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Effects of Various Doses of *Saccharomyces cerevisiae* on the Growth, Survival Rate, and Blood Profile of Saline Red Tilapia (*Oreochromis* spp.) in the Semi-Intensive Culture Conditions

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ABSTRACT

The availability of good feeding on fish performance is needed to improve the poor aquaculture condition. The study examines the effects of *Saccharomyces cerevisiae* supplementation on the growth, survival rate, and blood profile of saline red tilapia in the semi-intensive culture. Sixty saline red tilapia (4.58 ± 0.09 g) were divided into five groups and received standard feed with supplementation of *S. cerevisiae* at different doses: (A-E) 0, 5, 10, 15, and 20 g/kg feed. *S. cerevisiae* was sprayed onto the feed and given to fish three times/day for 49 days. The efficiency of feed utilization (EFU), feed conversion ratio (FCR), the protein efficiency ratio (PER), relative growth rate (RGR), survival rate (SR), and blood profiles were examined. The water quality parameters were also evaluated, including temperature, pH, dissolved oxygen, NH_3, and salinity. Data were analyzed using ANOVA followed by the Duncan test. The supplementation of 10 g/kg *S. cerevisiae* could significantly ($p<0.05$) increase EFU (85.13%), PER (3.76), RGR (4.53%), and survival rate (97.53%), and decrease FCR (1.42) of the saline red tilapia. All doses of *S. cerevisiae* significantly ($p<0.05$) increased the number of hematocytes (34.68, 35.96, 34.14, and 34.52%, respectively) and hemoglobin (12.98, 13.58, 12.73, and 12.67%, respectively) of fish. The highest number of erythrocytes and leucocytes was found in dose 10 g/kg feed. All water parameters were stable during the study.

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Therefore, *S. cerevisiae* can be used as a feed supplement for red tilapia fish to increase the growth, survival rate, and blood profile of the saline red tilapia.

Keywords: Immune system, *Saccharomyces cerevisiae*, saline red tilapia, semi-intensive intensive

INTRODUCTION

Saline red tilapia (*Oreochromis* spp.) is a cultivated fish species in Kendal Regency, Central Java Province, Indonesia. The increase in sea level, seawater intrusion, and seawater flooding into the rice field was due to climate change and global warming. Those caused a rise in brackish water areas and need special treatment to support aquaculture. The Kendal Regency has a high potential for aquaculture since the regency has a long shoreline (42.2 km) and a huge area of brackish water ponds (1,002.23 km^2) (Ayuniar & Hidayat, 2018). In 2018, the total production of Nile tilapia in the Kendal Regency was approximately 142 tons, with a total value of Rp. 2,342,385 (Statistics of Jawa Tengah Province, 2018). However, the saline red tilapia aquaculture in Kendal Regency has yet to develop because of the low growth of the fish and the use of traditional or extensive methods with high production costs. In addition, the use of standard fish feed pellet, which contains 35% protein, 5% fat, 6–8% fiber, 13% ash, and 12% water, has not been efficient yet and has not been able to increase the fish's immune system. One of the alternative solutions to solve this problem is the supplementation of *Saccharomyces cerevisiae* into the feed.

Saccharomyces cerevisiae is a yeast or single-celled fungus microorganism widely found on ripe fruits and the bark of oaks. The yeast is round to an oval with 5–10 µm in size. The optimum temperature for *S. cerevisiae* culture condition is 30–35^{o}C. *S. cerevisiae* is one of the most commonly used yeast species in aquaculture to maintain the health of fish species. *S. cerevisiae* has higher amino acid contents, such as methionine and cysteine, which could enhance the immune response in several fish (Agboola et al., 2021). In addition, *Saccharomyces cerevisiae* can increase growth (Rawung & Manoppo, 2014), enzyme activities in the digestive system (Tewary & Patra, 2011), feed and protein digestibility to improve feed efficiency (Manoppo & Kolopita, 2015), protein digestibility, the efficiency of feed utilization and growth (Rachmawati et al., 2019a; Rachmawati et al., 2019b) and disease resistance of the fish (Sheikhzadeh et al., 2012). Moreover, *S. cerevisiae* can produce peptidase, protease, and amylase, and the availability of these enzymes in the fish's digestive system can raise enzyme activities. Therefore, it can boost the breakdown of complex nutrients into a simpler forms of the nutrient. As a result, feed nutrients can easily be absorbed by the fish's digestive system (Sitohang et al., 2012).

The supplementation of *S. cerevisiae* in the feed improved non-specific immune response and growth (Sheikhzadeh et al., 2012). In addition, the supplementation of *S. cerevisiae* in the feed could increase the growth, immune system, and disease resistance of *Oncorhynchus mykiss*. Rachmawati et al. (2019a) and Rahmawati et al. (2019b) also reported that the *S. cerevisiae*-supplemented feed could increase growths and survival rates of *Pangasius hypothalamus* and *Barbonymus gonionotus*. Abdel-Tawwab et al. (2010), Abu-Elala et al. (2013), and Manoppo and Kolopita (2016) suggested that the *S. cerevisiae*-supplemented feed can boost non-specific immune response and growth of tilapia (*Oreochromis niloticus*).

Meanwhile, the information on the *S. cerevisiae* incorporated feed for saline red tilapia was scarce. The red saline tilapia cultivation in Kendal Regency has yet to be maximally developed because of the high mortality. The availability of good feeding with a great impact on fish performance is needed to improve the poor aquaculture condition in Tilapia fish. The study of the effect of *S. cerevisiae* on the growth performance of saline red tilapia is still needed. Therefore, the present study aims to examine the growth, survival rate, and blood of saline red tilapia (*Oreochromis* spp.) in a semi-intensive culture.

MATERIALS AND METHODS

Fish Sample

This study was conducted from January until March 2021. The saline red tilapia with an average weight of 4.58±0.09 g/fish was obtained from the fish farmer association of saline red tilapia in the Village of Pidodo Kulon, Palebon Sub-district, Kendal Regency, Central Java, Indonesia. The fish were selected based on uniformity, defect-free, high activity level, and healthy. Fish were then acclimated in 1 m^3 of 15 floating cages and fed for seven days. The temperature was 26–32°C during the experimental period. The dissolved oxygen, pH, NH_3 concentration, and salinity were 4.46–4.95 mg/l, 7.5–7.53, 0.002%, and 20 ppt, respectively. After acclimation, the fish fasted for one day to rest their digestive organs and detoxification (Rachmawati et al., 2017).

Feed Preparation with *S. cerevisiae* as Diet Supplement

The standard fish feed (Infiniti, Cargill™) was a commercial pellet purchased from PT. Cargill Indonesia, Pasuruan, East Java, Indonesia. *S. cerevisiae* was purchased from Indrasari Chemical Store, Semarang, Central Java, Indonesia. The standard fish feed was a pellet containing 35% protein, 5% fat, 6–8% fiber, 13% ash, 12% water content, and 272.56 Kcal DE/kg (Rachmawati et al., 2018). The standard feed was supplemented with *S. cerevisiae* in various doses, including 0 g/kg feed (A), 5 g/kg feed (B), 10 g/kg feed (C), 15 g/kg feed (D), and 20 g/kg feed (E). The doses of *S. cerevisiae* were chosen based on Razak et al. (2017). First, *S. cerevisiae* was weighed and thoroughly mixed with 100 ml sterilized water. Then, the mixture was sprayed onto the feed. The dried *S. cerevisiae* incorporated feed was bagged using plastic bags and stored at 4^{o}C (Manoppo & Kolopita, 2015). The proximate method was used based on the Association of Official Analytical Chemists to analyze the nutrient contents in the feed, including protein (%), fat (%), Nitrogen Free Extract (NFE) (%), energy (kcal), and ratio E/P (AOAC, 2019). The results of the proximate analysis are displayed in Table 1.

Table 1
The results of the proximate feed analysis

Parameter	Treatments				
	A	B	C	D	E
Protein (%)	30.00	31.13	32.09	31.53	31.23
Fat (%)	10.76	10.64	10.66	10.53	10.53
Nitrogen Free Extract (NFE) (%)	34.34	34.34	34.40	34.50	34.50
Energy(kcal)	273.15	285.29	286.80	285.89	285.19
Ratio of Energy/protein (E/P)	9.10	9.16	9.21	9.22	9.13

Note. (A). 0 g/kg feed; (B). 5 g/kg feed, (C). 10 g/kg feed, (D). 15 g/kg feed, (E). 20 g/kg feed

Semi-Intensive Culture

The study was conducted in the fish farmer association of saline red tilapia in Pidodo Kulon, Palebon Sub-district, Kendal Regency, Central Java, Indonesia. The fish was cultivated in 1 m^3 of 15 floating cages. The saline tilapia was used at a density of 60 fish per m^2, with a total of 900 fish, with each cage filled with 60 red saline tilapia. Fifteen floating cages were assembled on the raft and randomly planted. Before cultivating the fish, the seawater as media culture was channeled into the pond until the salinity reached 20 ppt and 85 cm depth. The growth and water quality observation was conducted every seven days. The fish was fed at a fixed feeding rate of 3%/biomass fish weight/day. In addition, the fish were fed with experimental feed three times per day for 49 days.

Observed Parameters

The efficiency of feed utilization (EFU), the feed conversion ratio (FCR), the protein efficiency ratio (PER), the relative growth rate (RGR), and the survival rate (SR) were calculated based on Equations 1 to 5:

EFU = 100 (final weight-initial weight/the amount of feed consumed) (1)

$$RGR = 100(W_t - W_0)/(W_0 \times T) \quad (2)$$

Where Wo and Wt are the initial and final weight, respectively, and T is the number of days in the feeding period.

FCR = 100 [feed intake (g)/weight gain (g)] (3)

PER = 100 [weight gain (g)/protein intake (g)] (4)

SR = 100 (final count/initial count) (5)

The blood profile of saline red tilapia (hematocyte, hemoglobin, erythrocyte, and leukocytes) was analyzed based on Mohammed et al. (2013).

Water Quality

The water quality was evaluated based on the previous method by Rachmawati et al. (2019a). The observation of the water quality included physical and chemical characteristics of the water. The water temperature was examined based on the method of HANNA: HI. 8633. pH, dissolved oxygen, ammonia content, and salinity were observed using Jenway 3510, Jenway 970, American Water Works Association, and refractometer (ATAGO S-10, Japan) (APHA, 2017).

Data Analysis

The study was an experimental method with a completely randomized design with five treatments and three repetitions in each treatment. Data were analyzed using analysis of variance (ANOVA) and then tested using the Duncan test (Steel et al., 1996). $P<0.05$ was used as a statistical difference. A polynomial orthogonal test was used to examine the optimum doses of *S. cerevisiae*. Data analysis was performed using Maple v. 12.0. The water quality was descriptively explained.

RESULTS AND DISCUSSION

The supplementation of *S. cerevisiae* at a dose of 5–20 g/kg feed (group B–E) resulted in higher values of EFU (60.73–85.13%) than in group A (50.27%) (Table 2). The increase in EFU values was due to the supplementation of *S. cerevisiae* which could increase the efficiency of feed utilization of saline red tilapia. The suggested process was as follows: first, *S. cerevisiae* increased digestive enzyme activities. The enzyme activities could break down the complex feed into a simpler form. The simpler nutrients were easier to absorb, and it could increase the efficiency of feed utilization. The addition of bread yeast (*S. cerevisiae*) in the feed could increase the feed digestibility of *Cyprinus carpio* L (Razak et al., 2017). *Saccharomyces cerevisiae* also can be used as a growth promoter and immunomodulator in *Labeo rohita* (Ham.) fish (Tewary & Patra, 2011). Manoppo and Kolopita (2016) also revealed that bread yeast (*S. cerevisiae*) could increase the resistance of Carp (*Cyprinus carpio* L) against *Aeromonas hydrophila*. Therefore, *S. cerevisiae* can improve the feed efficiency and the better growth of the fish.

Table 2
The results of the efficiency of feed utilization (EFU), the feed conversion ratio (FCR), the protein efficiency ratio (PER), the relative growth rate (RGR), the survival rate (SR), of saline red tilapia

Parameters	Treatments				
	A	B	C	D	E
Initial weight (g)	4.58±0.09[a]	4.35±0.07[a]	4.43±0.15[a]	4.52±0.06[a]	4.48±0.04[a]
Final weight(g)	40.27±0.17[e]	62.27±0.24[c]	88.69±0.15[a]	73.19±0.15[b]	55.37±0.12[d]
EFU (%)	50.27±0.48[d]	62.67±0.59[c]	85.13±0.17[a]	73.49±0.64[b]	60.73±0.59[c]
FCR	2.23±0.14[e]	2.05±0.18[d]	1.42±0.31[a]	1.96±0.29[b]	2.19±0.27[c]
RGR (%)	2.15±0.36[d]	2.36±0.21[c]	4.53±0.29[a]	3.53±0.46[b]	2.57±0.38[c]
PER	2.04±0.46[c]	2.58±0.28[b]	3.76±0.23[a]	2.93±0.24[b]	2.37±0.13[b]
SR (%)	68.33±2.64[d]	78.42±2.75[c]	97.53±2.29[a]	82.33±2.35[b]	73.33±247[c]

Note. (A). 0 g/kg feed; (B). 5 g/kg feed, (C). 10 g/kg feed, (D). 15 g/kg feed, (E). 20 g/kg feed. EFU: efficiency of feed utilization, FCR: feed conversion ratio, PER: protein efficiency ratio, RGR: relative growth rate, SR: survival rate. Values with the same superscript in the column show insignificant

The highest value of EFU was observed in group C (85.13%), followed by group D (73.49%), B (62.67%), E (60.73%), and A (50.27%) (Table 2). Therefore, the supplementation of *S. cerevisiae* in the feed at 10 g/kg (group C) resulted in the highest value of EFU. Therefore, it was suggested that the dose was the effective amount of *S. cerevisiae* to boost the efficiency of feed utilization. Welker et al. (2007) stated that *S. cerevisiae* could improve enzyme production in the digestive system and then raise digestibility, nutrient absorption, and efficiency of feed utilization. Abdel-Tawwab et al. (2010) revealed that supplementing an *S. cerevisiae*-enriched diet for six weeks could improve feed utilization and increase serum glucose, lipids, and protein of Galilee tilapia (*Sarotherodon galileaus*). Rachmawati et al. (2019a) also demonstrated that the addition of *S. cerevisiae* in the feed affected the specific growth rate (SGR), apparent digestibility coefficient of protein (ADCp), and survival rate (SR) of the *Pangasius hypothalamus.* Figure 1 showed that the relationship between the *S. cerevisiae* supplementation and EFU was in a quadratic pattern with $Y = -0.2412x^2 + 5.4588x + 48.05$ and $R^2 = 0.8621$. Therefore, the optimum dose of *Saccharomyces cerevisiae* supplementation in the feed was 10 g/kg, resulting in the highest value of EFU (85.13%).

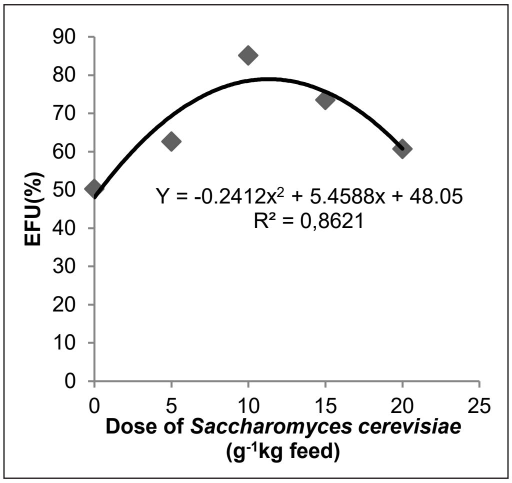

Figure 1. The relationship between the *S. cerevisiae* supplementation in the feed and (efficiency of feed utilization) EFU of saline red tilapia

The results showed that the *S. cerevisiae* enriched feed significantly ($P<0.05$) influenced on FCR of saline red tilapia.

According to Abu-Elala et al. (2013), *S. cerevisiae* contained mannaoligosaccharidae that could increase the feed conversion ratio in *Oreochromis niloticus.* The extract of *S. cerevisiae* wall is a natural immunostimulant and catalysator for growth (Abu-Elala et al., 2013). Table 2 showed that the lowest value of FCR was found in group C (10 g/kg feed), with a value of 1.42, followed by groups D (1.96), B (2.05), E (2.19), and A (2.23). The low value of FCR in group C (10 g/kg feed) was thought that the dose was the right amount of *S. cerevisiae* to support the optimum efficiency of feed utilization and decreased the value of FCR. The saline red tilapia fed with the dose of 10 g/kg feed (group C) had the highest value of EFU and the lowest value of FCR (Table 1).

Abdel-Tawwab et al. (2010) and Razak et al. (2017) revealed that *S. cerevisiae* enriched feed could increase feed efficiency and decreases feed conversion ratio. Moreover, Tovar et al. (2002) showed that *S. cerevisiae* in the feed caused a decrease in the feed conversion ratio. The low value of FCR and the increase of EFU showed that the fish could effectively and efficiently use the feed to grow. The values of FCR determined the effectiveness of the feed that is inversely proportional to the value of EFU. Goda et al. (2012) revealed that the growth performance and feed utilization efficiency of Nile tilapia (*Oreochromis niloticus*) fingerlings were increased after receiving *S. cerevisiae.* Figure 2 indicates the quadratic relationship between *S. cerevisiae* supplementation and FCR was $Y= 0.0057x^2 – 0.1171x + 2.2883$ and $R^2= 0.6724$. The optimum dose of *S. cerevisiae* from the equation could be calculated as 10 g/kg feed with an FCR value of 1.42.

The saline red tilapia fed supplemented with *S. cerevisiae* at 5-20 g/kg feed had higher values of PER (2.37–3.76) than 0 g/kg feed (1.96). The supplementation of *S. cerevisiae* in the feed significantly ($P<0.05$) affected PER. It was indicated that *S. cerevisiae* could boost the digestibility of the protein and the maximum feed utilization influenced the protein efficiency ratio. The highest value of PER (3.76) was obtained in group C (10 g/kg feed), which indicated that the dose was the effective dose of *S. cerevisiae* to increase protein digestibility and efficiency of feed utilization. Abdel-Tawwab et al. (2010) reported that *S. cerevisiae* improved the growth performance and resistance to Copper (Cu) addition by increasing PER and EU (energy utilization). This effect on tilapia growth and feed utilization might be caused by spermine and spermidine produced and released by yeast in the fish digestive tract.

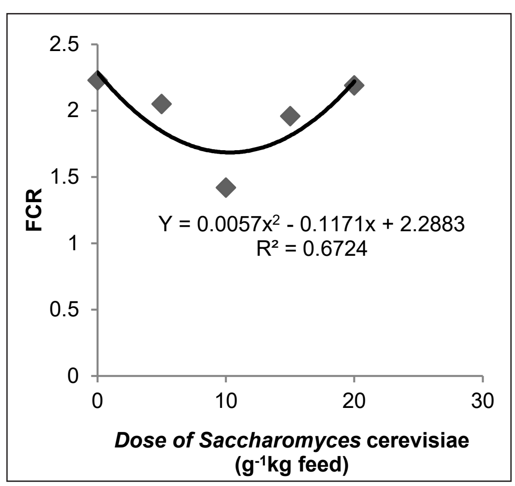

Figure 2. The relationship between the *S. cerevisiae* supplementation in the feed and feed conversion ratio (FCR) of saline red tilapia

This compound could increase the proliferation and regeneration of gut tissue. Moreover, Abu-Elala et al. (2013) stated that *S. cerevisiae* produced protease enzymes to improve the protein efficiency ratio and inhibit the bacterial toxin. Tovar et al. (2002) compared the use of *Debaryomyces hansenii* (yeast from the fish gut) and *S. cerevisiae* to improve fish digestive enzyme activity in sea bass (*Dicentrarchus labrax*) larvae. The supplementation of *S. cerevisiae* X2180 did not trigger gut maturation in sea bass compared with *D. hansenii* because *S. cerevisiae* produces a low polyamine than *D. hansenii* (Tovar et al., 2002).

Figure 3 showed that the relationship between the supplementation of *S. cerevisiae* in the feed and PER was in the quadratic form: $Y = -0.012x^2 + 0.2608x + 1.9326$; $R^2=0.7913$. The optimum dose of *Saccharomyces cerevisiae* obtained from the equation was 10 g/kg feed with a PER value of 3.76%. The higher dose of *S. cerevisiae* (20 g/kg feed) exhibited a low weight gain, EFU, and a high FCR than other doses of *S. cerevisiae*. Therefore, this dose was not optimal for increasing the weight and decreasing the FCR value.

In our study, the supplementation of *S. cerevisiae* in the feed significantly ($P<0.05$) affected the RGR value. *S. cerevisiae* increased feed and protein digestibility and the protein efficiency ratio, which supported the growth of the saline red tilapia. Manoppo and Kolopita (2015) claimed that 10 kg of *S. cerevisiae* could improve the growth of Nile Tilapia by increasing weight gain. At the same time, Rajagukguk et al. (2017) revealed that the highest growth of Nile Tilapia was found in fish fed with 20% of yeast. Furthermore, 2% of *S. cerevisiae* supplementation improved growth performances and food efficiency ratio in three-spot cichlid fish (*Cichlasoma trimaculatum*) (Mohammadi et al., 2016).

The saline red tilapia fed with the dose of 10 g/kg feed (group C) had the highest value of RGR (4.53%/day), followed by the group D (3.53%/day), E (2.57%/day), B (2.36%/day) and A (2.15%/day). The 10 g/kg feed (group C) was an effective dose of *S. cerevisiae* to increase digestive enzyme activities; therefore, the feed digestibility and efficiency of feed utilization were optimum to support fish growth. Moreover, the protein content in group C (10 g/kg feed) was higher (32.09%) than in group D (31.53%), E (31.23%), B (31.13%), and A (30%). Thus, the need for protein could be fulfilled for the saline red tilapia growth. Adding *S. cerevisiae* to the feed increased the feeding pattern, improving growth and feed. Huyben et al. (2017) also reported that supplementing *S. cerevisiae*

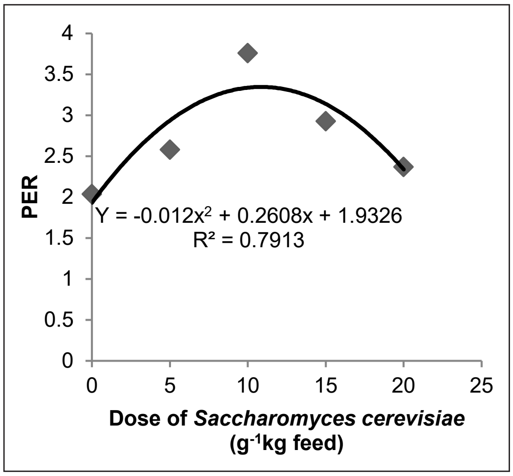

Figure 3. The relationship between the *S. cerevisiae* supplementation in the feed and protein efficiency ratio (PER) of saline red tilapia

and *Wickerhamomyces anomalous* was good for rainbow trout (*Oncorhynchus mykiss*) fish growth because it contains raw protein and amino acids to support fish growth and changed the fish gut microbiota. The study showed that the saline red tilapia fed with the dose of 10 g/kg feed (group C) had the highest values of RGR (4.53%/day), EFU (85.13%), and PER (4.53). Rawung and Manoppo (2014) revealed that the supplementation of 10 g of yeast cells/kg pellet for three weeks exhibited the highest total leukocyte and phagocytosis activity of Nile tilapia. Figure 4 showed that the relationship between the *S. cerevisiae* enriched feed and RGR was quadratic: $Y = -0.0157x^2 + 0.3551x + 1.8389$; $R^2 = 0.6538$. From the equation, the optimum dose of *S. cerevisiae* was 10 g/kg feed with the RGR value of 4.53%/day.

The supplementation of *S. cerevisiae* in the feed significantly ($P<0.05$) affected the survival rate of the saline red tilapia. Table 2 demonstrated that the saline red tilapia fed with *S. cerevisiae* had higher survival rates (78.42–97.53%) than without adding *S. cerevisiae* (68.33%). The saline red tilapia fed with 10 g/kg feed of *Saccharomyces cerevisiae* (group C) had the highest survival rate. It was suggested that group C exhibited the highest resistance to the disease compared to other treatments. *Saccharomyces cerevisiae* contained β-glucan as an immunostimulant that can improve the immune system in the fish; therefore, the fish was disease-prone and had a high survival rate (Manoppo & Kolopita, 2015). β-glucan could increase the phagocytosis of granulocytes, macrophages, and dendritic cells, which plays a role as effector cells against the pathogen (Rodrigues et al., 2020). The relationship between the *S. cerevisiae* supplementation in the feed and SR of saline red tilapia was in the quadratic form: $Y = -0.2071x^2 + 4.4205x + 66.85$: $R^2 = 0.7959$ (Figure 5). The optimum dose of *Saccharomyces cerevisiae* from the equation was 10 g/kg feed with an SR value of 97.53%.

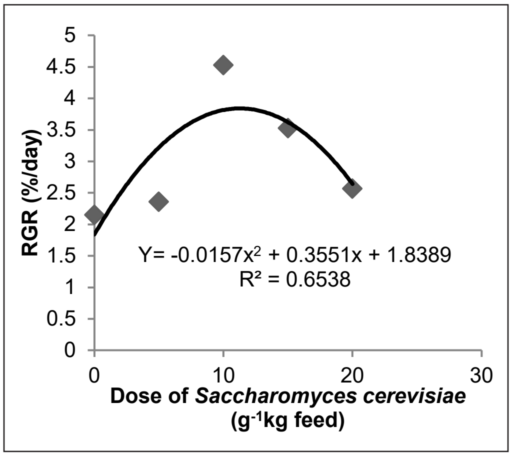

Figure 4. The relationship between the *S. cerevisiae* supplementation in the feed and relative growth rate (RGR) of saline red tilapia

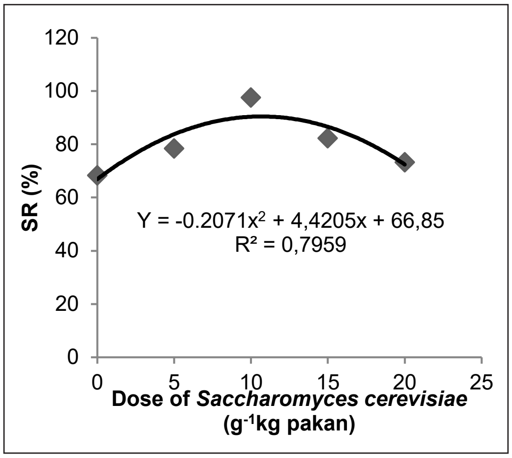

Figure 5. The relationship between the *S. cerevisiae* supplementation in the feed and survival rate (SR) of saline red tilapia

Table 3 indicated that the saline red tilapia fed with the supplementation of *S. cerevisiae* in the feed had higher values of Hematocyte (%), Hemoglobin (G%), Erythrocyte (cell/mm^3), and Leukocyte (cell/mm^3) compared to the fish fed without supplementation. Abu-Elala et al. (2013) revealed that the saline red tilapia fed with *S. cerevisiae* incorporated feed for two months could significantly increase the amount of erythrocyte, hemoglobin, and leukocytes in the *O. niloticus* (Abu-Elala et al., 2013). Furthermore, adding *S. cerevisiae* to the catfish feed for one week exhibited high amounts of red and white blood cells compared to feeding without *S. cerevisiae* (Welker et al., 2007). Enhancing leukocytes is important to recognize and eliminate pathogens in fish bodies. The major action of β-glucan contained in yeast could increase the proliferation of leukocytes, including neutrophils, monocytes, natural killer cells, and macrophages. This action is mediated by binding activity between β-glucan with a specific receptor in the membrane of leukocytes (Dectin-1 and CR3), promoting T cell activation and antibody production by B cells. The binding between β-glucan and their receptor also resulted in ROS and NO production, which then enhanced the destruction of pathogenic agents (Rodrigues et al., 2020). Other studies revealed that using prebiotic mannan oligosaccharide (MOS) and *Bacillus subtilis*, isolated or combined (synbiotic), could improve growth performance, body index, intestine morphometry, and carcass composition in Nile tilapia (de Azedevo et al., 2016).

Table 3
Blood profiles of saline red tilapia after receiving S. cerevisiae *in their feed*

Parameters	Treatments				
	A	B	C	D	E
Hematocyte (%)	29.15^b	34.68^a	35.96^a	34.14^a	34.52^a
Hemoglobin (%)	12.05^b	12.98^a	13.58^a	12.73^a	12.67^a
Erythrocyte (cell/mm^3)	$1.95 \times 10^{6\,a}$	$2.95 \times 10^{6\,b}$	$3.25 \times 10^{6\,c}$	$3.05 \times 10^{6\,b}$	$3.07 \times 10^{6\,b}$
Leukocyte (cell/mm^3)	87.537^a	153.875^b	155.012^d	154.959^c	153.528^b

Note. (A). 0 g/kg feed; (B). 5 g/kg feed, (C). 10 g/kg feed, (D). 15 g/kg feed, (E). 20 g/kg feed. Values with the same superscript in the same row show insignificant

Table 4
Water quality parameters on the saline red tilapia culture

Treatment	Water Quality				
	Temperature (^{o}C)	pH	Dissolve Oxygen (DO) (mg/l)	NH_3 (%)	Salinity (ppt)
A	26 - 32	7.50 - 7.53	4.46 - 4.95	0.002 - 0.002	20
B	27 - 32	7.34 - 7.48	4.27 - 4.76	0.002 - 0.002	20
C	28 - 31	7.36 - 7.50	4.37 - 4.83	0.002 - 0.002	20
D	27 - 32	7.35 - 7.49	4.48 - 4.92	0.002 - 0.002	20
E	27 - 31	7.29 - 7.38	4.35 - 4.87	0.002 - 0.002	20

Note. (A). 0 g/kg feed; (B). 5 g/kg feed, (C). 10 g/kg feed, (D).15 g/kg feed, (E). 20 g/kg feed

The observation of water quality parameters during the study is demonstrated in Table 4. The results showed that all water quality parameters, including temperature, pH, Dissolve Oxygen (DO), NH3, and salinity, were stable for the saline red tilapia culture during the study (Table 4). Therefore, it was indicated that water quality was still viable for the red tilapia in semi-intensive culture.

CONCLUSION

The results showed that the supplementation of 10 g/kg *S. cerevisiae* in the feed exhibited the highest EFU, PER, and RGR and decreased FCR, which supported the high survival rate of the saline red tilapia. Therefore, *S. cerevisiae* can be used as a feed supplement for red tilapia fish to increase the growth, survival rate, and blood profile of the saline red tilapia. In addition, *S. cerevisiae* has improved feed utilization by reducing the food necessary for animal growth and decreasing production costs.

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