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Dietary Vitamin E Potential on Growth Performance, Protein Efficiency Ratio, Liver Biochemical Status, and Rearing Media Water Quality Optimization in Male Mono-sex of the Nile Tilapia (*Oreochromis niloticus*)

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ABSTRACT

Under saline conditions, the ionic balance between the environment and the body of the Nile tilapia must be maintained, and this can be supported through dietary supplementation of vitamin E, which inhibits the release of free radicals. This study aimed to analyze the effect of dietary vitamin E supplementation and determine the optimal dose for improving growth performance, protein utilization efficiency, biochemical status, and survival of the Nile tilapia fry reared in a male monosex culture system over a 60-day period. The study used a completely randomized design with four treatments: Control (A), 50 mg/kg diet (B), 100 mg/kg diet (C), and 150 mg/kg diet (D), each with four replications. The Nile tilapia fry were stocked at a density of 1 fish/L with an initial biomass of 0.89 ± 0.00 g. All data were analyzed using analysis of variance (ANOVA), followed by the least significant difference (LSD) test. The results showed that the highest values for relative growth rate, survival rate, feed efficiency, and feed conversion ratio were observed in treatment D, which was significantly different ($P < 0.05$) from the other treatments. The best dose of vitamin E supplementation was found to be 150mg/ kg diet, as it resulted in the highest average relative growth rate (19.26 ± 0.87%) and survival rate (92.50 ± 2.89%). These parameters were positively correlated with liver biochemical conditions, as reported in this study.

INTRODUCTION

The Nile tilapia (*Oreochromis niloticus*) is one of the prospective fishery commodities in Indonesia, due to its relatively fast growth rate **(Rahman *et al.*, 2021; Anonymous, 2023; Poernomo, 2025)** and high adaptability to environmental change **(*Baring et al.*, 2022)**, making it easier to be cultured further **(Supardan *et al.*, 2023)**. Worldwide, Indonesia is the second-largest producer of the Nile tilapia after China, with a total production of 1,171,698 trillion in 2018, contributing up to 25% of the total national aquaculture production **(FAO, 2020; Gustiano *et al.*, 2023)**. The Nile tilapia is an omnivorous fish that responds quickly to various feeds **(Bonham, 2022)**. It is also highly tolerant of saline water, thus capable of surviving in brackish water conditions **(Rusidi *et al.*, 2022)**.

One of the Nile tilapia varieties developed from freshwater species, allowing it to tolerate high salinity levels, is the saline Nile tilapia. This strain can withstand water salinity of around 0–40 ppt **(Diego *et al.*, 2023)** by utilizing its euryhaline characteristics. The saline Nile tilapia has become a promising option due to its high adaptability and rapid growth rate **(Azis & Barades, 2021)**. Other advantages include a high survival rate, low feed conversion ratio, and abundant seed availability **(Fahrurrozi, 2024)**. Its prolific egg production from broodstock spawning also facilitates a high supply of seeds for culturists **(Ariadi *et al.*, 2024; Linayati *et al.*, 2024)**.

A widespread habitat distribution and broad salinity tolerance certainly influence the physiological processes of the saline Nile tilapia **(Zuib *et al.*, 2024)**. These changes include growth disturbances and productivity levels, which are consequences of disrupted homeostasis mechanisms within the body **(Angadi, 2024; Li *et al.*, 2024)**. Therefore, tolerating high salinity levels **(Song *et al.*, 2021)** should be combined with dietary supplementation of antioxidants.

Various natural and synthetic antioxidants have long been supplemented in fish diets to minimize oxidative stress. For example, α-lipoic acid at 0.8 g/kg diet, either in coated diets **(Rifai *et al.*, 2022a)** or formulated diets **(Rifai *et al*., 2022b)**, accelerated growth performance in the striped catfish (*Pangasianodon hypophthalmus*). Moreover, vitamin C at 300mg/ kg diet enhanced growth performance in Vaname shrimp (*Litopenaeus vannamei*) **(Rifai *et al*., 2025c)**. In addition to α-lipoic acid and vitamin C, another synthetic antioxidant that can also be utilized is vitamin E. This vitamin mitigates free radical exposure, thereby optimizing growth performance and survival rates in the Nile tilapia **(Xia *et al.*, 2024)**.

Vitamin E is one of the essential components required for fish growth **(Rahman *et al.*, 2023)**. It also serves as an antioxidant, particularly for optimizing antioxidant capacity and enhancing feed utilization **(Alybeigi *et al.*, 2025)**. Furthermore, vitamin E optimizes feed energy utilization to maximize protein retention in body tissues **(Ebi *et al.*, 2024)**. Several studies have reported that vitamin E deficiency in feed can inhibit aquatic animal performance, leading to weight loss, low protein efficiency ratio, and high feed conversion **(He *et al.*, 2017)**. Catfish require relatively high levels of vitamin E to support growth **(Jr Serrano *et al.*, 2022)**. Accordingly, dietary supplementation of vitamin E at 50– 100mg/ kg diet has been shown to enhance growth performance and improve intestinal structure and function in catfish **(He *et al.*, 2017)**.

However, further information regarding the effects of vitamin E dietary supplementation on the growth performance of the saline Nile tilapia cultured in a mono-sex male system is limited, thus making it necessary to conduct a study on this topic.

MATERIALS AND METHODS

1. Location and period

This research was conducted at the Teaching Farm Laboratory of the Department of Fisheries Cultivation, Pangkajene Islands State Agricultural Polytechnic, from February to May 2024. The activities consisted of feed formulation, tilapia maintenance for 60 days, sample preparation, biochemical analysis, and water quality analysis for 90 days.

2. Diet preparation

The diets, consisting of manufactured pellet feed (30% protein), were supplemented with vitamin E according to the treatment levels applied per 1kg of feed. Before supplementation, vitamin E was first mixed with 30g of egg whites, 0.9g of egg yolk, and 100ml of water, then homogenized using a blender to produce a suspension. This suspension was evenly coated onto the feed, which was then dried under medium light intensity and stored in an airtight container before being administered to the fish.

3. Experimental design

This study employed a completely randomized design (CRD) by applying different dietary supplementation doses of vitamin E as treatments. According to **He *et al.* (2017)**, supplementing diets with vitamin E at 50 and 100mg/ kg has been shown to improve growth performance and intestinal structure and function in the catfish. Based on this, the treatment doses were determined as follows:

- **A**: No dietary supplementation of vitamin E (control)
- **B**: 50 mg/kg diet of vitamin E
- **C**: 100 mg/kg diet of vitamin E
- **D**: 150 mg/kg diet of vitamin E

Each treatment was replicated four times, resulting in a total of 16 experimental units.

4. Fish rearing

The 5-cm saline Nile tilapia seeds as test objects were obtained from breeding center in Maros, South Sulawesi. Subsequently, each fish was validated as male to provide the mono-sex culture system by inspecting the oval-shaped genital openings near the urogenital region. The Nile tilapia seeds were acclimatized with 5ppm of seawater, followed by saline concentrations of 10ppm and a high concentration of 25ppm. After adaptation, the seeds were graded at 15 individuals/L of water, with a standard deviation for all replications consistently at 0.00-0.02. Grading was performed under anaesthetic condition by immersing the fish in 0.3 ml/L clove oil solution **(Rifai *et al*., 2022)**. Fish were reared for 60 days. During the study, fish were sampled and graded to assess the average weight gain.

Fish seeds were fed with the supplemented diets, following the treatments applied. Feeding was performed twice a day in the morning and afternoon until apparent satiation. The total diet supply was recorded to obtain the feed conversion ratio value on the final rearing period.

Water quality management, including regular water changes, was conducted throughout the 60-day maintenance period. Siphoning was carried out daily after 6 hours of afternoon feeding. Water changes were carried out every 3 days after feeding, with a 75% water change.

5. Growth performance and survival rate

At the final rearing period, the Nile tilapia biomass was weighed using a Sartorius digital scale with an accuracy of 0.00 grams - 5.00kg, and survival rates were calculated. Before sampling, the fish were fasted for 24 hours and anesthetized using 0.025ml/ L clove oil solution **(Rifai *et al*., 2022a; Rifai *et al*., 2022b)**.

The survival rate of tilapia was calculated using the formula:

$$\text{SR}\ (\%) = \frac{Nt)}{No}\ x\ 100$$

SR = Survival Rate (%)

Nt = Number of fish surviving at the end of the maintenance period

No = Number of fish seeds released at the beginning of the maintenance period.

Growth performance was evaluated based on the specific growth rate (SGR), protein efficiency ratio (PER), and feed conversion ratio (FCR).

$$SGR\ (\%) = \sqrt{\frac{(Wt - W0)}{t}}\ x\ 100$$

Note : SGR = Specific growth rate (%)

Wt = Final average fish weight (g)

W0 = Initial average fish weight (g)

The protein efficiency ratio was calculated to determine the relationship of weight gain and the amount of consumed protein, using the following formula:

$$PER = \frac{\text{Wt} - \text{W0}}{\text{KPP x FI}}$$

Note :

PER = Protein efficiency ratio

Wt = Final fish biomass weight (g)
W0 = Initial fish biomass weight (g)
KPP = Protein content in diets (%)
FI = Feed intake (g)

The diets given was recorded throughout the rearing period. The feed intake (FI) was determined by weighing the diets given minus the amount of uneaten diet. Feed conversion ratio was calculated using the formula **(Tacon, 1987)**:

$$FCR = \left(\frac{F}{Wt + Wd - W0}\right)$$

Note : FCR = Feed conversion ratio
F = Feed intake (g)
Wt = Final fish biomass weight (g)
Wd = Dead fish weight (min. after 2 weeks of rearing) (g)
W0 = Initial fish biomass weight (g).

6. Liver biochemical analysis

The oxidative response was evaluated based on the superoxide dismutase activity (SOD), malondialdehyde (MDA), liver fat levels and hepatosomatic index (HSI) values. In this analysis, the clove oil dosage used was 0.1ml per 1 liter of water (the anesthetic dose required to kill tilapia) **(Rifai *et al*., 2022a, b)**.

The analysis of MDA enzyme levels was based on the method of **Conti *et al.* (1991)**, based on the thiobarbituric acid test. Initially, liver samples were removed from the stomachs of anesthetized tilapia, weighing 0.5-1 gram. Fresh liver samples were ground in a test tube using LDPE plastic filled with dry ice. A 1mL phosphate buffer saline (PBS) solution containing 11.5g L-1 KCl and a pH of 7.4 was stirred thoroughly until the liver color changed from red to pale red. The grinding process was stopped when the liver and PBS solution were homogeneous. Next, the homogenate was centrifuged at 10,000 rpm for 20 minutes. A total of 0.5mL of clear supernatant was added with two mL of a mixture solution containing 2.23mL of concentrated HCl, 10g of TCA (ticoloacetic acid), and 0.38% of TBA (thiobarbituric acid) added with 100mL of distilled water. The mixture was incubated at 80°C for one hour. After cooling, the mixture was centrifuged at 3000 rpm for five minutes. The supernatant was poured into another tube to read its absorbance with a spectrophotometer at a wavelength of 532nm. TMP (tetramethoxypropane) was used as a standard solution. Determination of MDA levels was determined by the regression equation of MDA standard solutions made at concentrations of 0,1,2,3,4,5,10,20,40,80 µmol/L with reference to the formula:

$$\text{MDA (nmol/g protein)} = \text{A (nmol/g)} \times 5\ \text{mL}/500\ \text{mg (ww)}.$$

The SOD analysis was carried out referring to **Misra and Fridovich (1972)**. One g of finely chopped tilapia liver was added with two mL of phosphate buffer pH 7.4 and made into a homogenate using a tissue grinder, centrifuged at 10,000 rpm for 20 minutes. The supernatant (I) was poured into a polyethylene tube and SOD was tested. 0.25mL of the formed supernatant was taken into a tube, 0.4mL of a mixture of chloroform and ethanol (3:5) was added, and centrifuged at 3,000 rpm for 10 minutes. Supernatant (II) was taken as 100µL, added with 3mL of carbonate buffer pH 10.2 at 30°C, and 100 µL of SOD was determined by adding 100µL of epinephrine (0.05 mg in 10mL of 0.01 N HCl). The inhibition was measured using the following formula:

$$\text{SOD (Units/Ml Enzyme)} = \%\ \text{inhibition} \times 10\ \text{(dilution)} / 0.5 \times 0.1.$$

Sample readings were taken on a spectrophotometer at a wavelength of 480nm five times at minutes 0, 1, 2, 3, and 4. The resulting absorbance changes were used for calculations. The blank used 100µL of distilled water, three mL of carbonate buffer, and 100µL of epinephrine.

The hepatosomatic index (HSI) was calculated based on the total weight of the Nile tilapia and liver weight of the Nile tilapia. The HSI value was calculated using the following formula:

$$HSI = \frac{\text{Fish liver weight}}{\text{Total fish weight}}$$

The liver fat content analysis referred to **Watanabe (1988)**. 0.5g of liver organ (C) was added with 30ml of chloroform-methanol solution and incubated in a fat flask for 24 hours with the addition of $MgCl_2$. Next, the liver fat extract was removed slowly by opening the flask tap and collected in a fat flask whose initial weight was known (B). Next, the fat flask was evaporated so that the crude fat extract attached to the fat flask was visible and the evaporation was stopped. The fat flask was then placed in an oven for 10 minutes and placed in a desiccator jar for 10 minutes, before weighing (A). The liver fat content was determined using the formula:

$$\text{Liver fat} = \frac{A - B}{C} \times 100$$

7. Water quality

Water quality measurements included temperature, DO, pH, salinity, and ammonia. Temperature was measured daily, in the morning, afternoon, and evening using a thermometer. pH was measured using a pH meter, and salinity was measured using an Atago Hand Refractometer, each nine times during the maintenance period: three at the beginning, three in the middle, and three at the end. Ammonia and dissolved oxygen measurements were conducted three times during the maintenance period: at the end of the 20th day, the middle of the 40th day, and the end of the 60th day. Ammonia and dissolved oxygen parameters were measured by taking water samples from the maintenance period and bringing them to the water quality laboratory for analysis using the Winkler method (dissolved DO) and the Phenate method (ammonia).

7.1. Procedure for dissolved oxygen measurement with the winkler method

a. The maintenance water was collected using a BOD bottle, ensuring no air bubbles were trapped.
b. Then, 1ml of manganese sulfate ($MnSO_4$) reagent and 1ml of alkali iodide (KI) solution were added.
c. The bottle was sealed and shaken until the solution was homogeneous and a precipitate formed. The precipitate was allowed to settle completely.
d. Next, 1ml of concentrated H_2SO_4 was added, the bottle was resealed, and shaken until the precipitate dissolved and the solution turned yellow.
e. A 25ml aliquot of the solution was pipetted into a 250ml Erlenmeyer flask.
f. The sample was titrated with 0.025N sodium thiosulfate ($Na_2S_2O_3$) solution until the solution became pale yellow. A few drops of starch indicator were then added, causing the solution to turn blue.
g. The titration was continued with sodium thiosulfate until the solution became colorless (clear).

$$\text{Calculation: DO (Mg/L)} = \frac{\text{Ml titrated x N titrated x 8 x 1000}}{\text{Ml Sample}}$$

7.2. Procedure for measuring ammonia levels using the phenate method

a. A standard series was prepared using NH_4Cl with concentrations of 0, 0.005, 0.01, 0.05, 0.1, 0.2, and 0.5ppm on a spectrophotometer.
b. The water samples from the rearing medium were filtered using Whatman No. 42 filter paper.
c. To each sample, 1ml of phenol solution was added and shaken, followed by the addition of 1ml of sodium nitroprusside solution and shaking again.
d. Then, 2.5ml of oxidizing solution (4:1) was added, the sample was covered, shaken, and left to stand for 1 hour.

e. Absorbance was measured using a spectrophotometer at a wavelength of 640nm, with distilled water as a blank.
f. Ammonia concentrations in the rearing water samples were calculated using a standard curve generated from the same procedure.

The recorded water quality parameters were then entered into Microsoft Excel and analyzed descriptively.

8. Data analysis

Before statistical analysis was conducted, all data (growth performance and liver biochemical profiles) were validated using the normality test. Then, a one-way ANOVA was applied to determine the significant difference in treatments on survival rate, relative growth rate, feed conversion ratio, and protein efficiency ratio. Furthermore, the Tukey's test was then performed to identify differences between treatment groups. All statistical analyses were conducted using *SPSS 26.0* for Windows.

RESULTS & DISCUSSION

1. Results

After 60 days of rearing, the results of growth performance and liver biochemical status of the saline Nile tilapia in the male mono-sex culture system are presented in Table (1). At the dietary supplementation level of 150mg/ kg of vitamin E, the highest final weight and specific growth rate values were observed, which corresponded to the lowest feed conversion ratio and the highest protein efficiency ratio, resulting in an optimal survival rate.

Table 1. Growth performance and liver biochemical status of the saline Nile tilapia in male mono-sex culture system after dietary supplementation of vitamin E

Parameter	Vitamin E dosage (mg/kg diet)			
	K	50	100	150
Initial fish weight biomass (g)	0.89 ± 0.00[a]	0.89 ± 0.00[a]	0.89 ± 0.00[a]	0.89 ± 0.00[a]
Final fish weight biomass (g)	7.14 ± 0.06[d]	7.71 ± 0.13[c]	8.21 ± 0.15[b]	8.63 ± 0.35[a]
SGR (%/day)	4.620±0.019[d]	4.791±0.038[c]	4.932±0.042[b]	5.040±0.089[a]
Protein Efficiency Ratio (PER)	1.67 ± 0.02[a]	1.86 ± 0.03[b]	2.25 ± 0.03[b]	2.55 ± 0.09[a]
Feed Conversion Ratio (FCR)	1.52 ± 0.01[d]	1.43 ± 0.01[c]	1.33 ± 0.02[b]	1.24 ± 0.04[a]
Survival Rate (%)	76.25± 2.50[c]	83.75 ± 4.79[b]	87.50 ± 2.89[b]	92.50 ± 2.89[a]
SOD (unit/mL enzyme)	79.93±17.82[b]	81.07±12.59[b]	96.65±17.42[ab]	118.84±14.20[a]
MDA (nmol/mg protein)	0.068±0.015[b]	0.044±0.004[a]	0.043±0.003[a]	0.035±0.001[a]
HSI	2.14±0.14[b]	1.41±0.19[a]	1.65±0.34[a]	1.39±0.27[a]
Fat Liver (%)	9.03±0.45[b]	8.24±0.64[b]	6.04±0.73[a]	5.31±0.20[a]

Note: Values are presented in average±standard deviation (Tukey *P*>0.05), SGR = Specific Growth Rarte; MDA = Malondialdehyde. SOD = Superoxide Dismutase; HSI = Hepatosomatic index.

Growth performance is highly correlated with antioxidative response and liver biochemical status of the Nile tilapia. This condition means that dietary supplementation of vitamin E at 150mg/ kg diet can reduce free radicals' exposure and elevate superoxide dismutase enzyme production.resulting in lower levels of MDA, liver fat and HSI.

2. Discussion

2.1. Growth performance

Increased vitamin E in diets could significantly increase the growth of the Nile tilapia (Table 1). This growth improvement reflects optimal nutrient utilization, characterized by increased intestinal height and mucosal thickness, and stimulates the digestive and absorptive capacity in fish **(Morales & Almeida, 2020; Wang *et al*., 2020; Torres *et al*., 2022)**. Furthermore, vitamin E could also improve protein efficiency ratio (REP) **(Saheli *et al*., 2021)** and feed conversion ratio (FCR), indicating that the fish utilize feed efficiently to promote growth **(Kotit *et al*., 2025)**. In addition, vitamin E can also be used as an antioxidant, especially to protect unsaturated fatty acids and phospholipids in cell membranes **(Treber & Bruno, 2020)**.

Deficient vitamin E induces excessive production of toxic lipid peroxides, leading to decreased weight gain and feed efficiency **(Niki, 2021)**. As an antioxidant, vitamin E enhances the ability of fish to cope with oxidative stress, thereby conserving energy for homeostasis **(El-Sayed & Izquierdo 2021)**. Thus, energy and protein can be optimized for growth and weight gain **(Radhakrishnan *et al.,* 2020)**. The results of this study indicate that dietary supplementation of vitamin E significantly increased growth rate, weight gain, and feed efficiency. Furthermore, supplementation at 150mg/ kg resulted in the best growth performance, emphasizing vitamin E's role in improving intestinal structure and function **(Torres *et al.,* 2022)**, as well as inhibiting oxidative stress to optimize protein and energy utilization for growth **(Kiyase, 2021)**.

The use of male Nile tilapia in this study was specifically based on their growth capacity and physiological tolerance to salinity, enabling more efficient feed utilization and better growth performance compared to females **(Felix *et al.*, 2019; Bardhan *et al.*, 2021)**. This finding is consistent with reports that the growth performance of the male Nile tilapia has a significant impact on weight gain **(Kembenya & Ondiba, 2021)**.

A supplementation dose of 150 mg/kg diet also significantly increased the protein efficiency ratio, confirming vitamin E's role as an antioxidant in protecting against oxidative stress **(Ebhohimen *et al.*, 2021)**. Oxidative stress occurs when fish are exposed to free radicals generated by metabolism or unstable environments **(Chowdhury & Saikia, 2019)**. By reducing oxidative stress, vitamin E helps maintain cell health, reduce unnecessary metabolic energy expenditure, and prevent protein breakdown for energy under stress conditions **(Traber, 2021)**. Consequently, vitamin E increases the efficiency of protein and energy utilization from the diet for growth. Similar improvements in protein efficiency ratio have been observed in the Nile tilapia with 100mg/ kg vitamin E supplementation and in the Caspian trout (*Salmo caspius*) at up to 78.8mg/ kg **(Saheli *et al.*, 2021; Rohani *et al.*, 2023)**.

The survival rate of the saline Nile tilapia was also improved at a dose of 150mg/ kg. This suggests that vitamin E enhances fish survival indirectly through various mechanisms, including maintaining physiological homeostasis during digestion and osmoregulation **(Rahman *et al.*, 2023)**. In contrast, vitamin E deficiency reduces antioxidant capacity, fat metabolism, and immunity in tilapia fry **(Qiang *et al.*, 2019)**. Vitamin E has further been reported to enhance specific immune responses, maintain meat quality **(Karjee *et al.*, 2023)**, and improve vascular health **(Kumar *et al.*, 2023)**.

Dietary supplementation of vitamin E also significantly reduced the feed conversion ratio (FCR) **(Fadhillah *et al.*, 2022)** by improving protein utilization and facilitating nutrient conversion into growth **(Joshi *et al.*, 2021)**. The lowest FCR was achieved at the 150mg/ kg diet treatment.

2.2. Liver biochemical status of the saline Nile tilapia

Growth performance was significantly influenced by vitamin E through its role in enhancing muscle development and affecting liver size **(Saheli *et al.*, 2021; Rohani *et al.*, 2023)**. As an antioxidant, vitamin E protects the liver, the primary site of detoxification, as indicated by the hepatosomatic index (HSI). Enlarged liver size observed in the control treatment (without vitamin E supplementation) reflected a higher detoxification load. Increased HSI values can be linked to elevated lipogenesis, reduced fatty acid oxidation, and imbalances in triglyceride transport from the liver to other tissues. Conversely, the 150 mg/kg vitamin E treatment supported a smaller liver size (lowest HSI value), indicating more efficient triglyceride hydrolysis and redistribution to muscle and adipose tissue **(Heeren & Scheja, 2021)**.

Antioxidant capacity, represented by malondialdehyde (MDA) levels, was the lowest in the 150mg/ kg treatment. This demonstrates that vitamin E supplementation alleviated oxidative stress **(Rifai *et al.*, 2022b)** by reducing the accumulation of reactive oxygen species in liver cells **(Rifai *et al.*, 2022a; Banerjee *et al.*, 2023)**. In contrast, lipid peroxidation in the control group led to cell membrane damage and MDA formation **(Su *et al*., 2019)**. Lower MDA levels corresponded with higher superoxide dismutase (SOD) activity, indicating greater antioxidant defense. Vitamin E supplementation at 150mg/ kg significantly elevated SOD activity compared to other treatments ($P< 0.05$, Table 1), highlighting its role in counteracting free radicals in the male Nile tilapia. Similar findings were reported by **Li *et al.* (2023)** in the snapper (*Lateolabrax maculatus*).

The mechanism involves vitamin E reducing the glutathione/oxidized glutathione (GSH/GSSG) ratio, which signals the Nrf2 gene to induce liver production of SOD.

2.3. Water quality

Water quality during the vitamin E supplementation experiment influenced the rearing conditions. According to **Yanuar (2017)**, changes in water quality in controlled culture media are affected by several factors, including temperature, pH, dissolved oxygen, salinity, and ammonia.

Table 2. Water quality parameters in each treatment dosage

Treatment	Water Quality Parameters				
	Temperature (°C)	pH	DO (mg/l)	NH_3 (mg/l)	Salinity (ppt)
Control	26.9 – 31	7.72 – 8.54	1.76 – 2.28	0.55	10
50 mg/l	26.9 - 30.9	7.87 – 8.55	2.18 – 2.40	0.25	10
100 mg/l	26.9 - 30.9	7.85 – 8.56	2.75 – 3.39	0,15	10
150 mg/l	26.9 - 30.8	7.85 – 8.55	3.78 – 4.78	0.10	10
OR	20-30	6.5-9	1.5-5	< 0.3	19

Note: OR (Optimum Range) is in accordance with **Boyd (2017)**.

Temperature is a significant factor influencing fish growth, as it increases oxygen consumption **(Leonard & Skov, 2021)**. This mechanism improves the physiological status of tilapia by reducing CO_2 levels **(Omer, 2021)**. Research has shown that the optimal temperature for rearing fish ranges from 26.9 to 31°C, which is consistent with **Zidni (2019)**, who reported an optimal range of 24–31°C. Maintaining optimal temperature increases the metabolic rate, allowing the Nile tilapia to maximize the utilization of vitamin E-supplemented diets.

The pH value of the rearing medium during the study ranged from 7.72 to 8.56, which is within the acceptable range for the Nile tilapia growth **(Jadhao, 2023)**. Water pH can directly influence fish growth. An increase in pH within the optimal range improves appetite and feed utilization, thereby minimizing feed waste and fecal accumulation, which could otherwise increase ammonia levels **(Li *et al.*, 2023)**.

Dissolved oxygen (DO) levels ranged from 1.76 to 4.78mg/ L, with the optimal value recorded at 150mg/ kg vitamin E supplementation. This suggests that DO affects tilapia survival, with the highest survival rate (92.89%) observed in the 150mg/ kg treatment. DO also reflects water pollution or wastewater treatment status, with the recommended optimum range being 3–5 mg/L **(Mohan *et al.*, 2021)**. The availability of DO is critical not only for supporting metabolism and overall survival **(Ali *et al.*, 2022)** but also for neutralizing deteriorating water quality by accelerating the oxidation of toxic gases such as ammonia and hydrogen sulfide **(Dhamorikar *et al.*, 2024)**.

Ammonia levels in the rearing media ranged from 0.10 to 0.55 mg/L. Supplementation with vitamin E, acting as a synthetic antioxidant, minimized residual feces and urine in the water, thereby reducing nitrogenous waste accumulation, particularly ammonia. Ammonia buildup is a major cause of water quality decline **(Ott *et al.*, 2024)**. The Nile tilapia are more tolerant of elevated ammonia compared to other fish species **(Ghozlan *et al.*, 2017)**. Typically, 80–90% of ammonia (inorganic nitrogen) is excreted via osmoregulation, while 10–20% originates from feces and urine. However, excessive ammonia accumulation can lead to culture production failure **(Mramba & Kahindi, 2023)**.

Salinity measurements during the experiment remained stable and consistent with the findings of **Franciska and Muhsoni (2021)**.

CONCLUSION

Optimal growth performance was correlated with the best liver biochemical status, when fish were fed with vitamin E supplemented diet at 150mg/ kg diet. This condition was observed from an average of HSI level at 5.040±0.089, the lowest MDA levels of 0.035±0.001 nmol/L, liver fat levels of 5.31±0.20, and the highest SOD of 118.84±14.20 units/Ml. Water quality parameters, ammonia and DO, are related to the impact of vitamin E dietary supplementation with a tolerable feasibility in the following treatment.

Conflicts of Interest

Authors declare that there are no conflicts of interest to pursue.

Authors' Contribution

RR (Ratnawati Rifai) analyzed the data and wrote the manuscript; R (Ridwan) analyzed the data and wrote the manuscript; A (Adriansyaf) performed the experiment, analyzed the data, and wrote the manuscript.

Data availability statement

Authors would like to state that the data for this manuscript is not publicly available due to privacy or ethical constraints. Therefore, authors will consider the complete data available whenever the editors inquire further.

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