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Application of vitamin E in commercial feed to improve gonadal maturation in blue devil damselfish/Sapphire devil *(Chrysiptera cyanea)*

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ABSTRACT

This study examined the application of vitamin E with different doses in commercial feed on the gonad maturity of blue devil damselfish or the sapphire devil. This study used a completely randomized design with four levels of treatment doses and three replications. The parent fish used were blue devil damselfish that were reared for six weeks. The vitamin E test doses mixed in the feed were A. 0.50, B. 60, and C. 70 mg/kg feed. The results showed that the effect of vitamin E with different doses had a significant effect on the percentage of gonad maturity level (GML), gonadal somatic index (GSI), fecundity, and egg maturity level (EML) (P<0.05). The application of vitamin E at a dose of 0.70 mg/kg of feed proved to be the most effective dose for the gonadal maturation of blue devil damselfish, or sapphire devil, reared for six weeks. The GML percentage was 29.033±1.010; the GSI was 0.145±0.77, th fecundity was 306±0.936; the percentage of mature eggs (EML) ranged from 19.875±1.714-42.5±1.667; absolute growth was 1.166±0.30, and the survival rate was 86.666±1.13. Physiologically, vitamin E in feed is a fatty acid antioxidant that acts as a precursor to accelerate the process of gonadal maturation in blue devil damselfish.

INTRODUCTION

The blue devil damselfish (*Chrysiptera cyanea*) is a type of ornamental marine fish from the Fomancentridae family, with a slender body and a body structure similar to *Mozambique tilapia*. Its entire body is bright blue with a few white dots on its head and base of the tail. The blue devil damselfish in North Maluku is known as blue fish who takes the coral reef as its habitat. The blue devil damselfish/sapphire devils hold (s) a great potential with a selling price of 5000 per fish; the selling price is promising with increased production. The selling price might encourage people to over-exploit, causing a scarcity of blue devil damselfish in the wild. The existence of blue devil damselfish in its

habitat is a concern due to the damage to coral reef ecosystems caused by human activities, such as beach reclamation, coral mining, plastic waste, etc.

One of the solutions to overcome the scarcity of blue devil damselfish in North Maluku in general and especially in Ternate City, is to develop fish reproduction engineering technology. People still rely on wild catches and have a low success rate. Knowledge about reproduction greatly influences hatchery efforts; however, information about blue devil damselfish gonad development until reproductive performance and the nutritional composition of the feed is limited.

Feed is important in stimulating gonadal growth processes such as reproductive performance, fecundity, fertilization, hatching, and survival rates. In aquaculture, feed is the main component in forming vitellogenin (egg yolk) since providing certain nutrients in the feed can accelerate the maturation process and improve the quality of the gonads. **Tarigan *et al*. (2017)** stated that providing quality feed can improve fish reproduction. Feed quality can be improved by adding vitamins to the feed. **Mokoginta *et al*. (2000)** cited in. **Tarigan *et al*. (2017)** stated that providing quality feed can be done through the supplementation of vitamin E in the feed. **Napitu *et al*. (2013)** indicated that vitamin E plays an important role in improving fish reproduction since vitamin E functions as an antioxidant that can maintain the presence of fatty acids and prevent the oxidation of fat in cell membranes and accelerate the secretion of reproductive hormones. In addition, **Septian *et al*. (2022)** stated that vitamin E plays a role in protecting the fish from bacteria, stimulating gonadal maturation, and improving cell membrane function.

To improve and optimize the gonadal maturation process, growth, survival, and increase egg quality in blue devil damselfish reared in aquaculture vessels not directly affected by environmental factors such as light, temperature, salinity, reproductive engineering approaches such as environmental manipulation, hormone manipulation, and feed supplementation are necessary to accelerate the reproductive process of blue devil damselfish. This study used a nutritional approach, adding different doses of vitamin E to commercial feed. These doses are expected to optimize the reproductive process so that the incoming feed material input can be optimally utilized in the vitellogenesis process to increase gonad development in blue devil damselfish. Vitamin E is required for the maturation of fish gonads. Vitamin E levels in the feed will increase the essential fatty acid content. The higher the requirement for feed fatty acids, the higher the need for vitamin E. Vitamin E plays an important role in the hydroxylation reaction of steroid hormone biosynthesis that is necessary for the gonad formation process. While vitamin E deficiency in the ovaries can interfere with vitellogenin formation, thus preventing optimal absorption by oocytes. This can cause low phospholipid content.

MATERIALS AND METHODS

1. Location and time

This study was conducted between February and April 2023 at LIPI (Lembaga Ilmu Pengetahuan Indonesia, the Indonesian Institute of Sciences) Sasa Urban Village, South Kota Ternate Subdistrict, North Maluku Province.

2. Test feed

The test feed used was commercial feed with a composition of 40.00% protein, 14.00% fat, 4.25% crude fiber, and 18.69% carbohydrates. The commercial feed was mixed with vitamin E (Hovagrove®) at different doses. The vitamin E was first dissolved in corn oil and then mixed into the feed evenly. The feed was then dried until it reached a moisture content of 10%. The dose of vitamin E mixed in the feed was divided into four doses as follows:

A. Vitamin E dose of 0.50 mg/kg feed
B. Vitamin E dose of 0.60 mg/kg feed
C. Vitamin E dose of 0.70 mg/kg feed
D. Control

3. Experimental broodstock and data collection

The blue devil damselfish broodstock was procured from catches in the waters of Ternate City (Sasa, Jambula, Kastela, Sulamadaha, Tobolo) with a length ranging from 1.9 – 2 cm and a weight ranging from 0.12 – 0.14 cm. The broodstock used were those that had never spawned before and whose gonads were not yet visible. The broodfish were reared in aquariums measuring 20 × 20 × 30 cm with a stocking density of 10 fish/container for six weeks.

During the rearing period, the water was weekly changed by as much as 50%. The fish were administered with the test feed three times per daya (09.00, 12.00, and 18.00) on an *ad-satiation* basis. Observations were made once a week for six weeks by randomly collecting one fish per replication. The parameters observed were absolute weight gain percentage, survival rate (SR), gonadal maturity level (GML), ovary histological structure, gonadal maturity index (GSI), fecundity, and egg maturity level (EML) determined by observing the germinal vesicle breakdown (GVBD) indicator. The gonadal maturity level was microscopically observed during each observation.

3.*1Absolute weight gain*

The absolute weight gain analyzed was calculated using the following the formula by **Muchlisin *et al.* (2016)** as follows: $Wm = Bt - Wo$

Notes:
Wm = Absolute weight gain (g)
Wt = Final weight (g)

Wo = Initial weight (g)

3.2 Survival rate

The survival rate was calculated at the beginning and end of the rearing period, employing the formula detailed in **Muchlisin *et al*. (2016**) as follows:

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

Notes:

Sr = Survival rate (%)

Nt = Number of fish at the end of the rearing period (individuals)

No = Number of fish at the beginning of the stocking (individuals)

3.3 Gonad maturity level

The percentage of the gonad maturity level was calculated by adding the broodstock whose gonad maturity was apparent divided by the total number of broodstock observed and multiplied by 100%.

The percentage of gonadal somatic index (GSI) was calculated using the following formula:

$$IKG\ \% = \frac{Bobot\ Ovari}{Bobot\ tubuh} \times\ 100$$

Notes:

GSI = Gonadal somatic index (%)

Bo = Weight of ovaries

Bt = Body weight

3.4 Fecundity

Fecundity is the number of eggs released during spawning. Fecundity was calculated using the following formula:

$$F = \frac{BG}{Bs} \times\ Fs$$

Notes:

F = Total number of eggs

Bg = Weight of entire gonad (gram)

Bs = Number of eggs in part of the gonad

3.5 Percentage of egg maturity level (EML)

The percentage of EML was calculated at the end of the study by observing the condition of the eggs using microscopically determined transparency. Mature eggs are characterized by the different breakdown of the egg plasma membrane (GVBD) at the edges of the ova and then calculated using the following formula:

$$TKT\ \% = \frac{Banyaknya\ telur\ dengan\ inti\ di\ tepi}{Jumlah\ telur} \times 100$$

4.Data analysis

The data were analyzed using a two-way ANOVA, and in the case of a significant difference, further analysis was conducted using Duncan's test with the assistance of SPSS.

RESULTS

The observation results on several variables measured in the treatments using feed supplemented with different doses of vitamin E for six weeks are presented in Table (1). The analysis of variance showed that supplementation of vitamin E in feed for six weeks had a significant effect on the parameters measured. These parameters are presented in Table (1)

Table 1. The absolute weight gain percentage, survival rate (SR), gonadal maturity level (GML), gonadal somatic index (GSI), fecundity, and egg maturity level (EML) in blue devil damselfish/sapphire devil (*Chrysiptera cyanea*).

	Vitamin E levels (mg kg^{-} feed)			
Parameter	A 0.50	B 0.60	C 0.70	D (control)
Absolute weight gain	0.46 ± 0.37^{a}	1.123 ± 0.26^{b}	1.166 ± 0.30^{c}	0.13 ± 0.053^{d}
SR (%)	63.34 ± 0.75^{a}	83.333 ± 0.89^{b}	86.666 ± 1.13^{c}	43.333 ± 0.6^{d}
GML IV (%)	11.0167 ± 1.00^{a}	23.43 ± 0.504^{b}	29.033 ± 1.010^{c}	0.00
GSI (%)	0.031 ± 0.027^{a}	0.074 ± 0.36^{b}	0.145 ± 0.77^{b}	0.00
Fecundity (%)	186 ± 1.027^{a}	284 ± 0.869^{b}	306 ± 0.936^{c}	0.00
EML (%)	19.875 ± 1.714^{a}	27.55 ± 0.70^{b}	42.5 ± 1.667^{c}	0.00

Note: Numbers followed by letters with different superscripts in the same line indicate a significant difference ($P<0.05$)

1. Absolute weight gain

The observation results considering the growth parameters of blue devil damselfish during the six weeks of rearing showed that treatment with vitamin E at different doses can increase absolute weight gain compared to the control treatment (without vitamin E), as displayed in Fig. (1). The absolute weight gain percentage of blue devil damselfish during the study ranged from 0.46±0.37 - 1.166±0.30. The best percentage was in treatment C at a dose of 0.70 mg/kg feed with a value of 1.166±0.30. The results of observations of absolute weight gain during six weeks of maintenance demonstrated an average absolute weight gain as demonstrated in Fig. (1).

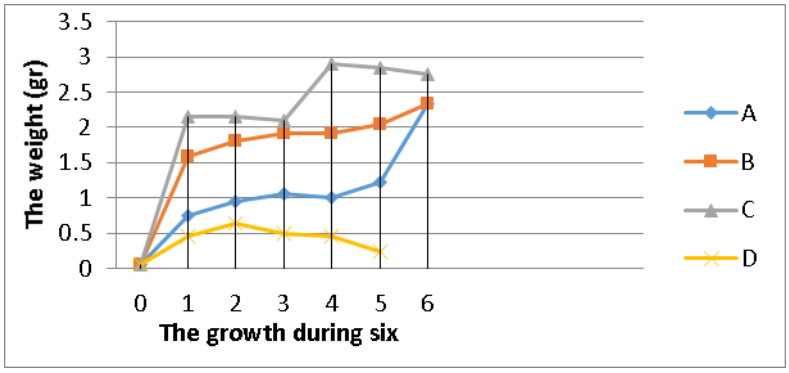

Fig. 1. The fish's average growth during six weeks of rearing

The analysis results of absolute weight growth showed that there was a very significant difference (P <0.50) between treatment C at 1.166±0.30 and treatment D at 0.13±0.053. Moreover, it was also significant between treatment B at 1.123±0.26 and treatment A at 0.46±0.37.

2. Survival rate (SR)

The observation results with respect to the survival rate in Table (1) showed a difference in the survival rate (SR) of blue devil damselfish for each treatment during the six weeks of rearing. This demonstrates that during the rearing period, there were deaths in all the treatments. The results of the analysis of variance showed that there was a highly significant difference (P<0.50) between treatment C at 86.666±1.13 and treatment D at 43.333±0.6. Furthermore it was also significant between treatment B at 83.333±0.89 and A at 63.34±0.75.

3. Gonad maturity level (GML)

In general, gonad maturity level in fish is divided into two main developmental stages, namely the stage of gonad growth until the fish reaches sexual maturity and the stage of sexual maturation. During gonad maturation, as it gains body weight, the fish individual changes with a change in the gonads color. The observation results of the gonadal maturity level of blue devil damselfish during rearing were in the range of 11.0167±1.00- 29.033±1.010. The results of the analysis of variance of gonadal maturity for blue devil damselfish differed significantly (P <0.50) between treatment C at 29.033±1.010, and treatment A at 11.0167±1.00, as well as it was significant for treatment B at 23.43±0.504 (Table 1).

4. Fecundity

The highest fecundity observed for blue devil damselfish during the six weeks of rearing was found in fish given vitamin E at a dose of 0.70 mg/kg feed, with an average fecundity of 306±13.80, followed by treatment B with a dose of 0.60 mg/kg feed at 284±11.50, whereas the lowest fecundity was found in treatment A with a dose of 0.50 mg/kg feed at 189±10.88. The analysis of variance showed that the supplementation of

vitamin E in feed interacted to affect fecundity (P<0.05). Treatment C was significantly different from treatment B and very significantly different from treatments A and D (Table 1)

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5. Gonadal somatic index (GSI)

The gonadal somatic index (GSI) of the fish increased in line with the increase in the level of gonadal maturity. The highest fish gonadal maturity index was found in treatment C at a vitamin E dose of 0.70 mg/kg feed, followed by treatment B at a vitamin E dose of 0.60 mg/kg feed, then treatment A at a vitamin E dose of 0.50 mg/kg feed after a rearing period of 6 weeks. The highest average GSI was found in treatment C, followed by treatments B and A, whereas in treatment D, it was absent. The mean BMI value of blue devils for each treatment during the six weeks of rearing showed a continuing increasinge pattern. In treatment C, the blue devil damselfish broodstock reached the preparatory phase of the reproductive cycle, indicated by the composition of the ovarian oocytes. In this phase, oocyte size grew due to increased cytoplasmic volume and material synthesized by reproductive steroid hormones synthesized by the ovaries. The results of the analysis of variance showed that the interaction between the treatment of vitamin E at a dose of 0.70 mg/kg on the gonadal maturity index (GSI) was very significant (P<0.05) between treatment C at 14.02±2.082 and treatment A at 2.99±1.025, as well as it was significant with treatment B at 6.86±1.664 (Table 1).

6. Egg maturity level

The observation results of the maturity level of blue devil damselfish/sapphire devil eggs showed a significant difference between the treatments as presented in (Table 1). The maturity level of blue devil damselfish eggs during the study ranged from 19.875 to 42.5. The research results were found in treatment C at a dose of 0.70 mg/kg feed followed by treatments B and A. Based on the results of the analysis of variance at the test level (*P*<0.05), treatment C at 42.5±1.667 was significantly different from treatment A at 19.875±1.75, and it was significantly different from treatment B at 27.55±0.70.

7. Egg histology

The results of the manual observations of the histological structure of the gonads are presented in Fig (2). The development and growth of oocytes can be observed through the histological structure of the gonads. The administration of vitamin E through feed influences the development and growth of egg cells. The histological features in Fig (2) are eggs at the GML III stage; Fig (2A) shows the oocytes and cells in the follicles. The condition of the follicles showed developing oocytes. Fig (2B) shows stadium III oocytes that are beginning to grow and develop, the diameter of the eggs is starting to increase, and eggs are visible. At this stage, gonadal development is already in the GML III phase. In GML III, since the vitellogenesis process begins, this stage can be called the yolk accumulation or maturation stage. Fig (2C) shows that the final stage of egg maturity

marked by the position of the nucleus at the periphery or at the poles of the anima gonads that have entered GML IV. In addition, Fig (C2) shows that the gonads have developed.

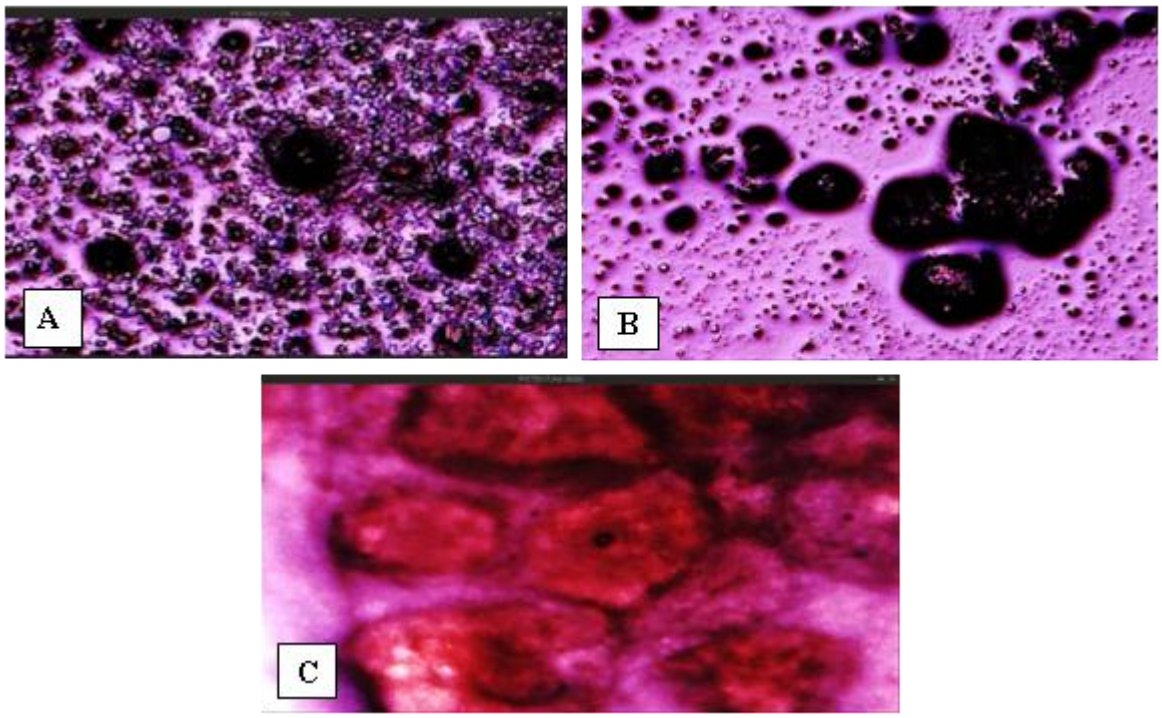

Fig 2. Histological results of the gonads of blue devil damselfish after 44 days of rearing showing A. Vitamin E 0.50 g/kg of feed, B. Vitamin E 0.60 g/kg of feed, C. Vitamin E 0.70 mg/kg of feed. Manual histological results with 40x magnification.

DISCUSSION

Vitamin E is a supplement necessary for fish growth and survival. Vitamin E can also be considered a functional feed additive for its antioxidant role in enhancing immunity, resulting in better growth and survival during early life. However, the role of vitamin E in blue devil damselfish feed has not been studied in detail. Vitamin E requirements vary depending on the fish species and age. The vitamin E requirement for catfish ranges between 60-240 mg/kg fish feed. Meanwhile, for salmonids, the vitamin E requirement ranges between 35-300 mg/kg of feed (Basri, 1997). Cawev and Sargent (1979), as cited in Pangkey (2011) and Sargent (1979), demonstrated that essential fatty acid requirements for marine fish are strongly influenced by the temperature and salinity of the waters.

Vitamin E in the feed will act as an antioxidant to prevent fatty acids from fat oxidation. The higher the dose of vitamin E in the feed, the higher the fatty acids in the fish's body (Tarigan *et al*., 2016). The higher the vitamin E content in the feed, the higher the fatty acid content and the less chance of the fatty acids being oxidized during gonadal development. In addition, vitamin E can increase metabolism which is the process of

breaking down complex compounds into simple compounds that can be used to replace damaged cells to increase the growth and survival of fish. Growth can occur if there is excess energy input from feed containing vitamin E, Rohani *et al*. (2023) found that adding vitamin E to feed significantly increases feed efficiency and maximizes growth in terms of the number of hyperplastic muscle fibers and nuclei.

The blue devil damselfish's growth and survival rates values in Table (1) showed that the highest growth and survival rates were in treatment C at a dose of 0.70 mg/kg of feed. The high growth and survival of blue devil damselfish in treatment C are presumably due to the fulfillment of protein needs, compared to treatments A, B, and D. This show that the higher the dose of vitamin E in the feed, the higher the fatty acid content in the fish's body, thus increasing the activity of the fish's digestive enzymes in the pancreas and intestines. The study by Min He *et al*. (2017) found that vitamin E supplementation at 50 and 100 mg/kg of feed can increase the activity of protease enzymes in the hepatopancreas and intestinal segments of fish and can significantly increase growth in catfish compared to the group without vitamin E supplementation. In addition, vitamin E can suppress the accumulation of toxins in the fish's body that can inhibit the fish's growth and survival.

Moniruzzaman *et al*. (2017) found that feed supplemented with vitamin E can significantly increase growth and suppress toxicity, for example, Hg in the tissues, muscles, liver, and kidneys decreased significantly. Moniruzzaman *et al*. (2017) also added that vitamin E could potentially affect growth positively and improve inorganic Hg bioaccumulation in juvenile olive flounder fish. The results of a study of Saheli *et al.* (2021) revealed that the addition of vitamin E to feed can improve growth performance and improve feed utilization, change the proximate composition, increase vitamin E concentration in the liver, improve the immune response, and increase antioxidants in Caspian trout.

Eminently vitamin E maintains fatty acids that are the main precursor of vitellogenin formation during the process of forming egg yolks (vitellogenesis), and fat is one of the main materials for oocyte formation. Apart from being an antioxidant, vitamin E can also act as a coenzyme to convert fatty acids into cholesterol. Cholesterol is one of the stimulatory materials for reproductive hormones such as estradiol -17β to help form egg yolk (vitellogenin) in the liver. Mustika (2005), as cited in Tarigan *et al*. (2017) stated that vitamin E is an antioxidant in maintaining the presence of fatty acids during gonadal development and accelerating the formation of reproductive hormones. Golli *et al*. (2017) stated that vitamin E regulates hormone secretion through gene function regulation.

In addition to being an antioxidant, vitamin E can increase the performance of reproductive hormones in fish. During the reproductive phase, 75% of the food that enters the body is utilized in gonad development. Masoudi Asil *et al*. (2017) stated that more energy is used during reproduction and gonadal development than during body weight

gain. Environmental factors such as temperature and light intensity received by the blue devil damselfish's brain will be transmitted to the hypothalamus to release the gonadotropin-releasing hormone, which will stimulate the pituitary gland to affect the follicle-stimulating hormone (FSH). FSH is carried to the gonads through the blood circulation to the oocytes and will stimulate theca cells to synthesize the steroid hormone estradiol (Mylonas *et al*., 2010). Estradiol synthesis also involves cytochrome P-450scc enzymes. Cytochrome P-450scc is a catalyst in synthesizing steroid hormones such as estradiol. Besides involving cytochrome P-45scc enzymes, steroid hormone synthesis is also influenced by cholesterol. Zhang *et al*. (2023) stated that cholesterol, like certain lipids, is a hormone precursor involved in the synthesis of sex hormones.

Wahyudi *et al.* (2016) elucidated that during vitellogenesis, estradiol is secreted by the ovaries and transported to the liver through blood circulation. Estradiol stimulates the liver to synthesize vitellogenin. Fat, a basic ingredient of vitellogenin, and vitamin E stored in the body are transported to the liver with the help of HDL. Increased lipid concentrations that are closely related to gonadal development include various fatty acids such as eicosapentaenoic acid, docosahexaenoic acid, arachidonic acid, and sterols (Nhan *et al*., 2020). Lipids and their derivatives are used as nutrients by most organisms and can serve as an energy source that plays a role in the structure of cell membranes (Zhang *et al*., 2023).

The effect of the treatment with different doses of vitamin E in commercial feed on the observed variables showed significant differences in each vitamin E dose treatment. The vitamin E dose of 0.70 mg/kg of feed resulted in a GML IV percentage (Table 1) ranging from 11.0167±1.00 - 29.033±1.010, and a GMI ranging from 14.02±2.082-2.99±1.025 (Table 1) during the six weeks of rearing. Pamungkas *et al*. (2014) postulated that 225 mg kg^{-1} of vitamin E in feed resulted in an 80% percentage of gonadal maturity in tilapia.

The increase in GSI values and the percentage of GML IV in each treatment during the six weeks of rearing was due to the high doses of vitamin E in the feed which increased the amount of fatty acids available. This can increase the level of fatty acids in the body which accelerates the formation of vitellogenin during the process of vitellogenesis in the liver, which is then quickly transported to the ovaries for egg cell formation. Vitellogenin is a precursor of egg yolk protein which is actively synthesized in the female fish's liver and then transported to the ovaries and accumulates in oocytes through receptors (Mushirobira *et al.*, 2020). However, several vitellogenin subtypes have been reported with various vitellogenin synthesis strategies observed among different species (Hiramatsu *et al.*, 2015; Hara *et al*., 2016; Reading *et al*., 2018). In acanthomorph fish such as white perch (*Morone americana),* mosquitofish (*Gambusia affinis*), red seabream (*Pagrus major*), gray mullet (*Mugil cephalus*), and striped bass (*Morone saxatilis*), there are three vtg subtypes classified into vitellogenin Aa, vitellogenin Ab, and vitellogenin C (Fin *et al*., 2007). During vitellogenesis, the ovaries will absorb

vitellogenin, maximizing the accumulation of vitellogenin. Optimal accumulation of vitellogenin causes faster gonad formation and growth. The rapid formation and growth of the gonads cause the gonad weight and the percentage of GML to increase. The increase in gonad weight causes the GSI value to rise as well. Wouters *et al*. (2001) deduced that changes in GSI values were caused by the increase in gonad weight during gonad growth and maturation, while Arfah *et al*. (2013) stated that the increase in GSI values was due to an increase in the amount of vitellogenin in vitellogenesis which was transported to the gonads.

The results in Table (1) present the fecundity value and percentage of egg maturity level (EML), and show that there are differences between the treatments in terms of quantity which are predicted to be a result of the feed supplemented with vitamin E with different doses. Fecundity is considered an important criterion for determining the quality of fish eggs (Fei *et al.*, 2020). Efrizal *et al*. (2020) stated that different doses of vitamin E in feed affect fecundity in female crabs. Different doses of vitamin E in the artificial feed are believed to affect vitellogenesis in the gonads, especially in producing essential fatty acids. Furuita *et al*. (2000) reported that one of the factors affecting fecundity was the quality of the feed given to the test animals. In this context, Millamena and Quinitio (2000) found that the ratio between omega-3 and omega-6 fatty acids affected the fecundity of mud crabs (*Scylla serrata*).

Napitu *et al*. (2013) indicated that supplementation of vitamin E as much as 300 mg/kg in feed resulted in the best fecundity value at 938 eggs in the tilapia fish. In addition, Etika *et al*. (2013) revealed that 150 mg/kg feed of vitamin E could increase egg diameter by 0.401 mm in climbing perch. In this study, treatment at 0.70 mg/kg feed of vitamin E resulted in an average fecundity ranging from 189±10.88-306±13.80 eggs. The egg maturity level (EML) in blue devil damselfish (Table 1) ranged from 19.875-42.5%. The percentage of fecundity and the egg maturity level showed that in terms of vitamin E utilization, there are differences between fish that live in seawater and fish that live in freshwater, as well as the type, age, and size of the fish. The egg maturity level increased in line with the increased dose of vitamin E in the feed. Egg maturation in blue devil damselfish is characterized by germinal vesicle breakdown (GVBD), the fusion of the egg plasma membrane.

During the process of vitellogenesis, theca cells secrete the luteinizing hormone (LH) which then stimulates the secretion of the hormone 17α-hydro progesterone which acts as a maturating inducing factor (MIH). MIH is transported to the oocyte surface through blood vessels and then enters the egg cell and encourages the release of maturation-promoting factor (MPF). MPF plays a role in triggering the migration of the egg nucleus from the center to the periphery of the egg so that later the egg cell nucleus undergoes fusion just before ovulation occurs. Arfah *et al*. (2013) stated that GVBD occurs due to the influence of MPF which is followed by nucleus fusion under the micropil. High doses of vitamin E in feed can indirectly accelerate the process of

secreting the reproductive hormone estradiol 17β, accelerating the process of vitellogenesis in blue devil damselfish. The faster the vitellogenesis process occurs, the faster the blue devil damselfish's gonads mature.

CONCLUSION

In conclusion, the addition of vitamin E to the feed has a significant effect on the absolute weight gain, survival rate, gonadal maturity level, gonadal somatic index, fecundity, and egg maturity level. Treatment C proved to be the most effective dose in accelerating gonadal maturation in blue devil damselfish (*Chrysiptera cyanea*) during the six weeks of rearing.

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