Effects of dietary vitamin E supplementation on growth performance, body composition of golden trevally, *Gnathanodon speciosus*

ABSTRACT

Golden trevally, *Gnathanodon speciosus* is a new candidate for aquaculture in Viet Nam. This species has rapid growth, high market value, delectable flavour. Finding solutions to enhance production by promoting growth is necessary in golden trevally aquaculture. Vitamin E is one of the feed supplements which has proven the benefit on other aquaculture species but there has not been any study on golden trevally. Therefore*,* this experiment was designed to test the effect of vitamin E on the golden trevally, *Gnathanodon speciosus*. Three levels of vitamin E (50, 100, and 200 mg kg-1 diet) were supplemented to the basal diet (control diet). There was 4 diet treatments and 3 replicates for each treatment. The golden trevally (initial weight 7.63 g ± 0.13 (SEM)) were fed experimental diets for eight weeks. The growth performance and protein and lipid content of tissues were evaluated. At the end of the feeding trial (week 8), the presence of vitamin E in a fish's diet resulted in a significant increase in its growth rate ($P < 0.05$). The survival rate of fish fed diets containing 50 - 200 mg of vitamin E was substantially higher than that of control fish. In addition, protein and lipid levels in the flesh of golden trevally increased significantly as vitamin levels in their diets rose. For optimal growth and survival, it is recommended to supplement the diet of golden trevally with at least 50 mg of vitamin E per kilogramme. In conclusion, supplementing the diet with vitamin E improves growth, survival, and body composition in juveniles of this species. As this experiment is the first study on the effects of vitamin E on golden trevally, it is worthy of investigation.

Keywords: Vitamin E, growth, survival, protein, lipid content, golden trevally, *Gnathanodon speciosus,*.

1. INTRODUCTION

Vitamin E (VE) is a group of fat-soluble molecules with the most active component in this group was tocopherol. Vitamin E can protect the phospholipids and red blood cells of farmed fish against oxidation, preserving the structural and functional integrity of animal cells [1]. It has been showed that vitamin E supplements promote immune responses, increase survival, and enhance growth performance [1, 2], maintain the flesh quality [3], increase the survival [4], improve the immunological responses [5]. Fish are incapable of synthesizing all biologically active forms of vitamin E and rely on exogenous dietary sources for their supply [6].

The vitamin E requirements of several farmed fish have been documented including Atlantic salmon, *Salmo salar* [7], grass carp, *Ctenopharyngodon idellus* [8], cobia, *Rachycentron canadum* [4], which ranged from 6 to 200 mg kg^{-1} α-tocopherol. A deficiency or absence of vitamin E in the diet can result in stunted growth, impaired erythropoiesis, muscular dystrophy, darkened skin, exudative diathesis, skin depigmentation, liver fat degeneration, and even death [1]. In contrast, supplementing an extra concentrations of vitamin E could cause adverse effects such as induction of lipid peroxidation in grass carp, *Ctenopharyngodon idellus* [8], rainbow trout, *Oncorhynchus mykiss* [9], and spotted snakehead, *Channa punctatus* [10].

The golden trevally (*Gnathanodon speciosus*) inhabits tropical and subtropical environments in the Eastern Pacific, Western Indo-Pacific, Eastern and Western Atlantic Oceans. The golden trevally is both a sustenance fish and ornamental species. Its natural habitat is the tropical Indo-Pacific region. This species, whose spawning has been effectively induced in Viet Nam, is a new candidate for aquaculture. Due to its rapid development, high market value, delectable flavour, and current supply problems, the golden trevally is a crucially important cultivated species in Viet Nam. However, this species faces significant obstacles due to environmental stressors present in aquaculture facilities, such as water pollution, high stocking density, and poor water quality.

Numerous research has investigated the effects of vitamin E on aquatic species, but to the authors' knowledge, no study has yet identified how vitamin E influences golden trevally growth. The appropriate dosage of feed additives is crucial because an inappropriate dosage can have adverse effects [11, 12]. Therefore, the purpose of the present investigation was to determine the optimal range of vitamin E inclusion in diets for golden trevally, *Gnathanodon speciosus*, growth performance, and protein content.

2. MATERIALS AND METHODS

2.1 Experimental fish and culture systems

The golden trevally, *Gnathanodon speciosus*, was purchased from a hatchery in Nha Trang, Vietnam. A total of 300 fish from the same broodstock with a mean initial wet weight of 7.63 g ± 0.13 (SEM) were randomly stocked in 12 composite tanks (50 × 80 × 80 cm). Each was outfitted with a separate recirculation system at a flow rate of 350 L/min.

2.2. Experimental diets and husbandy

A base diet (consisting of 39.3% crude protein, 8.71% lipid, and 19.72 GE MJ/kg) was supplemented with vitamin E at three levels (50, 100, and 200 mg kg-1 diet). On the first day, experimental fish were fed 5% of their average body weight in each tank. Thereafter, the amount of feed supplied was monitored and adjusted daily based on the quantity of leftover pellets. The remaining feed and feces were siphoned out and about 30% of the water was changed daily. The fish were given meals twice a day, at 08:00 and 17:00, for eight weeks.

Table 1. Composition of the basal diet

Ingredients	Percentage
Fish meal	40.50
Wheat	22.20
Soybean	10.40
Fish oil	6.10
Binder	1.10
Mineral mix	1.5
Vitamin mix (Vitamin E free)	1.5
Corn starch	16.7
TOTAL	**100**

2.3 Experimental design

The experiment was designed to evaluate the growth response and mortality of fish fed an 8-week vitamin E-supplemented diet. The four dietary treatments were divided into three replicate tanks with 25 fish were stocked in each tank using a randomization technique. There were 300 golden trevally (25 fish each tank, 50 × 80 × 80 cm) stocked in a total of 12 tanks.

2.4 Data collection and sampling

Fish were weighed and total length was measured individually at beginning and end of the experiment. At the end of the experiment, two fish from each tank (6 animals in each treatment) was randomly sampled and sacrificed for measurement of muscle composition. Fish were starved for 24 h prior to measuring or sampling. All individual fish were weighed, and their total lengths were measured before and after the experiment. At the end of the experiment, two fish from each tank - a total of six fish in each treatment - were randomly selected and sacrificed to be measured for muscle composition. Prior to measuring or sampling, fish were starved for 24 hours.

2.5 Chemical analysis of culture fish

Six fish from each treatment were sampled at the conclusion of the experiment (week 8), and their muscles were preserved at -20 °C for protein and lipid analyses. Crude protein and fat concentrations were determined using standard method, as described by Do-Huu et al. [13].

2.6 Data calculation

Following equations were used to calculate specific growth rate (SGR,% d^{-1}) and survival [14]: SGR (% d^{-1}) = 100 x (LnWt LnWo)/days; Survival rate = 100 x (Nt)/No, where Wt and Wo were the fish's weights at the end of week 8 and their respective starting weights (in g), respectively. The number of fish at the beginning of the experiment was No, and the number at its conclusion was Nt. Following is how the coefficient of variation (CV, %) was determined: CV

= (100 x S/M, where S represents the standard deviation and M represents the mean fish weight.

2.8 Statistical analysis

The presentation of data is by means of standard error (SEM). The growth performance and body composition data of fish under various feeding treatments were examined using ANOVA and Least Significant Difference (LSD) procedures. If $P < 0.05$, differences were considered significant. To compare survival rates, a non-parametric Kruskal-Wallis test was used [15]. SPSS 18 (IBM, Chicago, IL) was used for all statistical analyses.

RESULTS

3.1 Growth performance of golden trevally fed different levels of vitamin E

The fish were all similar weight (7.63 g + 0.13) at the beginning of the experiment. At the start of the experiment, there was not a significant difference in the average weight of golden trevally across treatments (ANOVA, P = 0.524).

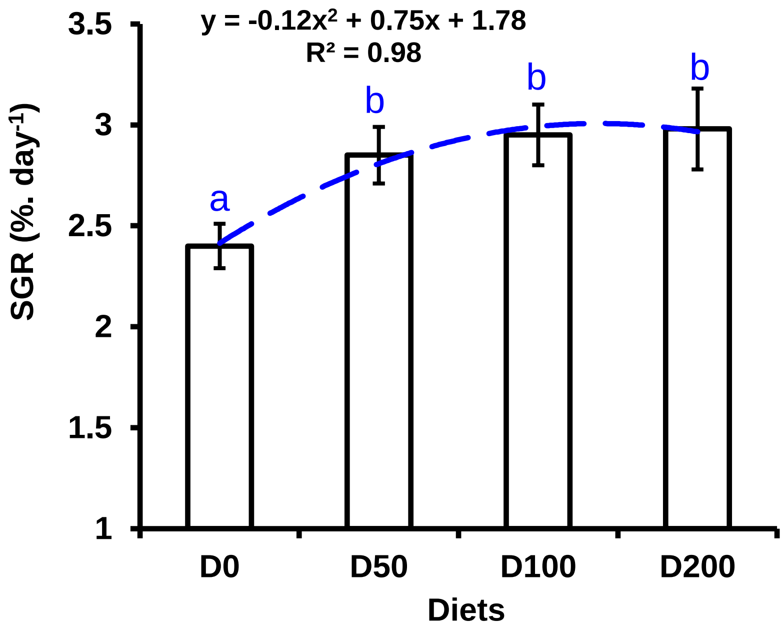

Fig. 1. Average daily growth coefficient (SGR % d^{-1}) (± SEM) of golden trevally fed vitamin E. Significant alterations between treatments are indicated by different letters.

Figure 1 shows the effects of various vitamin E supplementation levels on golden trevally growth. Fish given vitamin E supplementation had a better growth rate at the trial's conclusion (week 8). The specific growth rate (SGR) ranged from 2.4 to 2.98% day^{-1}. Golden trevally receiving 200 mg of vitamin E experienced the greatest growth, followed by growth of fish receiving 100 and 50 mg of vitamin E in their diets, but there was no discernible difference between them (P = 0.532). Fish fed the control food grew much less than fish fed the three vitamin concentrations (P ≤ 0.003).

2.2 . Survival rate of golden trevally

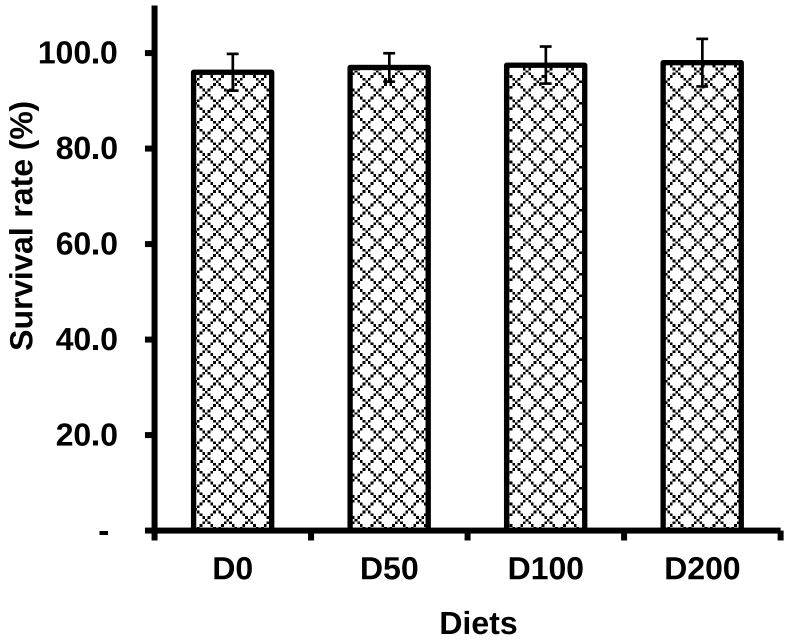

Fig. 2. Survival rate of golden trevally. Different letters indicate significant differences between treatments.

The effect of dietary vitamin E incorporation on the golden trevally's survival rate is demonstrated in Figure 2. The final survival of golden trevally among treatments ranged from 96.05% to 98.12%. Fish fed diets containing 200 mg of vitamin E had the highest survival rate (98.12%), followed by fish fed diets containing 100 mg, 50 mg, and no vitamin supplementation, which had survival rates of 97.50%, 97.00%, and 96.05%, respectively. The survival rates of fish fed with any dose of vitamin E and fish on a control diet did not differ significantly from one another, though ($P = 0.438$).

3.3. Variations in the size of golden trevally

The coefficient of variation (CV, %) was used to evaluate the heterogeneity of fish body weight. Results at week eight showed that the fish fed a control diet had the largest variation coefficient (CV, %) of body weight for golden trevally. As the amount of vitamin E supplements in the diet increased, the CV declined. When compared to fish fed a control diet, there was a significant difference in CV value between diets containing 100 and 200 mg of vitamin E ($P \leq 0.010$). The size variations of fish given a diet containing 50mg of vitamin E per kg^{-1} did not, however, differ significantly from CV in the control group (P = 0.276). Additionally, no correlation between the CV values of fish fed any quantity of vitamin E was discovered (P = 0.161).

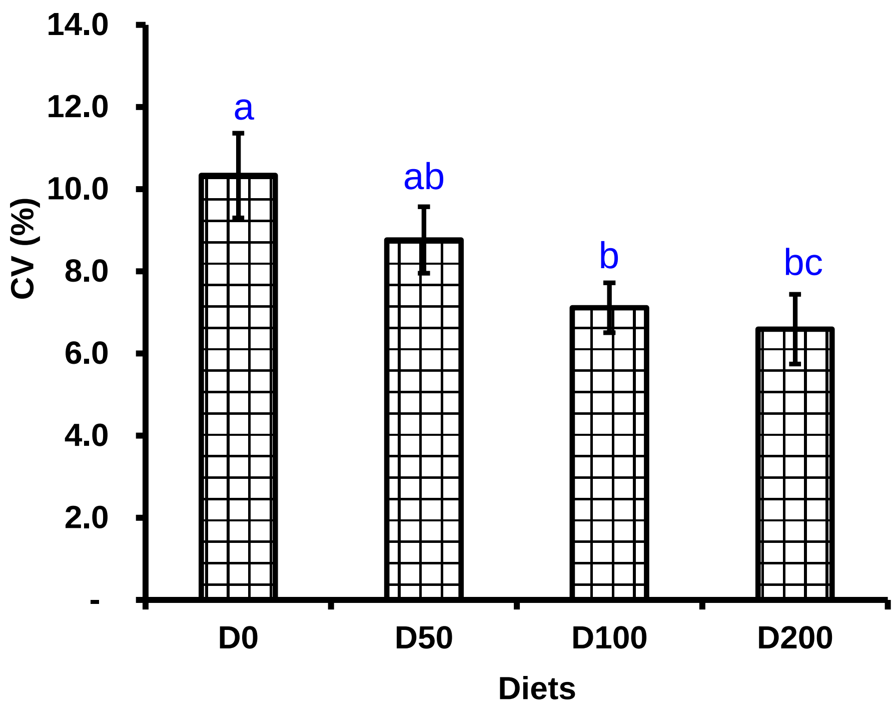

Fig. 3. Coefficient of variations in weight (CV, %) of golden trevally fed vitamin E. Different letters indicate significant differences between treatments.

3.4 Protein content in flesh of golden trevally

Figure 4 demonstrates the protein content of golden trevally diets supplemented with vitamin E. As a result of our research, we were able to determine that the protein content in the muscle of golden trevally varied from 19.02% in the group given the control diet to 22.73% in the group given a meal containing 200 mg E per kilogramme. Diets supplemented with graded levels of vitamin E significantly influenced protein content (P ≤ 0.001). However, there was no significant difference in the protein content of fish fed any level of vitamin E added to the diets (P = 0.110) (Figure 4).

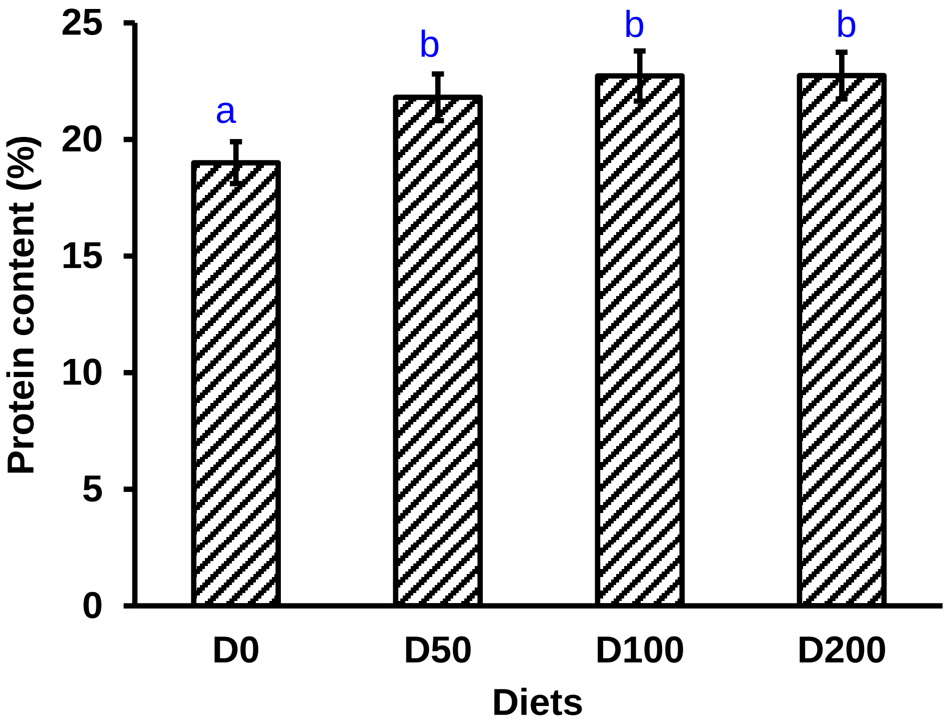

Fig. 4. Protein in the muscle of golden trevally fed vitamin E. Different letters indicate significant differences between treatments.

3.4 Lipid content in flesh of golden trevally

Figure 5 shows the effect of vitamin E supplementation on the lipid content of the golden trevally. The lipid content of golden trevally among the diet regimens ranged from 6.5 to 8.4% at the completion of the experiment. Additionally, more vitamin E in the diet resulted in a rise in the lipid content of the golden trevally. Fish fed the control diet had the lowest amount of lipids (6.5%), whereas fish fed diets with 200 mg of vitamin E had the highest lipid content (8.4%). Fish fed any dose of vitamin E had lipid contents that were considerably higher than this value when compared to fish fed the control diet ($P \leq 0.013$). However, lipid levels did not significantly differ between the groups that received vitamin E supplements at any dosage ($P = 0.438$).

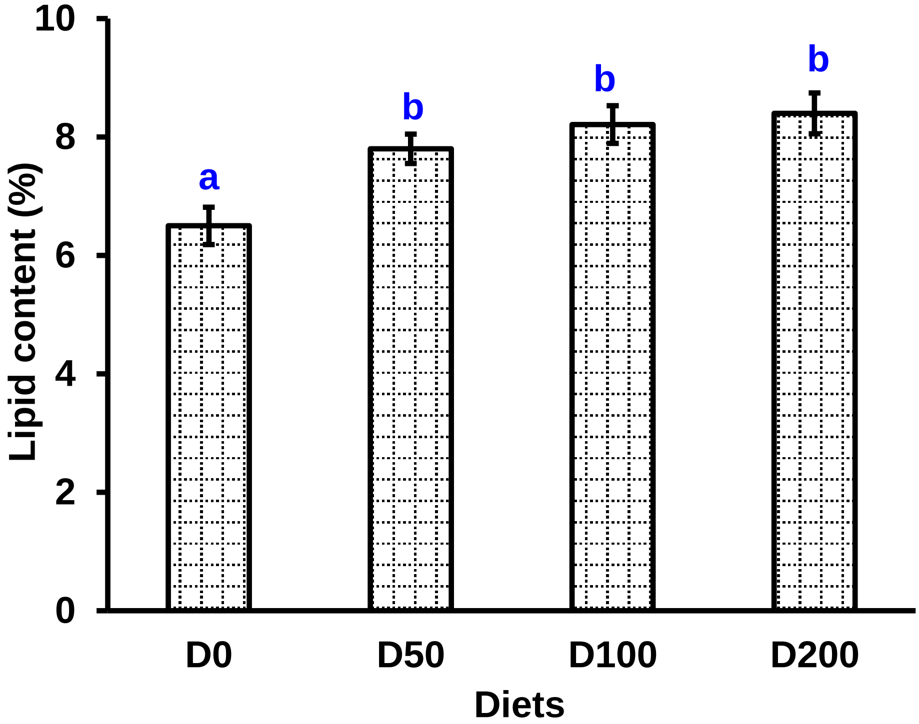

Fig. 5. Lipid in the muscle of golden trevally fed vitamin E. Different letters indicate significant differences between treatments.

4. DISCUSSION

This study is the first to investigate whether dietary vitamin E affects the growth and body composition of golden trevally. According to this study, vitamin E is beneficial for the growth and survival of the golden trevally, *Gnathanodon speciosus*. Fish growth was enhanced when fed diets containing 50–200 mg of vitamin E per kilogram of diet.

This was in line with other studies that discovered vitamin E to be essential for promoting the growth and survival of fish, such as the Japanese eel, *Anguilla japonica* [16], caspian trout, *Salmo caspius* [17], hybrid snakehead, *Channa argus* × *Channa aculate* [18], milkfish, *Chanos chanos* [19], parrot fish, *Oplegnathus Fasciatus* [20], zebrafish, *Danio rerio* [21], channel catfish (*Ictalurus punctatus*) [22] and great sturgeon, *Huso huso* [23]. According to previous findings, dietary vitamin E promotes survival of Caspian trout, *Salmo caspius* [17], channel catfish, *Ictalurus punctatus* [22] and milkfish, *Chanos chanos* [19]. In contrast above results, this study is in line with other reports which has shown dietary vitamin E did not change survival of hybrid tilapia, *Oreochromis niloticus* × *O. aureus* [24], shrimp, *Litopenaeus vannamei* [25].

The result of this research is similar to a previous report that vitamin E has boosted growth of hybrid tilapia, *Oreochromis niloticus* × *O. aureus* [24]. The levels of vitamin E requirement is different depending on species for example in Atlantic salmon, *Salmo salar* (120 mg kg^{-1}) [7], rohu, *Labeo rohita* (131.91 mg kg^{-1}) [26], and Indian major carp, *Catla catla* (150 mg kg^{-1}) [27]. In contrast, studies on rainbow trout, *Salmo gairdneri* [28] and channel catfish [29] have shown that weight gain did not respond to dietary vitamin E supplementation. In this study, supplementation of 50 - 200 mg kg^{-1} boosted the growth rate of golden trevally. The increase in growth of golden trevally with the addition of vitamin E in the current study may be due to optimum vitamin E supplementation.

The biochemical composition of fish, such as its protein and lipid content, is frequently used as an indicator of its nutritional condition and health [30]. The body composition of fish plays an essential role in aquaculture because it affects growth, survival, and food utilisation efficiency [31]. In the present study, the protein content of golden trevally fed various vitamin E concentrations showed substantial differences in the current investigation. This was consistent with recent research that found that increasing dietary vitamin E supplementation in the diet of the Caspian trout, *Salmo caspius*, increased protein content and crude fat in the whole body [17]. Similar findings have been made by [26], who reported vitamin E has enhanced whole-body crude protein and lipid in *Labeo rohita*. However, the total body proximate composition of the cobia, *Rachycentron canadum* [4], sea bass, *Dicentrarchus labrax* [32], and Japanese eel, *Anguilla japonica* [33] did not significantly change when the quantities of vitamin E in the meal were varied. Vitamin E deficiency leads to a decrease in whole-body crude protein and an increase in moisture content in fish [34].

5. CONCLUSION

The inclusion of vitamin E in diets enhances the growth and survival of golden trevally, *Gnathanatodon speciosus*. 50-200 mg kg^{-1} of vitamin E has been proposed as a supplement to the golden trevally diet to promote optimal growth. Also, additional research is required to determine the vitamin E concentration necessary to optimise the growth of golden trevally exposed to diverse environmental conditions and stressors, as well as their physiological and immunological responses. The effects of dietary vitamin E on various life stages should be further investigated. In conclusion, supplementing dietary vitamin E may enhance the growth, survival, and body composition of juvenile golden trevally. It is suggested that adding a minimum amount of 50 mg of vitamin E kg^{-1} will improve the growth and reduce mortality in juvenile golden trevally.

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COMPETING INTERESTS

The author declare no competing interest.

REFERENCES

1. El-Sayed A-FM, Izquierdo M. The importance of vitamin E for farmed fish—A review. Reviews in Aquaculture. 2022; 14:688-703.
2. Lu Y, Liang X-P, Jin M, Sun P, Ma H-N, Yuan Y, *et al.* Effects of dietary vitamin E on the growth performance, antioxidant status and innate immune response in juvenile yellow catfish *(Pelteobagrus fulvidrac*o). Aquaculture. 2016; 464:609-617.
3. Ruff N, FitzGerald RD, Cross TF, Hamre K, Kerry JP. The effect of dietary vitamin E and C level on market-size turbot (*Scophthalmus maximus*) fillet quality. Aquac Nutr. 2003; 9:91-103.
4. Zhou QC, Wang LG, Wang HL, Wang T, Elmada CZ, Xie FJ. Dietary vitamin E could improve growth performance, lipid peroxidation and non-specific immune responses for juvenile cobia (*Rachycentron canadum*). Aquac Nutr. 2013; 19:421-429.
5. Montero D, Tort L, Izquierdo M, Robaina L, Vergara J. Depletion of serum alternative complement pathway activity in gilthead seabream caused by α-tocopherol and n-3 HUFA dietary deficiencies. Fish Physiol Biochem. 1998; 18:399-407.
6. Peng LI, Gatlin DM, III. Dietary vitamin E requirement of the red drum *Sciaenops ocellatus*. Aquac Nutr. 2009; 15:313-319.
7. Hamre K, Lie Ø. Minimum requirement of vitamin E for Atlantic salmon, *Salmo salar* L., at first feeding. Aquac Res. 1995; 26:175-184.
8. Li J, Liang X-F, Tan Q, Yuan X, Liu L, Zhou Y, *et al.* Effects of vitamin E on growth performance and antioxidant status in juvenile grass carp *Ctenopharyngodon idellus*. Aquaculture. 2014; 430:21-27.
9. Tokuda M, Takeuchi M. Effects of Excess Doses of α-Tocopherol on Lipid in Serum and Muscle of Rainbow Trout. Fisheries science. 1999; 65:496-497.
10. Abdel- Hameid NAH, Abidi SF, Khan MA. Dietary vitamin E requirement for maximizing the growth, conversion efficiency, biochemical composition and haematological status of fingerling *Channa punctatus*. Aquac Res. 2012; 43:226-238.
11. Do-Huu H, Tabrett S, Hoffmann K, Köppel P, Lucas JS, Barnes AC. Dietary nucleotides are semi-essential nutrients for optimal growth of black tiger shrimp (*Penaeus monodon*). Aquaculture. 2012; 366-367:115-121.
12. Do-Huu H, Jones CM. Effects of dietary mannan oligosaccharide supplementation on juvenile spiny lobster *Panulirus homarus* (Palinuridae). Aquaculture. 2014; 432:258-264.

13. Do-Huu H, Thanh Thuy NT, An HT. Supplementing the diet of pompano *Trachinotus ovatus* with MacroGard® to increase innate immunity, intestinal microbes, growth and ammonia tolerance. Regional Studies in Marine Science. 2022; 55:102621.

14. Do-Huu H, Tabrett S, Hoffmann K, Köppel P, Barnes AC. The purine nucleotides guanine, adenine and inosine are a dietary requirement for optimal growth of black tiger prawn, *P. monodon*. Aquaculture. 2013; 408-409:100-105.

15. Zar JH. Biostatistical Analysis. 4th edition. Prentice-Hall, Englewood Cliffs, New Jersey, 1999; 929.

16. Shahkar E, Hamidoghli A, Yun H, Kim D-J, Bai SC. Effects of dietary vitamin E on hematology, tissue α-tocopherol concentration and non-specific immune responses of Japanese eel, *Anguilla japonica*. Aquaculture. 2018; 484:51-57.

17. Saheli M, Rajabi Islami H, Mohseni M, Soltani M. Effects of dietary vitamin E on growth performance, body composition, antioxidant capacity, and some immune responses in Caspian trout (*Salmo caspius*). Aquaculture Reports. 2021; 21:100857.

18. Zhao H, Ma H-J, Gao S-N, Chen X-R, Chen Y-J, Zhao P-F, *et al.* Evaluation of dietary vitamin E supplementation on growth performance and antioxidant status in hybrid snakehead (*Channa argus* × *Channa maculata*). Aquac Nutr. 2018; 24:625-632.

19. Sivaramakrishnan T, Ambasankar K, Sathish Kumar T, Sandeep KP, Bera A, Raja RA, *et al.* Effect of dietary vitamin E supplementation on growth, fatty acid composition, intestinal histology, and haemato-immune indices of milkfish, *Chanos chanos*, larvae. Journal of Applied Aquaculture. 2023:1-22.

20. Galaz GB, Kim S-S, Lee K-J. "Effects of Different Dietary Vitamin E Levels on Growth Performance, Non-Specific Immune Responses, and Disease Resistance against Vibrio Anguillarum in Parrot Fish (*Oplegnathus Fasciatus*). Asian-Australasian Journal of Animal Sciences, vol. 23, no. 7. Asian Australasian Association of Animal Production Societies, pp. 916–923. 2010.

21. Mehrad B, Jafaryan H, Taati M. Assessment of the effects of dietary vitamin E on growth performance and reproduction of zebrafish, *Danio rerio* (Pisces, Cyprinidae). 2023.

22. He M, Wang K, Liang X, Fang J, Geng Y, Chen Z, *et al.* Effects of dietary vitamin E on growth performance as well as intestinal structure and function of channel catfish (*Ictalurus punctatus*, Rafinesque 1818). Experimental and therapeutic medicine. 2017; 14:5703-5710.

23. Amlashi AS, Falahatkar B, Sattari M, Gilani MHT. Effect of dietary vitamin E on growth, muscle composition, hematological and immunological parameters of sub-yearling beluga *Huso huso* L. Fish Shellfish Immunol. 2011; 30:807-814.

24. Shiau SY, Shiau LF. Re-evaluation of the vitamin E requirements of juvenile tilapia (*Oreochromis niloticus* ×*O. aureus*). Anim Sci. 2016; 72:529-534.

25. Ruff N, Lavens P, Huo JZ, Sorgeloos P, Nelis HJ, De Leenheer A. Antioxidant effect of dietary tocopherol and ascorbic acid on growth and survival of *Litopenaeus vannamei* postlarvae. Aquac Int. 2001; 9:115-126.

26. Sau SK, Paul BN, Mohanta KN, Mohanty SN. Dietary vitamin E requirement, fish performance and carcass composition of rohu (*Labeo rohita*) fry. Aquaculture. 2004; 240:359-368.

27. Sinha A, Sinha YKP. Role of vitamin E in growth of an Indian major carp, Catla (*Catla catla*). 1994.

28. Cowey CB, Adron JW, Walton MJ, Murray J, Youngson A, Knox D. Tissue distribution, uptake, and requirement for alpha-tocopherol of rainbow trout (*Salmo gairdneri*) fed diets with a minimal content of unsaturated fatty acids. J Nutr. 1981; 111:1556-1567.

29. Wilson RP, Bowser PR, Poe WE. Dietary vitamin E requirement of fingerling channel catfish. J Nutr. 1984; 114:2053-2058.
30. Jobling M. A short review and critique of methodology used in fish growth and nutrition studies. J Fish Biol. 1983; 23:685-703.
31. Breck JE. Body composition in fishes: body size matters. Aquaculture. 2014; 433:40-49.
32. Gatta, Pirini, Testi, Vignola, Monetti. The influence of different levels of dietary vitamin E on sea bass *Dicentrarchus labrax* flesh quality. Aquac Nutr. 2000; 6:47-52.
33. Bae J-Y, Park GH, Yoo K-Y, Lee J-Y, Kim D-J, Bai SC. Evaluation of optimum dietary vitamin E requirements using DL-α-tocopheryl acetate in the juvenile eel, *Anguilla japonica*. J Appl Ichthyol. 2013; 29:213-217.
34. Watanabe T, Takeuchi T, Matsui M, Ogino C, Kawabata T. Effect of α-tocopherol deficiency on carp. VII. The relationship between dietary levels of linoleate and α-tocopherol requirement. Bulletin of the Japanese Society of Scientific Fisheries 1977; 43:935-946.