3247-3257. http://dx.doi.org/10.20546/ijcmas.2020.905.385.