The effectiveness of feeding *artemia* enriched with vitamin C on the growth performance and survival of *Lemeduk* fish larvae (*Barbonymus schwanenfeldii*)

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Abstract. The culture of lemeduk fish (*Barbonymus schwanenfeldii*) still have several obstacles including lack of nutrients in fish diet which causes slow growth rate and low survival. The objective of this study was to analyze the effectiveness of feeding *Artemia* enriched with vitamin C at different doses on the growth performance and survival of lemeduk fish (*Barbonymus schwanenfeldii*). This research used completely randomized design method consisting 5 treatments and 3 replications. The treatments tested were *Artemia* enriched with vitamin C at different doses, namely A (*Artemia* without vitamin C enrichment), B (*Artemia* enriched with vitamin C 100 mg/l), C (*Artemia* enriched with vitamin C 200 mg/l), D (*Artemia* enriched with vitamin C 300 mg/l) and E (*Artemia* enriched with vitamin C 400 mg/l). The results showed that the addition of vitamin C in the *Artemia* had a significant effect (P<0.05) on absolute length growth, daily growth rate and survival of *lemeduk* fish larvae, but there were no significant effect (P>0.05) on the absolute weight and coefficient of variation. The research showed that the highest value of absolute length growth and daily growth rate were found in treatment D (*Artemia* enriched with vitamin C 300 mg/l) with an absolute length growth of 6.6±0.48 mm and daily growth rate of 0.330±0.026 mm/day, and the highest survival value was found in treatment C (*Artemia* enriched with vitamin C 200 mg/l) of 91.7±7.6%.

1. Introduction
Lemeduk fish (*Barbonymus schwanenfeldii*) is one of native species found in upstream of river. This fish commonly live in river that has medium current with sandy mud and rocky substrate. The main food of lemeduk fish in nature is phytoplankton and water plants that are around it. Lemeduk fish is one of the consumption fish that has high economic value, besides that lemeduk fish is also potential as ornamental fish because of its unique shape, yellowish silver body color and has orange or red dorsal and tail fins [1].

Lemeduk fish cultivation development is currently being carried out at the lukup badak fish seed center (BBI), Central Aceh. However, in its development, lemeduk fish still have several obstacles, including lack of nutrients in feed which causes stunted fish growth and low survival. Feed serves as nutritional intake that can produce energy to support fish growth. Fish larvae need feed that has adequate nutritional content and is suitable for its mouth opening. According to Jusadi et al. [2] fish need feed with adequate and balanced nutritional content so that growth can take place properly. The feed given during the fish larvae is in the form of natural food. Natural food is live food for fish larvae and seeds which include phytoplankton and zooplankton. *Artemia* is one of the natural feed consumed by fish larvae. Setiawati et al. [3] revealed that *Artemia* is feed that commonly used at stadia larvae to seeds with size 19.05 mm. Moreover, *Artemia* has a body...
size that suitable to mouth openings of fish larvae and easy to digest also has high nutrition [4]. Enrichment of live feed often is carried out by fish farmer for enhancing nutrition in feed [5]. One of the methods used is by using vitamin C.

Vitamin C is needed by fish to support growth rate and survival rate. However, vitamins cannot be synthesized in the body of the fish, so that to meet the needs of vitamins in the body of the fish, these vitamins can be added to the feed. According to Handajani and Wahyu [6], vitamin C has a role in several oxidation-reduction reactions and is easily absorbed in the body, vitamin C deficiency can result in irregularities (Cycosis, lordosis, and abnormal support of cartilage, eyes, gills, and fins).

Research on the use of vitamin C in feed has been carried out in several types of fish, such as depik [7], red rainbow fish [8], pedih fish [9], peres fish [10], biawan fish [11], cuttlefish [12], yellowfin seabream [13] and many other types of fish. Research on the use of vitamin C in the enrichment of Artemia is important because vitamin C is needed by the fish body for growth and survival.

2. Material and Methods

2.1. Time and Site
This study has been carried out from February to March 2020. It has been conducted at Technical Implementation Unit of Balai Benih Ikan (BBI) Lukup Badak, Fisheries Department of Aceh Tengah Regency, Aceh Province.

2.2. Research Procedure
This research used completely randomized design method consisting 5 treatments and 3 replications. The treatments tested were Artemia enriched with vitamin C at different doses, namely A (Artemia without vitamin C enrichment), B (Artemia enriched with vitamin C 100 mg/l), C (Artemia enriched with vitamin C 200 mg/l), D (Artemia enriched with vitamin C 300 mg/l) and E (Artemia enriched with vitamin C 400 mg/l). Fish used in this study were 300 fish aged 14 days with an average length of 4.10 mm which were reared for 20 days. Fish fed Artemia 2 times a day by ad libitum.

2.3. Absolute length growth
The absolute length growth (L) were calculated in this study based on Effendi [14] as follow: \( L = L_f - L_0 \), where: \( L_f \) is fish length at final experiment (mm) and \( L_0 \) is fish length at initial experiment (mm).

2.4. Absolute weight growth
The absolute weight growth (W) were calculated in this study based on Weatherley [15] as follow: \( W = W_f - W_0 \), where: \( W_f \) is Fish weight at final experiment (g) and \( W_0 \) is Fish weight at initial experiment (g).

2.5. Daily growth rate
The daily growth rate (DGR) were calculated based on Elliott dan Hurley [16] as follow: \( DGR = \frac{(L_f - L_0)}{t} \), where: \( L_f \) is final length of fish (mm), \( L_0 \) is initial length of fish (mm) and \( t \) is experiment period (day)

2.6. Coefficient of Variation of Length (CV)
Coefficient of Variation (CV) were calculated according to Steel and Torrie [17] as follow: \( CV = \frac{(S/Y)}{100\%} \), where: S is square root of sample, Y is average of sample.

2.7. Survival rate
Survival rate (SR) were calculated based on Han et al. [18] as follow: \( SR = \frac{N_f}{N_0} \times 100\% \), where \( N_f \) = final number of fish, and \( N_0 \) = initial number of fish.

3. Results and discussions
Based on the result, length growth of Lemeduk fish larvae enhanced during the experiment in all treatments. It can be seen that at the final experiment, the highest length growth found at treatment D
(Artemia enriched with vitamin C 300 mg/L) was about 10.67 mm and the lowest length growth was about 9.70 mm found at treatment A (Artemia without vitamin C enrichment).

![Figure 1. Length growth of Lemeduk fish larvae (Barbonymus schwanenfeldii)](image)

According to ANOVA test, feeding Artemia enriched with vitamin C had a significant effect (p<0.05) on absolute length growth, daily growth rate, and survival of Lemeduk fish larvae, but no significant effect (p>0.05) on absolute weight growth and coefficient of variation of length. For the further test, the highest length growth and daily growth rate found at treatment D was about 6.6 ±0.48 mm 0.330±0.026 mm/day, respectively. But no significant difference was observed between the other treatments (Table 1.). This has similar result with study of Uliza et al. [10], the addition of vitamin C with a dose 300 mg/kg of feed had the highest growth rate of Osteochilus vittatus.

**Table 1.** Average of absolute length growth, absolute weight growth, daily growth rate, coefficient of variation of length and survival of Lemeduk fish larvae.

| Treatment | Absolute Length Growth (mm) | Absolute Weight Growth (g) | Daily Growth Rate (mm/day) | Coefficient of Variation of Length (%) | Survival Rate (%) |
|-----------|-----------------------------|----------------------------|---------------------------|----------------------------------------|------------------|
| A         | 5.6±0.40<sup>a</sup>        | 0.0049±0.0006<sup>a</sup> | 0.280±0.020<sup>a</sup>  | 6.7±1.5<sup>a</sup>                    | 75.0±5.0<sup>a</sup> |
| B         | 5.8±0.26<sup>a</sup>        | 0.0055±0.0003<sup>a</sup> | 0.290±0.017<sup>a</sup>  | 7.7±1.6<sup>a</sup>                    | 78.3±7.6<sup>ab</sup> |
| C         | 6.1±0.18<sup>ab</sup>       | 0.0062±0.0009<sup>a</sup> | 0.303±0.058<sup>ab</sup> | 8.4±2.4<sup>a</sup>                    | 91.7±7.6<sup>b</sup> |
| D         | 6.6±0.48<sup>b</sup>        | 0.0059±0.0008<sup>b</sup> | 0.330±0.026<sup>b</sup>  | 5.3±0.7<sup>a</sup>                    | 86.7±7.6<sup>ab</sup> |
| E         | 5.9±0.12<sup>c</sup>        | 0.0052±0.0007<sup>c</sup> | 0.296±0.058<sup>c</sup>  | 9.4±1.2<sup>a</sup>                    | 73.3±7.6<sup>c</sup> |

Different superscript in the same column are significantly different (p <0.5)

Feeding Artemia enriched with vitamin C had the high absolute length growth and daily growth rate compared with the control treatment (treatment A), because the vitamin C as supporting growth and play a role in enhancing immune function so that treatment with the addition of vitamin C produces the better growth rate. This is supported by Sunarto et al. [19] statement, vitamin C is useful in increasing the growth and immunity of fish, reducing stress, and can accelerate the wound healing process in fish. According to Sinjal [20], vitamin C contains two amino acids namely the hydroxylation of proline and lysine which are the main components of collagen. Collagen is a type of protein in the body which amounts to between 20-35% of total body protein [3]. Fuadi et al. [21]
revealed that collagen has an important role in maintaining the health and repair of cartilage, skin, bones and teeth.

The absolute weight growth ranged from 0.0049±0.0006 g to 0.0062±0.0009 g. The level of vitamin C requirements in each fish varies, influenced by body resistance, fish species, age, growth rate, size and metabolic function in fish. The addition of vitamin C in feed with doses above 200 mg/kg of feed can increase fish growth [10].

The coefficient of variation of length in this study was below 20%, it was included in the low category [22]. Moreover, the similar results was found in blue tilapia, Gunadi et al. [23] stated that the coefficient of variation of blue tilapia was included in the low (4.94%) to medium (25.05%) category. The lower the coefficient of variation of length, the better and more profitable it is in the cultivation process. The higher the coefficient of variation of length, the higher the competition that occurs between individuals. The analysis of variance showed that feeding Artemia enriched with vitamin C in this study has no significant effect on the coefficient of long variability, this is because variations in the size of lemeduk fish larvae were low and the feed given can still be utilized by fish evenly and sufficiently so that it did not occurred the competition in feed.

This study showed that feeding Artemia enriched with vitamin C at a dose of 200 mg/l and 300 mg/l resulted in higher growth and survival rate of lemeduk fish larvae than feeding Artemia without vitamin C enrichment (control). Vitamin C is needed by fish for growth and survival, if there is a deficiency of vitamin C in fish, it can cause internal and external bleeding, slow fish growth and make fish more susceptible to bacterial infection [2]. According to Siregar and Adeliana [24], not all of the vitamin C doses that are given can be absorbed by the body but will be excreted in the form of urine, and excess vitamin C intake can lead to the differentiation of vitamin B12, one of which plays a role in forming new tissue. Fuadi et al. [21] also stated that another effect of excessive vitamin C doses is that it can disrupt the absorption of vitamin B12 in the body and can interfere with the digestive tract in fish.

4. Conclusion
Feeding Artemia enriched with vitamin C had a significant effect on the absolute length growth, daily growth rate and survival rate of lemeduk fish larvae, but did not significantly affect the absolute weight gain and the coefficient of variation of length. Artemia enrichment treatment with 300 mg/l vitamin C produced the highest length growth of lemeduk fish larvae (Barbonymus schwanenfeldii).

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