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Enrichment of *Daphnia magna* (Straus, 1820) with Viterna and Its Effects on the Growth and Survival Performance of the Freshwater Angelfish *Pterophyllum scalare* (Schultze, 1823) Larvae

Siti Hudaidah [1,*], Hilma Putri Fidyandini [1], Khoiriyah Nurya Yulianti [2], Muhammad Browijoyo Santanumurti [3,4], Syifania Hanifah Samara [3] and Hutama Satriana Farizky [5]

[1]Department of Aquaculture, Faculty of Agriculture, Universitas Lampung, Bandar Lampung, Lampung, 35145, Indonesia
[2]Program Study of Aquaculture, Faculty of Agriculture, Universitas Lampung, Bandar Lampung, Lampung, 35145, Indonesia
[3]Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya, East Java, 60115, Indonesia
[4]Department of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya, Indonesia Department of Marine Biology, Faculty of Marine Sciences, King Abdulaziz University, Jeddah, 21589, Kingdom of Saudi Arabia
[5]Program Study of Aquaculture, Faculty of Fisheries and Marine, Universitas Airlangga, Surabaya, East Java, 60115, Indonesia

[*]Corresponding Author: idahasan64@gmail.com

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ABSTRACT

The freshwater angelfish (*Pterophyllum scalare*) is a quite popular freshwater ornamental fish in Indonesia due to its distinguished body shape and pattern. However, its growth tends to be slow due to low nutrients in its main diet, namely *Daphnia magna*. The most feasible solution is to enrich *D. magna* to increase its nutritional content with Viterna (livestock vitamins). The purpose of this study was to determine the effectiveness of *D. magna* enriched with Viterna to increase the growth of freshwater angelfish. This study used a Completely Randomized Design to compare three enrichment dosages (10, 20, and 30 ml/L) with a non-enriched control in three replications. This study showed that 3 hours-enrichment can result in an increase in fat (0.6%) and protein (1.25%) profiles in *D. magna*. Absolute Weight Growth (AWG), Absolute Length Growth (ALG), and Specific Growth Rates (SGR) showed significant differences (P≤0.05) between all treatments. The best result was obtained at a Viterna dosage of 30 ml/L which resulted in an Absolute Weight Growth value of 207.14 mg, an Absolute Length Growth of 14.19 mm, and an SGR of 2.58%/day. Survival rates during the larvae culture were not statistically different (P≥0.05) among the treatments. Enrichment of *D. magna* with Viterna has been proven to optimize its potential as live food for fish larvae cultivation.

INTRODUCTION

The national ornamental fish production in Indonesia has increased from 1.22 billion individuals in 2018 to 1.68 billion in 2019 (**Ministry of Marine Affairs and Fisheries, 2021**). Freshwater angelfish (*Pterophyllum scalare*) is one of the most popular ornamental freshwater fish in the Cichlid family (**Pandolfi *et al*., 2021**). This fish is quite popular both in the domestic and foreign markets (**Dwiputra *et al*., 2021**). The selling price and consumer demand for this fish are determined by the fish's colors and patterns (**Kurnia, 2007**). Freshwater angelfish originates from the Amazon Basin in the American continent, particularly in the Ucayali River, Peru, and quickly become a top aquaculture commodity (**Ribeiro *et al*., 2021**).

However, freshwater angelfish production in Indonesia is still relatively low, especially at the early stage. A study revealed freshwater angelfish's embryogenesis and larval stage occurred at a slower rate (**Thilakarathne *et al*., 2021**). Not only slow seedling growth, but low survival is also challenging to fulfill the market demand (**Zubaidah *et al*., 2020**). This is due to sub-optimal nutritional conditions, namely *D. magna* which has less nutritional content to meet the needs of freshwater angelfish growth (**Putra *et al*., 2017; Zubaidah *et al*., 2020**).

Daphnia magna is the most commonly used live food for freshwater angelfish hatcheries. Despite its nutritional shortcomings, *D. magna* is still popular because it is easily digested by fish, does not reduce water quality, contains essential amino acids, and is easy to obtain. **Putra *et al*. (2017)** stated that the growth performance of freshwater angelfish seeds fed with *D. magna* resulted in poor growth. Thus, it is necessary to enrich to increase the nutritional content of *D. magna*. One solution that can be done is to use Viterna (livestock vitamins or livestock vitamins). Viterna is a feed supplement containing minerals, vitamins, amino acids, probiotics and fatty acids (aspartic acid and glutamic acid) to increase nutritional content and accelerate growth (**Agustina and Wuniarto, 2020**). Viterna consists of 42.82% protein, 47.31% carbohydrates, 4.5% fat, 2.74% minerals and 2.63% vitamins (**Erwin *et al*., 2016**). Therefore, Viterna has great potential as a *D. magna* enrichment agent.

Several studies regarding *D. magna* enrichment has a positive impact on the growth profile and survival rate of fish larvae. **Wiratama *et al*. (2021)**, in their research also enriched *D. magna* using ascorbic acid for freshwater angelfish cultivation. It showed a significant impact on the growth and the survival rate after challenge testing with *Aeromonas hydrophila*. This survival rate was 100% before the challenge test and decreased to 79.99 ± 1.00% and has an SGR of 2.393 ± 0.003%/day. **Fereidouni *et al*. (2013)** enriched *D. magna* using canola oil to determine its effect on the growth, survival rate and stress resistance of *Caspian cutum* larvae. The 6-hour enrichment yielded the greatest amounts of C_{18} PUFAs in *D. magna*. It also showed that the weight gain, SGR, and resistance to salinity stress all markedly improved in the treated larvae. In addition, there has been research using Viterna on *D. magna* for Rasbora fish (*Rasbora tawarensis*) cultivation and showed that it increased the survival profile to 88.89% and a specific growth rate of 0.66%/day **(Saputri *et al*., 2019)**. In addition, research by adding 10 ml/L Viterna to *D. magna* was able to increase growth in length by 17.09 mm, weight growth by 27.53 mg, specific growth rate by 9.657%/day and seed survival of pearl trout

(*Trichogaster leeri*) by 100 % **(Basri, 2015)**. Based on this description, it is important to research the potential for *D. magna* enrichment using Viterna to increase the growth and survival rate of freshwater angelfish larvae.

MATERIALS AND METHODS

1. Experimental design and diets preparation

This study used a completely randomized design (CRD) with 4 treatments and 3 replications (**Table 1**). The determination of Viterna dosage in this *D. magna* enrichment experiment has been modified regarding the study of **Mufidah *et al*. (2009)** and **Saputri *et al*. (2019).** *Daphnia magna* inoculum was obtained from Lampung Marine Cultivation Center while Viterna was gotten from PT Natural Nusantara, Yogyakarta, Central Java. The nutritional content of Viterna in this study was shown in **Table 2**.

Table 1. Dosage of Veterna enrichment in each treatment

No.	Treatment(s)	Dosage
1	A (Control)	Giving *Daphnia magna* without enrichment with Viterna
2	B	Giving *Daphnia magna* Viterna enriched 10 ml/L
3	C	Giving *Daphnia magna* Viterna enriched 20 ml/L
4	D	Giving *Daphnia magna* Viterna enriched 30 ml/L

The enrichment process was carried out by soaking *D. magna* in Viterna solution for 3 hours **(Wiratama *et al*., 2021)**. First, *D. magna* was put into each enrichment aquarium (20x15x15 cm) containing one liter of freshwater which was added with Viterna at the dose according to the treatment (A = 0 ml/L; B = 10 ml/L; C = 20 ml/L; D = 30 ml/L) and then left for 3 hours with aeration in each aquarium. After 3 hours, the *D. magna* is filtered and dipped in freshwater (rinsing) and ready to be given to freshwater angelfish larvae.

2. Experimental fish and maintenance technique

First, the rearing aquarium (50x40x30 cm) was sterilized with 0.5 g chlorine dissolved in 40-liter freshwater and let stand for 24 hours. After the sterilization and drying process is complete, 25 liter freshwater was poured into a sterile aquarium, aerated and set aside for 24 hours. The freshwater angelfish larvae have an average length of 12 – 19 mm and an average weight of 90 – 240 mg. The fish in this study were obtained from the Lampung Marine Cultivation Center. The stocking density used in the rearing period is one individual/liter maintained for 30 days. The larvae were fed 3 times a day (7 am, 12 pm, and 5 pm). *Daphnia magna* in each treatment will increase weekly from 50 individuals/larvae, 100 individuals/ larvae, 150 individuals/larvae, 200 individuals/larvae, and 250 individuals/larvae in the last week.

Table 2. Content of Viterna as enricher

Vitamin	Probiotics	Mineral	Amino Acid	Volatil Fatty Acid
• A	• *Lactobacillus* sp. (2.5 x 10^7 cfu/ml)	• N	• Tyrosine	• Aspartic acid
• D	• *Streptomyces* sp. (2.42 x 10^6 cfu/ml)	• P	• Histidine	• Glutamic acid
• E	• *Saccharomyces* sp. (8.20 x 10^7 cfu/ml)	• K	• Isoleucine	
• K	• *Azotobacter* sp. (1.31 x 10^6 cfu/m)	• Ca	• Leucine	
	• *Aspergillus* sp. (1.90 x 10^5 cfu/ml)	• Na	• Lysine	
	• *Trichoderma* sp. (2.8 x 10^5 cfu/ml)	• Mg	• Methionine	
		• S	• Phenylalanine	
		• Ci	• Tryptophan	
		• Fe	• Valine	
		• Cu	• Arganine	
		• Zn	• Therionine	
		• Mn		
		• Co		
		• I		
		• Se		
		• Mb		

3. Sampling

Sampling was conducted twice, at the beginning (t_0) and the end of maintenance (t_{30}) by randomly taking seven fish from each aquarium. Try to do it quickly during the sampling process to get data on the length and weight of each fish sample. The data taken during sampling included absolute weight growth (g), absolute length growth (cm), specific growth rate (%) and survival rate (%). The measurement of water quality includes parameters of temperature (^{o}C), pH and DO (mg/L). After all the data has been collected, the sampled fish were returned to their respective aquariums.

4. Proximate analysis of *D. magna* (Straus, 1820) after enrichment with Viterna

The proximate analysis of *D. magna* was carried out to determine the nutritional content before and after enrichment with Viterna. It includes a test for protein content, fat content, water content, ash content, crude fiber content, and carbohydrate content. The proximate analysis was carried out at the Laboratory of Agricultural Product Technology, Lampung State Polytechnic.

5. Growth performance parameters

Absolute weight growth

The absolute weight growth was calculated according to **Jobling (2003)** as follows:

$$W = Wt - W0$$

Notes:

W : absolute weight growth (g);

Wt : mean weight at the end of study (g);

W0 : mean weight at the initial of study (g).

Absolute length growth

The absolute length growth was calculated according to **Jobling (2003)** as follows:

$$L = Lt - L0$$

Notes

L : absolute length growth (cm);

Lt : mean length at the end of the study (cm);

L0 : mean length at the initial of the study (cm).

Specific growth rate (%)

The specific growth rate was calculated according to **Zonneveld *et al*. (1991)** as follows:

$$SGR = \frac{Ln\,Wt - Ln\,W0}{t}\ x\ 100\%$$

Notes:

SGR : specific growth rate (%);

LnWt : mean weight at the end of study (g);

LnW0 : mean weight at the initial of study (g);

t : experimental period in days.

Survival rate (%)

The survival rate was calculated according to **Hung *et al*. (1993)** as follows:

$$SR = \frac{Nt}{N0}\ x\ 100\%$$

Notes:

SR : survival rate (%);

N0 : number of fish alive at the end of the study (ind);

Nt : number of fish alive at the end of the study (ind).

5. Water quality parameters

During this study, the water quality parameters measured were temperature (^oC), pH and DO (mg/L). Measurements were taken twice daily (7 a.m. and 5 p.m.) using AMTAST EC910 (USA).

6. Statistical analysis

The data obtained were then analyzed with one-way ANOVA using the computer program Statistical Package for Social Sciences (Software of SPSS, UK, London) to determine the effectiveness of *D. magna* enriched with Viterna on the growth and survival performance of the freshwater angelfish larvae. To determine the differences among the experimental groups, Duncan's multiple range test was in case significant differences existed **(Duncan, 1955)**. The water quality parameters (temperature, pH, and DO/Dissolved Oxygen) would be presented in tabular form and analyzed descriptively.

RESULTS

1. *D. magna* proximate analysis

The results of the proximate analysis of *D. magna* before and after being enriched with Viterna based on wet weight can be seen in Table 3. The results of the proximate analysis of *D. magna* in each treatment showed an increase after enrichment, especially in the fat (0.87 – 1.47%) and protein (3.10 – 4.35%) profiles.

Table 3. Results of *Daphnia magna* proximate analysis after enrichment (based on wet weight)

Treatment(s)	Nutritional Content (%)					
	Water content	Ash content	Fat content	Protein content	Crude fibre content	Carbohydrate content
A (Control)	93.72	0.39	0.87	3.10	0.80	1.91
B (10 ml/L)	94.18	0.04	0.96	3.30	1.54	1.51
C (20 ml/L)	94.19	0.06	1.24	3.96	1.36	0.54
D (30 ml/L)	93.19	0.49	1.47	4.35	1.29	0.48

2. Absolute weight growth

The absolute weight growth of freshwater angelfish larvae during the study can be seen in **Fig. 1**. Based on the research, the absolute weight growth of freshwater angelfish larvae was highest in treatment D (207.14 ± 46.84 mg), treatment C (143.33 ± 8.73 mg), treatment B (111 ± 43.24 mg), and the lowest in treatment A (70.00 ± 36.45 mg). The results of the analysis of variance at the 95% confidence level showed a significant difference ($P<0.05$) in the absolute weight growth of freshwater angelfish larvae. Based on Duncan's post-hoc test, it was found that treatment A was significantly different ($P<0.05$) from treatment D, but not significantly different ($P>0.05$) from treatment B. Treatment D was significantly different ($P<0.05$) from treatment A and B, but not significantly different ($P>0.05$) in treatment C.

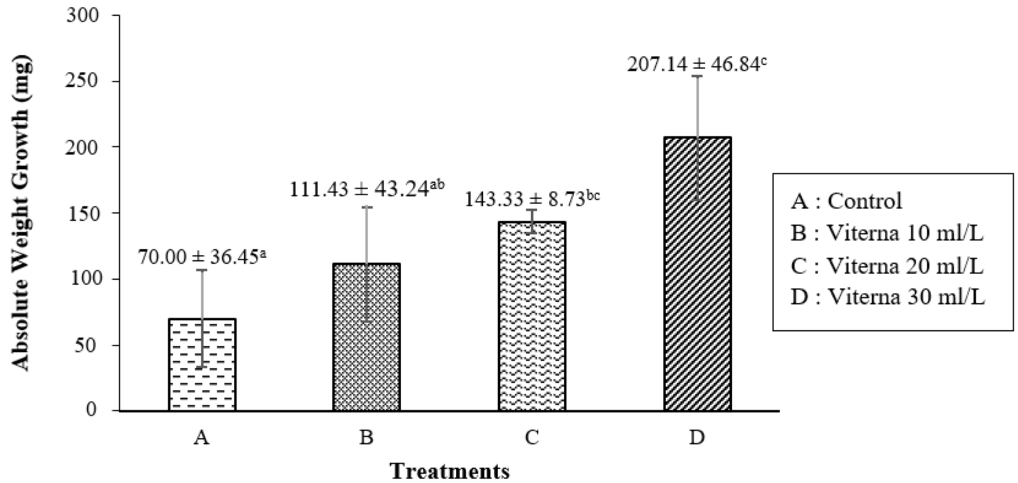

Fig. 1. Absolute weight growth of freshwater angelfish larvae during the research

Note: Values followed by different superscript letters indicate the effect of significant differences between treatments

3. Absolute length growth

The absolute length growth of freshwater angelfish larvae during the study can be seen in **Fig. 2**. Based on the research that has been done, it is known that the absolute length growth of freshwater angelfish larvae sequentially starting from the highest was treatment D (14.19 ± 5.79 mm), treatment C (8.48 ± 0.93 mm), treatment B (7.71 ± 1.79 mm), and the lowest was treatment A (5.95 ± 1,23 mm). The results of the analysis of variance at the 95% confidence level showed that the administration of Viterna to *D. magna* had a significant difference ($P<0.05$) in the absolute length growth of freshwater angelfish larvae. Based on Duncan's further test, it was found that treatment A was significantly different ($P<0.05$) from treatments B and D, but not significantly different ($P>0.05$) from treatment C.

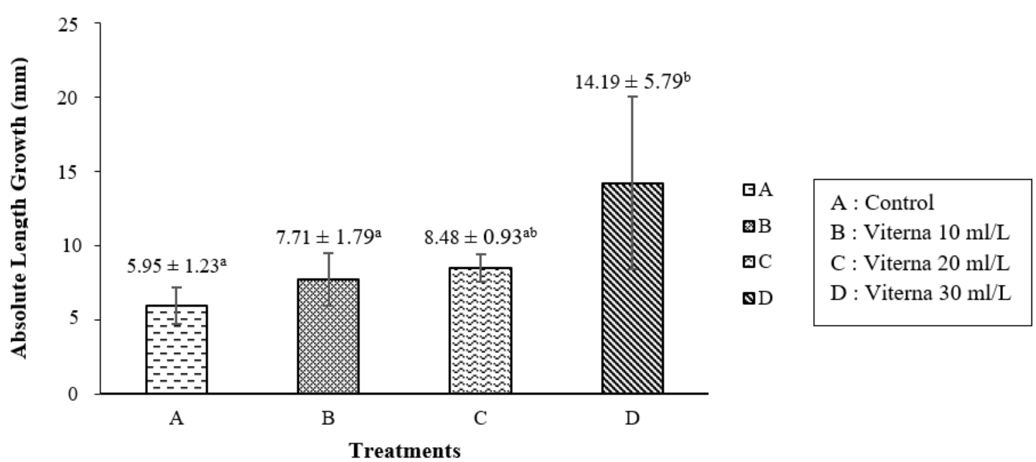

Fig. 2. Absolute length growth of freshwater angelfish larvae during the research

Note: Values followed by different superscript letters indicate the effect of significant differences between treatments

4. Specific growth rate

The specific growth of freshwater angelfish larvae during the study can be seen in **Fig. 3.** Based on the research that has been done, it is known that the specific growth rate of freshwater angelfish larvae sequentially starting from the highest was treatment D (2.55 ± 0.52 %), treatment C (1.94 ± 0.08 %), treatment B (1.82 ± 0.63 %), and the lowest was treatment A (1.33 ± 0.70 %). The results of the analysis of variance at the 95% confidence level showed that the administration of Viterna to *D. magna* had a significant difference ($P<0.05$) in the specific growth rate of freshwater angelfish larvae. Based on Duncan's further test, it was found that treatment A was significantly different ($P<0.05$) from treatment D, but not significantly different ($P>0.05$) from treatments B and C.

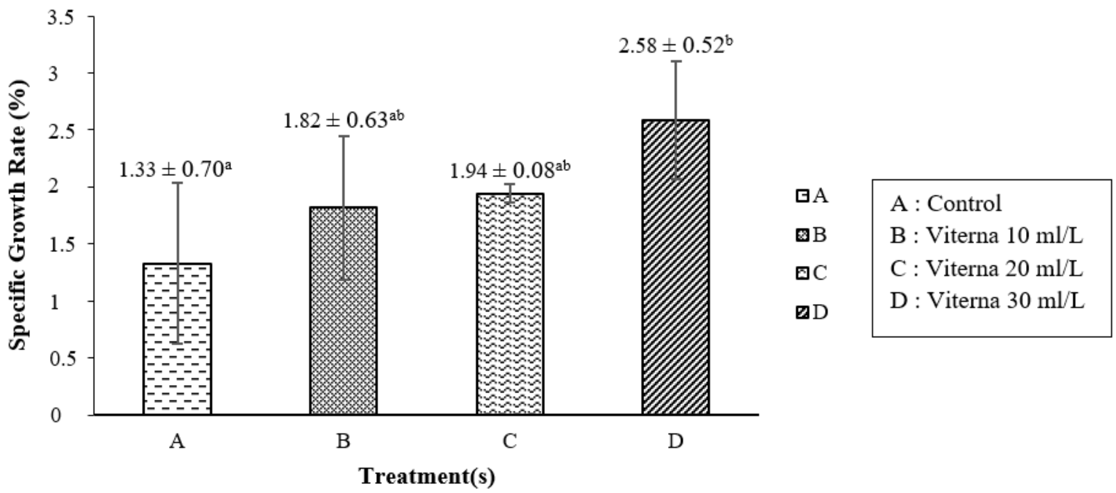

Fig. 3. Specific growth rate of freshwater angelfish larvae during the research

Note: Values followed by different superscript letters indicate the effect of significant differences between treatments

5. Survival rate

The survival rate of freshwater angelfish larvae during the study can be seen in **Fig. 4**. Based on the research that has been done, it is known that the survival rate of freshwater angelfish larvae sequentially starting from the highest was treatment D (100 ± 0.00 %), treatment C (99 ± 1.89 %), treatment B (99 ± 2.31 %), and the lowest was treatment A (95 ± 4.16 %). Based on Duncan's further test, no significant difference ($P>0.05$) was found.

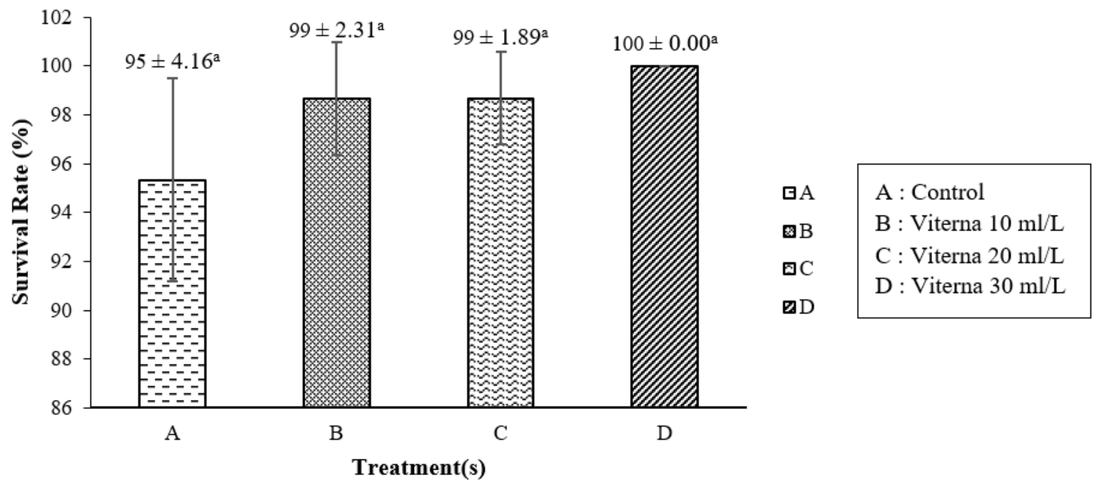

Fig. 4. Survival rate of freshwater angelfish during the research

Note: Values followed by different superscript letters indicate the effect of significant differences between treatments

6. Water quality parameters

Measurement of water quality in rearing freshwater angelfish larvae includes temperature, pH, and DO. The results of each water quality measurement are presented in Table 4. Based on the results of water quality measurements, the water quality during the maintenance of freshwater angelfish larvae was within the optimum range for life. From the measurement results, the average temperature in the morning (7 a.m.) ranges from 27 – 28℃. and evening (5 p.m.) around 28 – 29℃. The results of the average pH measurements in the morning (7 a.m.) ranged from 6 – 7.4 and in the afternoon (5 p.m.) ranged from 6 – 7.7. While the results of the average DO measurements in the morning (7 a.m.) ranged from 5.2 – 8.2 mg/L and in the afternoon (5 p.m.) ranged from 5.6 – 8.7 mg/L.

Table 4. Range of water quality parameters during the research

Parameter(s)	**Time**		**Optimum Value**	**Reference**
	7 a.m.	**5 p.m.**		
Temperature (ºC)	27 – 28	28 – 29	25 – 30	(**National Standards Agency**, 2013)
pH	6 – 7.4	6 – 7.7	6.5 – 7.5	
DO (mg/L)	5.2 – 8.2	5.6 – 8.7	≥5	

DISCUSSION

Live food enrichment has been widely carried out through various approaches (**Ako *et al*., 1994; Ravet *et al*., 2003; Ridha *et al*., 2019; Wiratama *et al*., 2021**). In the current study, Viterna enriched and unenriched *D. magna* significantly differed in lipid and protein content. Our results showed the duration of enrichment for 3 hours could increase fat (0.6%) profiles in *D. magna*. Thus, the fat content increases with increasing doses of Viterna. **Macedo and Pinto-Coelho (2001)** in their study reported an increase in fat content in *M. micrura* (from 11.4 to 19.9%) and *D. laevis* (from 1.11 to 22.2%) given a mixture of *Scenedesmus quadricauda* and *Ankistrodesmus gracilis* which has been known to be rich in fatty acids and proteins.

A study conducted by **Goulden and Place (1993)** found that zooplankton belonging to the Cladoceran group are capable of accumulating quite large amounts of fat (≥ 20% dry weight) in their bodies. However, some specific findings regarding *D. magna* in previous studies have stated that the total fat content contained is 1.09% (**Ghazy *et al*., 2009**) and 13% **(Watanabe *et al*. al., 1983**). Such differences in total body fat of *D. magna* species can be related to feeding consumed, culture conditions, species differentiation and/or enrichment methods (**Fereidouni *et al*., 2013**). *Daphnia magna* can absorb the nutrients contained in the enrichers because they are zooplankton which are filter feeders so that they can more quickly utilize the nutrients contained in their environment **(Pennak, 1989)**, including the nutrients contained in Viterna as enrichers.

Not only fat, but the protein content of *D. magna* in this study also increased to 1.25%. Protein is a macronutrient needed by fish seeds to form new tissue and replace damaged tissue during the growth phase. The protein content in *D. magna* profile is directly proportional to the increase in Viterna dose. This is thought to be due to *D. magna* being able to absorb amino acids and optimally utilize the good bacteria contained in Viterna so that the protein content can increase. A study stated that in the environment *D. magna* can absorb the protein directly from the Dissolved Organic Matter (DOM) through the cellular membrane or gut (**Lin *et al*., 2018**). Protein is needed by fish larvae especially in the early phase (growth) to repair and form cell tissue (**Balami *et al*., 2019**). Proteins also induce enzymes and hormones for growth such as IGF-1 (**Wei *et al*., 2020**).

The fat profile of *D. magna* after enrichment increased in each treatment except for the control treatment (without enrichment). The highest fat profile after 3 hours of enrichment was obtained by treatment D (30ml/L) with a total fat content of 1.47%. Fat is one of the important macronutrients which is a source of energy in feed (**Sargent *et al*., 2002**). The increase in fat content in *D. magna* after Viterna enrichment indicated that *D. magna* also experienced an increase in energy in the body (**Radhakrishnan *et al*., 2020**). This high energy availability in *D. magna* causes an increase in absolute weight, absolute length, and SGR in freshwater angelfish larvae that were given *D. magna* after enrichment compared to those that were not enriched (**Mokoginta *et al*., 2003**). Fat besides functioning as a source of energy is also a source of essential fatty acids. **Zhou et al. (2021)** in their research stated that the functions of essential fatty acids in living bodies include maintaining the integrity of cell membranes, as precursors for prostaglandin, prostacyclin, thromboxane, and leukotriene compounds. Viterna is known to contain aspartic acid and glutamic acid, both of which are essential fatty acids. In addition, fat also plays a role as a solvent for vitamins, especially vitamins A, D, E and K (**Tumiwa *et al*., 2020**), which are the four vitamins contained in Viterna so vitamins (A, D, E, K) are assumed to be more easily absorbed by freshwater angelfish larvae because they have previously been through the stages of metabolism (dissolved) in *D. magna* body which has a high-fat content.

The carbohydrate content in *D. magna* ranges from 0.40 – 1.91%. Carbohydrates are a source of energy for fish fry and can be used in the maintenance of their bodies. Giving Viterna to *D. magna* has a negative relationship with increasing the dose of Viterna. The more Viterna given, the nutrients absorbed by *D. magna* will increase. This is following the opinion of **Mufidah *et al*. (2009)** who stated that *Daphnia* sp. which has been enriched with Viterna, values its nutritional content will increase. According to **Putra *et al.* (2016),** *Daphnia* sp. can absorb the nutrient content in Viterna which will be used by the fish's body for its energy needs and growth. In general, the crude fiber content contained in *D. magna* has increased, the range of fiber contained is 0.80 – 1.54%. Crude fiber is a carbohydrate compound that is difficult to digest in the fish's body. Crude fiber that is too high in feed is not good for fish because it can inhibit the digestive process of fish.

Giving *D. magna* which is enriched with Viterna can increase the nutritional content which has a good impact on freshwater angelfish larvae, this is what will later support the growth of freshwater angelfish larvae better. This excess energy will be used optimally by freshwater angelfish larvae to accelerate their growth process. According to **Agus and Mardiana (2015)** in their research, it was stated that providing feed with good nutritional content and following the nutritional needs of fish will lead to an increase in more optimal fish growth. In addition, it has been explained that enrichment (Viterna) contains natural growth hormones that can help increase fish growth. Viterna is a multivitamin and probiotic that can be given through feed and contains amino acids that can play a role in its growth process. Amino acids play an important role as a source of energy in increasing growth and stimulating appetite in fish **(Zou et al., 2022).**

Freshwater angelfish larvae fed enriched *D. magna* with Viterna obtained higher absolute weight, absolute length and SGR values compared to the non-enrichment treatment, with D (30ml/L) as the best dose for these three growth parameters. The good protein and fat content in *D. magna* after being enriched with Viterna had a recorded effective impact on fish growth in this study. Based on this study, it is known that the absolute weight growth of freshwater angelfish larvae sequentially starting from the highest was treatment D (207.14 ± 46.84 mg), treatment C (143.33 ± 8.73 mg), treatment B (111 ± 43.24 mg), and the lowest was treatment A (70.00 ± 36.45 mg). Using Duncan's posthoc test, it was found that treatment A was significantly different ($P<0.05$) from treatment C and D, but not significantly different ($P>0.05$) from treatment B. Treatment D was significantly different ($P<0.05$) from treatment A and B, but not significantly different ($P>0.05$) in treatment C. This could be since the nutrients absorbed by *D. magna* after enrichment with Viterna were classified as optimal and appropriate for freshwater angelfish larvae so that they were able to significantly increase the absolute weight growth value. In addition, through research conducted by **Guscania *et al*. (2015)** regarding pearl gourami (*Trichogaster leeri*) larvae, we come to understand that the nutritional needs of each fish larvae are different, for example in their research, **Guscania *et al*. (2015)** revealed that the optimum dose of *Daphnia* sp. with Viterna which was broken down for pearl gourami larvae obtained at a dose of 10 ml/L with an absolute weight growth value of 27.53 ± 1.861 mg while at a dose of 30 ml/L Viterna was only able to produce an absolute weight growth value of 8.56 ± 0.608 mg.

In this study, it is found that the absolute length growth of freshwater angelfish larvae sequentially starting from the highest was treatment D (14.19 ± 5.79 mm), treatment C (8.48 ± 0.93 mm), treatment B (7.71 ± 1.79 mm), and the lowest was treatment A (5,95 ± 1,23 mm). Using Duncan's posthoc test, it was found that treatment A was significantly different ($P<0.05$) from treatment D, but not significantly different ($P>0.05$) from treatments B and C. This has been seen since the beginning of rearing through the high appetite of freshwater angelfish larvae when given *D. magna* which was enriched with Viterna compared to the control treatment which tended to be less active in eating *D. magna*. This good appetite cannot be separated from the role of the probiotics contained in Viterna such as *Lactobacillus* sp., *Streptomyces* sp., *Saccharomyces* sp., *Azotobacter* sp., *Aspergillus* sp., and *Trichoderma* sp. which is also supported by vitamins, minerals and other good fatty acids (NASA, 2004). The absolute length growth results in treatment A (control) showed that the protein content contained in *D. magna* without enrichment was less able to accommodate the nutritional needs of freshwater angelfish larvae for their absolute weight and length growth. The absolute length growth of freshwater angelfish larvae is closely related to the availability of protein and fat in the feed because protein acts as the main energy source for freshwater angelfish larvae for growth and fat serves as an energy reserve (**Mokoginta *et al*., 2003**). According to **Eiras *et al*. (2022)**, the nutrients contained in the feed are the main support in determining the high growth rate of freshwater angelfish larvae.

Based on this study, it is known that the specific growth rate of freshwater angelfish larvae starting from the highest was treatment D (2.55 ± 0.52 %), treatment C (1.94 ± 0.08 %), treatment B (1.82 ± 0.63 %), and the lowest was treatment A (1.33 ± 0.70 %) respectively. Using Duncan's posthoc test, it was found that treatment A was significantly different ($P<0.05$) from treatment D, but not significantly different ($P>0.05$) from treatments B and C. This was due to the protein content contained in treatment D of *D. magna* after enrichment increased to 4.35% from previously only 3.10%, so treatment D was considered more optimal for freshwater angelfish larvae in meeting protein needs for growth. Similar to the fat content, treatment D had better fat content than treatment A, which was 1.47% versus 0.87%, which is well-known that fat is an energy reserve for living things including freshwater angelfish larvae (**Mokoginta *et al*., 2003**). In addition, the carbohydrate content of *D. magna* in treatment A had a higher value than *D. magna* in treatment D, which was 1.91% versus 0.48%. Meanwhile, **Tacon (1987)** in his research, he stated that fish feed that has too high carbohydrates can inhibit the growth process of fish because there will be an increase in the amount of glycogen in fish livers which can also cause death in these fish if they reach their tolerance threshold. Glycogen accumulation in the liver can also be exacerbated by the minimal movement of fish in the rearing medium. This is what makes the SGR value in treatment D the best.

In addition, an increase in the survival rate of freshwater angelfish after being fed enriched *D. magna* occurred. However, after Duncan's further test, it was found that it was not significantly different (P>0.05) from the survival rate of freshwater angelfish larvae (*Pterophyllum scalare*). This indicates that the enrichment of *D. magna* with Viterna did not negatively affect the survival of freshwater angelfish larvae. This is also in line with research conducted by **Fadilah *et al*. (2020)** regarding the administration of Viterna with different doses of feed on the survival of tilapia larvae (*Oreochromis niloticus*) which stated that there was no significant effect between the control treatment and other treatments. The high fish survival rate at the maintenance stage is also influenced by the quality of the water that supports it (**Mufidah *et al*., 2009**).

Water quality is a supporting factor that influences the growth and survival rate of freshwater angelfish larvae rearing. Poor water quality can inhibit fish growth and can even cause death. From the results of water quality measurements during this study, the resulting water quality was at an optimum value for the growth of fish fry and could support the survival of freshwater angelfish larvae, so the survival value was still relatively high with a range of 95 – 100%. **Jayalekshmi *et al*. (2017)** in their research also said that apart from the nutrients needed by fish, controlled water quality will also affect the growth of freshwater angelfish larvae. Based on the results of measurements during the study, the temperature range obtained was morning temperature ranging from 27 – 28 ^{o}C. and in the afternoon around 28 – 29 ^{o}C. According to **National Standards Agency (2013)**, the ideal temperature parameter value for the growth of freshwater angelfish larvae is 25 – 30 ^{o}C. Above this temperature, the increase in appetite in fish will decrease so that it can cause an increase in metabolic activity and the digestive process of the freshwater angelfish larvae becomes hampered. The results of measuring these water quality parameters are in accordance with **National Standards Agency (2013)** standards indicating that the maintenance of freshwater angelfish larvae is in a good environment for growth and survival.

CONCLUSION

In this study, Viterna was applied to enrich *D. magna* which will be used as live food for freshwater angelfish (*Pterophyllum scalare*) larvae. The protein and fat profiles contained in *D. magna* increased rapidly as a result of enrichment with Viterna. This study shows that the duration of enrichment for 3 hours can result in an increase in fat (0.6%) and protein (1.25%) profiles in *D. magna*. Data on feeding *D. magna* to freshwater angelfish larvae enriched for 3 hours showed an increase in absolute weight growth, absolute length growth and specific growth rate (SGR) all significantly increased in treated larvae. The best dosage of Viterna was in treatment D (30ml/L). Enrichment of *D. magna* with Viterna has been proven to optimize its potential as live food for fish larvae cultivation.

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