Study of the hematological and some biochemical characteristics in common carp (*Cyprinus carpio* L.) fish feeding on fermented rations with varying concentrations growth stimulator (Bio boost aqua)

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Abstract

The current study was conducted to find out the influence of yeast on fermented rations. Saccharomyces cerevisiae, and to which the growth enhancer Bio Boost Aqua was added in different proportions to take into account some hematological and biochemical characteristics for common carp fish. The hematological results of the studied fish before and at the end of the experiment showed a significant ($p \leq 0.05$) superiority in T2 over the other treatments in RBC and PVC%, respectively (29.51±0.70; 2.85±0.07), while T1 and T2 recorded a significant decrease in leukocyte count at a rate of (25.70±0.14; 24.50±0.14) compared to the other experimental treatments before and at the end of the experiment. The results did not show any significant differences ($p > 0.05$) in the hemoglobin HB levels of the test fish before and at the end of the experiment. The results of the analysis of white blood cells at the end of the experiment (neutrophils, eosinophils and monocytes) showed that there were no significant differences ($p > 0.05$) in the experiments studied. While the white blood cells (the lymphocytes) in the control treatment showed higher rates with a rate of 36.01±1.45% compared to the other treatments which recorded lower values. The biochemical results in experimental fish before and at the end of the experiment showed an increasing value of total protein in blood serum in T2 and T3, which showed significant differences ($p \leq 0.05$) at rates of (2.15, 1.95)%. Glucose levels showed a significant increase in T4 levels ($p \leq 0.05$), reaching 76.5 mg/dL compared to the other experimental treatments where a decrease in levels was recorded before and at the end of the experiment. While the total cholesterol results for experimental fish before and at the end of the experiment showed that there were significant differences, T3 and T4 recorded higher values, reaching 76.49; 71.94 (mg/dl) compared to the other experimental treatments, which recorded a significant decrease in blood serum cholesterol analysis results $p \leq 0.05$.

Keywords: Biochemical parameters, Total protein, Glucose, Total cholesterol

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Introduction

The blood tests are one of the important metrics for assessing health and nutritional status and as an indicator of stress in fish culture (Nidhi and Meenakshi, 2022). The blood in fish is a red, liquid, sticky texture that enters the body through blood vessels. The percentage of blood volume is lower than that of the other vertebrates. Its size is 4 mil/100 g and this is due to the completion of the vascular system in teleost fish, which results in it requiring relatively less blood than the other vertebrates to carry out the vital processes in the body, it consists of plasma fluid, blood serum and Blood cells (Abdul Hamid, 2009). The study of blood indicators is of diagnostic importance. This includes examining the number of red blood cells, white blood cells, hemoglobin and packed cell size, all of which are influenced by environmental factors such as pollution from water pollutants. The blood indicators of fish are highly correlated with the fish's response to environmental and biological factors, which vary seasonally can affect changes in fish blood parameters such as reproductive cycle, nutrition, temperature, pH and photoperiod (Railo *et al*., 1985). It is also used as a diagnostic tool in biomonitoring, allowing us to detect physiological changes and pathogenesis resulting from diet, water quality, and disease (Adams *et al*., 1996). The blood tests are one of the indicators of fish health, physiological reactions, nutritional and environmental conditions (Iwashita *et al*., 2015). Nutritional status is a crucial factor in the host's defense against pathogens. The use of feed additives is therefore aimed not only at improving growth but also at improving the health and immune status of fish (Shokr and Mohamed, 2019). Fermentation is used to break down and digest the complex organic molecules to form smaller compounds and nutrients that are easily digestible (Nkhata *et al.*, 2018) and this process can increase the digestibility of feed ingredients by analyzing the materials present in the feed ingredients through enzymes produced from microbes, fungi or yeasts through fermentation (Reisinger *et al*., 2012). Fermentation occurs through the use of baker's yeast S. cerevisieae in the feed and in turn improves growth and enhances the immunological response to the various fish (Tewary and Patra, 2011). Because it contains many immunostimulating compounds that are used as natural immunostimulants in the common nutritional systems of fish (Huyben *et al*., 2017). Use baker's yeast and natural growth enhancers to improve the growth performance of fish, and conversely, use some antibiotics and hormones as feed additives, which may cause harmful side effects to fish (Mahmoud *et al*., 2019). Repeated use of antibiotics in fish feed can also lead to the development of antibiotic-resistant bacteria and the formation of harmful substances that can pose a threat to the ecosystem (Esiobu *et al*., 2002). Therefore, the World Health Organization (WHO) has promoted the use of natural growth promoters such as yeasts and some herbs and medicinal plants to reduce the use of chemicals and replace them with natural sources. The use of natural materials is considered acceptable feed additives as they improve feed effectiveness and production performance (Levic *et al*., 2008). The use of baker's yeast S. cerevisieae in feed has been proven to improve growth and enhance the immune response of various fish species (Tewary and Patra, 2011). The research shows that baker's yeast has the ability to produce some energy substrates for intestinal cells, which makes the intestine healthy by improving the mucosal surfaces and microflora and improving the elongation of villi in the intestinal tract of fish (Lawrence *et al*., 2007).

Materials and methods

Cultural system. The current study used carp fish (*Cyprinus carpio* L.) with an initial weight between 36.03 and 36.5 grams, which came from a private farm in Babylon Governorate. The fish were then distributed at a rate of 10 fish per tank. with two replicates for each treatment, taking into account that the weights of the fish were as similar as possible in all experimental sessions. The experience lasted 60 days. The experiment was carried out in a recirculation system consisting of eight glass tanks (150 liters) with dimensions (100 x 40 x 50 cm). Fish were fed 3% of their body weight twice daily and fish weighing was performed every two weeks. During the experiment, some environmental factors of the water in the ponds were measured, such as: B. Temperature (°C), dissolved oxygen concentration (mg/L), salinity (%) and pH value. Four diets were used in this experiment. The feed was ground well and homogeneously with an electric mill and then four feeds were formed, three of which were added with baker's yeast at an amount of 0.5 g/kg and added with water to form a dough. Thereafter, the three experimental diets were fermented for 48 hours using the method mentioned by Radwan (2014). After the fermentation of the three diets was completed, they were dried well, then two of them were taken out and ground well, and Bio Boost Aqua was added to them in the proportions shown in Tables 1 and 2, which represent the chemical composition of the diets used for feeding. Then it was put into a meat grinder to form pellets with a diameter of 2–3 mm, which corresponded to the size of the experimental fish's mouths. It was dried at room temperature for 72 hours, then stored in polyethylene bags with the name of the treatment and stored in the refrigerator at 4°C until use. The diets were formulated based on the treatments and distributed as follows:

T1: treatment control diet without any treatment

T2: fermented diet for 48 hours using S. cerevisiae at 0.5 g/kg

T3: fermented diet and supplemented with 0.5 g/kg of the growth promoter (Bio Boost Aqua).

T4: fermented feed and supplemented with 1 g/kg growth promoter (Bio Boost Aqua).

Table 1: component of experimental diets and its percentage (%) used in common carp fish feeding.

Components%	Experimental coefficients			
	T1	T2	T3	T4
Vegetable protein concentrate (Carp-5 Extra	10	10	10	10
Fish powder of Turkish origin	5	5	5	5
Soybean meal (Argentinian(	40	40	40	40
Flour	14	14	14	14
yellow corn	10	10	10	10
rice polishing	10	10	10	10
Wheat Bran	10	10	10	10
Premix	1	1	1	1
S. cerevisiae	-	0.05	0.05	0.05
Bio Boost Aqua	-	-	0.05	0.1

Table 2: the chemical composition % of the experimental diets according to the dry weight the values (Mean±SD) represent.

Proximate composition (%)	Treatments			
	First treatment T1	Second treatment T2	Third treatment T3	Fourth treatment T4
Moisture	0.04 ± 6.26^{b}	0.55 ± 7.72^{a}	0.04 ± 7.165^{a}	0.06 ± 7.05^{a}
Crude protein	0.30 ± 28.88^{b}	0.04 ± 31.87^{a}	0.48 ± 31.36^{a}	0.09 ± 31.11^{a}
Fat	1.11 ± 5.17^{a}	0.61 ± 5.57^{a}	0.35 ± 7.07^{a}	0.39 ± 6.55^{a}
Ash	0.29 ± 5.09^{ab}	0.12 ± 4.38^{b}	0.22 ± 5.29^{ab}	0.65 ± 5.98^{a}
fiber	0.40 ± 12.91^{a}	0.57 ± 7.36^{b}	1.18 ± 5.96^{b}	0.14 ± 6.78^{b}
NFE	1.57 ± 41.67^{a}	0.67 ± 43.08^{a}	0.88 ± 43.15^{a}	0.24 ± 42.51^{a}

*Different letters in the same row indicates significant differences ($p \leq 0.05$) among the treatments in chemical content.

Hematological and biochemical analyzes. At the beginning of the experiment, blood samples were taken from the tail vein of various fish in the control group and at the end of the experiment, blood was taken directly from the heart of the experimental fish (3 fish/treatment) (cardiac puncture). with plastic syringes of size 2 mm. and do not use narcotic substances on the fish when collecting blood, as this could affect the accuracy of the blood tests on the test fish. This was done by collecting blood samples (1 ml from all fish) from the heart of each fish using a sterile syringe, previously flushed with ethylenediaminetetraacetic acid (EDTA) solution as an anticoagulant. as mentioned by (Opiyo *et al*., 2019). Place the collected blood samples into the tube and move it gently. Then close it with a twisting motion for (2-3) minutes and stick on it the number of treatments and repeat the samples, keep them cooled with ice and transfer them to carry out the analyses., including RBC, WBC, hemoglobin (Hb) and packed cell volume (PCV%), based on the mentioned methods (Coles, 1986). The second part of the blood samples collected from fish were collected without anticoagulant in Eppendorf tubes containing no anticoagulant (such as heparin) to obtain the blood serum. The tubes are then left in the cursive direction at room temperature for half an hour and then ejected at 3000 revolutions per minute for ten minutes, depending on the method (Yang and Chen, 2003). The serum was collected using a micropipette tube and then stored in special tubes at -20°C. The biochemical tests were carried out using a spectrophotometer from Apel (Japan). by using private equipment from the company (Germany Human). The biochemical analyzes of the blood serum include the concentrations (total protein, glucose and total cholesterol).

Statistical Analysis: Statistical analysis was carried out using a completely randomized design (CRD) using the Statistical Analysis System (SAS, 2001) and the significant differences between the means of the characteristics were determined using Duncan's test (1955). Point tested level of (0.05).

Results

RBC and WBC number

The results of the current study demonstrate the importance of fermentation by baker's yeast *S. cereviseae* in the amount of 0.5 g/kg in the diet of common carp fish through its influence on blood indicators. This appears in the results of the statistical analysis thereof, which showed in Table 3 the superiority of T2 ($p \le 0.05$) over all other treatments before and at the end of the experiment, in (RBC) with an average of 2.85×106 cell/mm³ and the clear superiority of T1, T3 and T4 in the results of the (RBC) analysis compared to the (RBC) results of the fish before the start of the experiment, which had 1.5 x 106 cells/mm³. and for (WBC), the results of statistical analysis confirmed significant differences ($p \le 0.05$) between the fish in T1 and T2 and other treatments before and at the end of the experiment. The (WBC) count decreased in T1 and T2 at a rate of 24.5×10 and 25.7×10³ cells/mm³, respectively. while no significant differences were found in T3 and T4 in the fish before the start of the experiment.

Table 3: shows red blood cell count rates×10 ^{6} cells/mm³, white blood cell counts×10 ^{3} cells/mm³, and hemoglobin concentration (g/100 mL) and the percentage of the volume of packed blood cells of common carp fish fed on the experimental treatments for 60 days (Mean±SD).

Hematological analyses	Before the experiment	Treatments at the end of the experiment			
		T1 (con.)	T2	T3	T4
RBC (10^6/µL)	0.07±1.55^{d}	0.14±2.50^{b}	0.07±2.85^{a}	0.14±2.10^{c}	0.07±2.25^{bc}
WBC (10^3/µL)	0.07±26.45^{a}	0.14±24.50^{c}	0.14±25.70^{b}	0.21±26.45^{a}	0.14±26.61^{a}
Hemoglobin (g/dl)	0.07±8.35^{a}	0.21±8.45^{a}	0.21±9.15^{a}	0.91±6.65^{b}	0.28±6.80^{b}
PCV%	0.70±27.02^{b}	0.70±27.50^{ab}	0.70±29.51^{a}	1.41±21.01^{c}	0.70±22.50^{c}

*Different letters in the same row indicates significant differences ($p \le 0.05$) among treatments.

Hemoglobin concentration (Hb) and (PCV) %

The results of the analysis of hemoglobin concentration (Hb) and stacked cell size (PCV) in Table 3 showed significant differences ($p \le 0.05$) between the treatments before and at the end of the experiment. T1 and T2 recorded the higher values of hemoglobin concentration, reaching 8.45 and 9.15 g/100 ml, respectively, compared to the other treatments T3 and T4, which had lower values, which reached 6.65 and 6.8 g/100 ml, respectively. reached 100 ml. Concomitantly, there is also a significant superiority of (PCV) in the same treatments, which achieved (27.5, 29.51) % in T1 and T2, respectively, compared to T3 and T4, which showed a decrease in (PCV) at average values of (21.01 and 22.50%, respectively.

White blood cells types

The types of white blood cells was showed in Table 4. The results of the statistical analysis showed that the number of white blood cells of lymphocyte type in T2, T3 and T4 recorded a significant decrease ($p \leq 0.05$) compared to the control treatment T1, which recorded a higher value (36%). As for other types of white blood cells of the monocyte, eosinophil and neutrophil type, the results of the statistical analysis showed that there were no significant differences ($p > 0.05$) between the levels of these cells in the control treatment and all other treatments examined.

Table 4: Explains the types of white blood cells in the blood of common carp fish in various fish.

Types of (WBC)	Experimental treatments			
	T1 (con.)	T2	T3	T4
Lymphocyte	36.01±1.45[a]	33.03±1.414[b]	32.51±0.707[b]	33.53±0.707[b]
Monocyte	3.01±0.705[a]	3.50±0.707[a]	3.02±0.706[a]	3.50±0.707[a]
Eosinophil	1.00±0.703[a]	1.50±0.707[a]	1.50±0.707[a]	1.00±0.703[a]
Neutrophil	60.00±1.412[a]	62.00±1.414[a]	63.00±1.414[a]	62.00±1.414[a]

*Similar letters in the same row do not differ from each other significantly ($p > 0.05$).

Serum total protein

The results of the serum total protein analysis for the experimental fish in Table 5 showed that there were significant differences ($p \leq 0.05$) between T2, which recorded the highest value of 2.153 mg/dL, and the other experimental treatments before and at the end of the experiment, T3 followed at a rate of 1.954 grams/dl, while T1 and T4 showed no significant differences from the results of the analysis of the blood serum of the fish before the start of the experiment.

Table 5: appears some Blood serum test standards For Common Carp fish that fed on different experimental diets (Mean± SD).

Blood serum	At the beginning Of experiment	The treatments at the end of experiment			
		T1	T2	T3	T4
Protein (g/dl)	1.153±0.18[c]	1.708±0.0[bc]	2.153±0.073[a]	1.954±0.03[ab]	1.783± 0.02[c]
Glucose (mg/dl)	46.19±0.02[b]	49.45±1.159[b]	55.32±1.16[b]	54.095±5.02[b]	76.50±2.31[a]
Cholesterol(mg/dl)	49.075±2.46[b]	51.55±2.368[b]	49.525±0.17[b]	76.49 ± 0.33[a]	71.94±3.39[a]

*Characters differences in one row indicate a significant difference ($p \leq 0.05$) among the treatments.

Glucose concentration

The results in Table 5 showed significant differences ($p \leq 0.05$) in the glucose level of fish blood fed with feed containing the growth promoter (BBA) at an amount of 1 gram/kg in T4. The glucose level increased in the fish of this treatment by 76.50 mg/dl compared to all other experimental treatments before and at the end of the experiment, in which no significant differences were found between each other ($p>0.05$) in blood sugar content in common carp fish.

Total cholesterol

The results of the analysis of total cholesterol in blood serum in carp fish shown in Table 5 showed a significant increase in cholesterol levels in T3 and T4, reaching 76.49 and 71.94 mg/dl, respectively, in comparison with the other treatments. It was also found that treatment T2 recorded a significant decrease ($p\leq0.05$) in cholesterol levels at a rate of 49.525 mg/dL compared to control treatment T1, which had 51.55 mg/dL, as well as the other treatments.

Discussion

The yeasts, through their enzymes that convert the proteins, have played an important role in converting the low nutrient biomass into higher value nutrient compounds at low cost (Couture *et al*., 2019; Lapena *et al*., 2020). in peptides and amino acids (Nkhata *et al.*, 2018). Fermentation also has a better effect on the occurrence of biochemical changes in the food components, and the improvement of the food content of proteins and essential amino acids (Xiang *et al*., 2019) is promoted by the addition of baker's yeast S. cerevisiae to the food growth and enhances the immune response (Tewary and Patra, 2011). Some studies dealing with the evaluation of the nutritional value of baker's yeast S. cerevisiae in many fish species, including a study on (Korkmaz and Cakirogullari, 2011) on Nile tilapia fish and a study on Seabass fish by Peres *et al*., (1999) and also the study by (Tewary and Patra, 2011) on raw fish, all of these studies showed good results regarding the efficiency of using baker fish. s yeast in rations. The analyzes are carried out on blood contents to determine the health and physiological status of fish, which can serve as an indicator of disease or malnutrition and the stressful situations that occur due to undesirable nutritional or environmental factors (Witeska *et al*., 2016). Iwashita *et al*. (2015) pointed out that blood parameters of fish are indicators of health, well-being, physiological responses, and nutritional and environmental status. Blood tests are also considered valuable criteria for the nutritional situation as an indicator of stress in fish (Nidhi and Meenakshi, 2022). The analysis results of the blood tests carried out on the fish at the end of the experiment and the comparison with the blood tests before the start of the experiment showed a clear significant superiority of the fish fed with the T2 treatment compared to the other treatments. The results of the current study were consistent with the results of a study by Al-Refaiee *et al*. (2016) agree. This showed that adding yeast to fish rations increased the number of red blood cells in fish blood. This was confirmed by a study by Bransden *et al*. (2003) confirmed the addition of yeast in the diet of the Atlantic salmon fish *Salmo salar* L. can lead to an increase in the number of erythrocytes. While Witeska *et al*. (2015) pointed out that a decrease in the number of red blood cells in carp fish beyond the normal limits of the species is evidence that fish are suffering from anemia. This in turn results in fish being unable to absorb large amounts of oxygen, even though it is present in the water. As a result, the fish suffer from a lack of oxygen (Ikun *et al*., 2013). Therefore, as a preventive measure, the fish resort to increasing the production of red blood cells in order to physiologically adapt to the environment and to support the continuous supply of the body tissues with oxygen present on the surfaces of the red blood is transported to cells (Mallya, 2007). White blood cells play the most important role in the defense mechanism of fish and are composed of monocytes, acid and neutrophils, lymphocytes and platelets (Nidhi and Meenakshi, 2022), the fish suffering from stress caused by environmental or nutritional changes increase the number of leukocytes (Hastuti and Subandiyono, 2015). The results of statistical analysis of the white blood cell count in the current study showed that there was a significant difference ($p \leq 0.05$) between the fish before the start and the end of the experiment, and a decrease in the white blood cell count was in the control treatment and T2 compared to the other experimental treatments before and at the end of the experiment observed that higher values were recorded in the number of white blood cells, this can possibly be attributed to the active role of the synergistic action of baker's yeast with growth promoter (Bio Boost) in T3 and T4 because it contains an immune-boosting formula. Opiyo *et al*. (2019), showed that blood samples from fed tilapia enriched with probiotics, brewer's yeast *S. cerevisieae* and *Bacillus* Spp. They contained a greater number of white blood cells than the control group. The results of the present study are consistent with the results of Hassaan *et al*. (2018) carried out study which involved the addition of β-glucan and nucleotide-rich yeast extract to Nile tilapia juvenile rations, treatments with this mixture were significantly better than the control diet. This benefit is due to the effect of the sugar’s glucan, mannan and chitin on the cell wall of brewer's yeast, which help increase the number of white blood cells. Yeast is involved in the defense mechanism against pathogens, which has a positive effect on the immune parameters of the blood. Yeast also has an immunostimulant effect, fights diseases and increases the efficiency of phagocytosis and the effectiveness of the destruction of pathogenic bacteria and fungi (Schreck and Moyle, 1990). The results of the analysis of the concentration of hemoglobin Hb gm/dL and hematocrit % PCV showed a significant difference between the different experimental treatments before and after the experience. T1 and T2 recorded higher Hb gm/dL and PCV% values than T3 and T4, which recorded an observed decrease in Hb beyond the fish's natural limits. Research shows that the normal Hb concentration in teleost fish is between 7 and 10 g/100 ml (Abdul Hamid, 2009). In mixed treatments (T3, T4), the PCV% values decreased but were within the acceptable range. Sources also indicate that the proportion of PCV in the blood of teleost fish varies between 20 and 40% (Hoar *et al*., 1992). This is due to the role of beneficial microorganisms that increase the absorption of iron, copper, folic acid, vitamins and other minerals (Van der Heuvel *et al*., 2000). White blood cells play a defensive role in the body against all types of pathogens, including fighting cancer cells. These cells are produced in the bone marrow and stored in the blood and lymphatic tissue, which contains various types of lymphocytes, monocytes and eosinophils. and neutrophils (Witeska *et al*., 2022). The results showed that there were no significant differences (p>0.05) between the white blood cell treatments tested: monocytes, eosinophils and neutrophils. Studies indicate that these cells are primarily responsible for the nonspecific immune response to infectious diseases in fish (Jeney and Anderson, 1993). The results of the research carried out clearly show that the use of brewer's yeast in experimental diets and the processing of the mixture, to which the growth stimulator Bio Boost was added in various proportions, did not affect the health of common carp fish. Research shows that when the proportion of these cells in fish exceeds the norm, this is considered an indicator of stimulation of the immune system against a particular disease. This was configured based on a study (Cengizler and Sahan, 2000). When fish are infected with diseases or parasites, a decrease in the number of red blood cells and an increase in the number of leukocytes, including neutrophils are observed in infected fish. Lymphocytes come from blood cells, which are responsible for the production of antibodies in the bloodstream against any infection (Sahan and Duman, 2010). However, the decrease in the number of lymphoid cells in the experimental groups of this study indicates their activation and the absence of stimulation of fish Feeding with experimental treatments compared to the control treatment, clearly indicating the safe role of the fermentation process as well as the use of the natural growth stimulator

Bio Boost in feeding common carp. The study of serum parameters plays an important role in providing indicators of health, physiology and nutritional status, which help to determine the most appropriate feeding and breeding methods, making it possible to identify acute or chronic stress factors, as well as their manifestations to identify the disease (Peres *et al*., 1999). Whey proteins played an important role in the transfer of various nutritional materials and the defense of living beings against pathological factors, as well as in osmotic organization and some other tasks (Rudneva *et al*., 2011). Total protein results showed a significant benefit in T2 and T3, with rates higher than other experimental treatments where total protein decreased. This is due to the inability to synthesize proteins and limit the absorption or loss of proteins, thereby attenuating the effect in the blood (Patriche *et al*., 2011), and the exposure to stressful situations that occur in fish lead to increased energy levels so that they can cope with environmental conditions to which toxic materials are exposed (Jenkins and Smith, 2003) The results of the present study are consistent with those of the study (Opiyo *et al*., 2019) in which the addition of brewer's yeast S. cerevisiae with a probiotic to Nile tilapia fish rations resulted in an increase of total protein content compared to the treatment control. However, the results of this study did not agree with the study results (Rozita *et al*., 2013). They reported that there were no significant differences in the concentration of total protein, albumin and globulin in serum after adding different amounts of brewer's yeast. on rationing Oscar fish (*Astronotus ocellatus)*. This may be due to the active role of fermentation processes, which led to an increase in total protein concentration in the experimental diets. The sugar glucose is the main source of energy for most vertebrates and is a good indicator for checking the health of living beings (Jana *et al*., 2016). The results showed significant differences in glucose levels between the experimental groups. Compared to other experimental treatments, there was a significant increase in T4 before and after the end of the experiment. while there were no significant differences between them in the other treatments. Nemosok and Bores (1982) found that blood glucose appears to be a sensitive indicator of environmental and nutritional stress in fish. The results of the present study are consistent with the study by Abdel-Tawwab *et al*. (2008) agree. There is a significant increase in the percentage of glucose in the blood serum of tilapia fish fed with brewer's yeast compared to the control group, and the results of the study by Al-Refaiee *et al*. (2016), who demonstrated the superiority of brewer's yeast and growth stimulants, these results were attributed to the composition of the yeast cell wall, which contains chemical compounds, most of which are carbohydrates, beta-glucan and chitin, so the blood serum glucose The value increased after compliance of these diets around. The percentage of plasma cholesterol is associated with improved survival and health status of fish (Chatzifotis *et al*., 2004). The use of a growth promoter as a nutritional supplement to the feed ration inhibits pathogenic bacteria and also supports the immune response. Studies have shown increased cholesterol levels in fish fed a diet containing a mixture of probiotics and some growth promoters (Panigrahi *et al*., 2010; Piccolo *et al*., 2015). The results of the statistical analysis showed a significant increase in cholesterol levels in fish fed T3 and T4 compared to other experimental treatments before and after the end of the experiment, with no significant differences found between them. The results of the present study do not agree with the results of the study by Kowalska *et al*. (2015) agree. The results showed that the lowest blood serum cholesterol levels were found in the treatment in which yeast extract was added to 2% of feed ingredients and in another study in which iris trout were fed rations supplemented with 1-2 g/kg of yeast extracts. The results showed a significant reduction in total cholesterol compared to the control treatment (Mohebbi *et al*., 2013).

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