Growth performance of freshwater crayfish (*Cherax quadricarinatus*) as the effect of prebiotic-feed from sweet potato

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Abstract. Good growth of freshwater crayfish (*Cherax quadricarinatus)* is supported by an excellent intestinal digestion process in the absorption of feed nutrition. Implementing prebiotics from sweet potatoes is expected to maximize the nutrient absorption inside the digestive tract of freshwater crayfish. This research aims to evaluate the growth performance of freshwater crayfish in implementing sweet potatoes in feed. The research was conducted for one month, from March to April 2021, in the Laboratory of Hatchery and Cultivation Technology, Agriculture Faculty, Malikussaleh University. The experimental design was a non-factorial, completely randomized design (CRD) with four treatments and three replications. The experimental factor was different percentages of sweet potato in feed, namely A: 0% (Control), B: 1%, C: 2%, D: 3%. This research showed that prebiotic feed from sweet potatoes had a significant effect ($p<0.05$) on freshwater crayfish's growth and feed efficiency. The best result was demonstrated by treatment D, namely adding sweet potato 3% in feed at length growth of 2.64±0.035 cm and weight growth of 3.155±0.078 g. Meanwhile, the feed efficiency value of freshwater crayfish was 69.023±7.118%. The water quality parameters during the research were optimal for crayfish cultivation.

1 Introduction

Freshwater crayfish, or *Cherax quadricarinatus,* is an exotic invertebrate with red claws. Besides its red claw, it has a shining blue body. This commodity is used as ornamental crayfish that humans can consume for its protein. This invertebrate has an omnivore habit of consuming all types of feed to fulfill its nutritional needs. According to [1], the broodstock of crayfish needs 30-40% of protein, 5% of fat, 20% of carbohydrate, and 2% of fiber. Good nutrition content in the crayfish body leads to a high demand for crayfish for human consumption. Therefore, this freshwater crayfish becomes a prospective crustacean that is important to be cultured to fulfill the nutritional necessary of people and the market demand.

The primary purpose of freshwater crayfish culture is the optimal growth of crayfish, supported by good feeding and water quality. Nutritional feed becomes important to encourage its weight and length, but getting the appropriate nutrition in artificial feed is

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expensive. Some experiments found high protein content in artificial feed and high ammonia formed in water. It becomes an obstacle in freshwater crayfish culture to get good growth and productive culture. Therefore, an alternative solution is needed to support crayfish growth besides feeding by artificial feed.

Increasing the digestive ability in the digestive tract of freshwater crayfish is one of the solutions that is interesting to explore. Digestive ability can be improved by utilizing intestinal bacteria or probiotics. Intestinal bacteria can grow and replicate through prebiotics to form many colonies. Those intestinal bacteria help the intestine absorb the nutrition from feed, which is catabolized by enzymes secreted by intestinal bacteria. According to [2], the synbiotic *Micrococcus* spp. Combined with alginate as a prebiotic, it potentially induced immune responses, increased growth performance, and improved bacterial pathogens resistance in crayfish bodies. It means that prebiotics also give good performance for crayfish metabolism.

Prebiotics is food materials containing oligosaccharide that cannot be digested by the host but can be utilized by intestinal bacteria. One of the prebiotic sources that has the potential to be explored is sweet potato. Sweet potato contains some nutrients such as carbohydrates, vitamins, and oligosaccharides. The intestinal mucosa cannot digest this oligosaccharide, but intestinal bacteria, such as Lactobacillus sp and Bifidobacterium, can use it. According to [3], prebiotic mixtures in fish feed have good benefits, such as promoting growth, enhancing the immune system, stimulating disease resistance, and reducing the stress of aquatic animals.

The study conducted by [4] revealed that some Thai plants possessing prebiotic properties could defend against the acidic establishment and enzymatic digestion in the small intestine; meanwhile, fermented prebiotics in the large intestine could support short-chain fatty acids, vitamins, and other compounds production. In addition, [5] mentioned that the important groups of prebiotics, fructooligosaccharides, and galactooligosaccharides, have beneficial effects on organism health.

One of the potential prebiotic sources that are available and inexpensive is sweet potato (*Ipomoea batatas*). According to [6], sweet potato polysaccharides include arabinose, galactomannan, pectin, etc. This polysaccharide has properties such as anti-oxidation, anti-fatigue, anti-tumor, anti-inflammation, antibacterial, etc. Another finding also revealed that sweet potato residue could function as a prebiotic food for supporting the intestinal health of organisms [7].

Based on the information above, the study of 'The Growth Performance of Freshwater Crayfish (*Cherax quadricarinatus*) as the Effect of Prebiotic-Feed from Sweet Potato was important to be conducted. This study aimed to determine the best proportion of sweet potato as a prebiotic to increase the growth of freshwater crayfish.

2 Materials and methods

This research was conducted for 1 (one) month, which started in April 2021 at the Hatchery and Cultivation Technology Laboratory, Aquaculture Department, Malikussaleh University, North Aceh-Indonesia. The object of research was freshwater crayfish (*Cherax quadricarinatus*), with some materials being sweet potato extract (prebiotic), artificial feed, ethanol, and freshwater medium. The equipment used in the research was an analytical balance, an aeration set, a ruler, water quality equipment, a blender, an oven, etc.

The experiment tank to culture the freshwater crayfish was an aquarium size 60 x 30 x 30 cm^3. The amount of aquariums was 12 units. Before using aquariums, they were cleaned using detergent and rinsed using fresh water. The volume of the culture medium was 27 L and was equipped with a pipe diameter of ¾ inch.

The experimental object was a freshwater crayfish (*Cherax quadricarinatus*) at one month or a stadium juvenile. The object weighed ± 1.0 g, measuring 5-6 cm. The number of

objects was 120, which was ten individuals/ aquarium. The experimental objects were acclimatized for one day before experimenting.

The Sweet potatoes were peeled and washed clearly, then dried under sunlight. The dried sweet potatoes were ground using a flour blender; then, they were immersed in 70% ethanol with a ratio of 100 g of flour to 1 L ethanol. The mixture of sweet potato flour and ethanol was stirred for 15 hours using a magnetic stirrer at room temperature. Then, the mixture was filtered and evaporated at a temperature of 40°C to make concentrated sweet potato extract [8].

2.3 Mixing prebiotics into artificial feed

The artificial feed used in the experiment was fed 30% protein. The feed was ground and mixed with concentrated sweet potato extract into several treatments, namely 1%, 2%, and 3%, then CMC 1% was added to that feed mixture. The drying process of treated feed uses an oven with a temperature of 60°C for 24 hours. The parameters observed in this step were weight and length growth, feed efficiency, and survival rate of freshwater crayfish. The formula for each parameter is shown below:

$$\text{Weight growth} = \text{final weight} - \text{initial weight} \quad (1)$$

$$\text{Length growth} = \text{final length} - \text{initial length} \quad (2)$$

$$\text{Feed efficiency} = \frac{(\text{final weight-died weight})-\text{initial weight}}{\text{total consumed feed}} \times 100\% \quad (3)$$

$$\text{Survival rate} = \frac{\text{Final lived individuals}}{\text{Initial lived individuals}} \times 100\% \quad (4)$$

The prebiotic-added feed was given to freshwater crayfish (*Cherax quadricarinatus*) thrice daily at 09.00, 12.00, and 16.00 Indonesian time zone. The feeding method used in the experiment was 5% of biomass weight. During maintenance, the culture process was carried out for 30 days with controlled water quality. Siphoning was done daily, and water quality parameters were measured in the morning.

Data were analyzed using the ANOVA test for Completely Randomized Design (CRD), which was helped by SPSS software. If there was a difference among the treatments, the analyzed data was continued by the Tuckey test at a significant level of 0.05.

3 Results and dSiscussion

Prebiotic sweet potato extract added to feed significantly affected the growth of freshwater crayfish (*Cherax quadricarinatus*) ($p<0,05$), which was cultured for 30 days. The growth results of freshwater crayfish can be seen in Figure 1. Based on the result, the highest weight growth of freshwater crayfish was obtained from the treatment 'prebiotic 3% added in feed', which was 3.15 g. However, the lowest weight growth was shown by treatment 'control/without adding prebiotic,' which was 0.92 g. Then, a similar effect on growth was demonstrated by feeds 'control,' 'prebiotic 1%', and 'prebiotic 2%', which had different effects from feed 'prebiotic 3%'. The prebiotic sweet potato 3% was optimal to support the weight growth of freshwater crayfish caused by high polysaccharide concentration from sweet potato in feed, leading to enzymatic activity to optimize feed utilization in its intestine. High polysaccharides also encouraged the optimum probiotic population, which benefited crayfish.

This result is supported also by other studies [9]. Prebiotics from sweet potato (*Ipomoea batatas* L.) extract at a dose of 2% had a significant effect ($p<0.05$) on total viable bacterial count (TVBC) and protease activity in the common carp intestine. Then, 2% prebiotic from

sweet potato could encourage the best value for daily growth rate and feed conversion ratio ($p<0.05$). These results indicated that prebiotic supplementation from sweet potatoes positively affected the growth of fish and crustaceans.

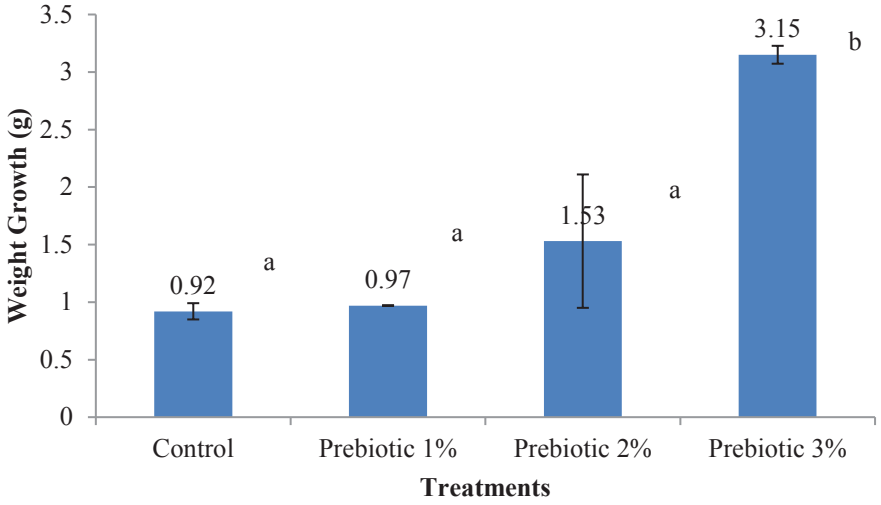

Fig 1. Weight Growth of Freshwater Crayfish (*Cherax quadricarinatus*)

Prebiotic sweet potato extracts also significantly affected freshwater crayfish's growth length. The highest length growth was obtained from treatment 'prebiotic 3%', 2.64 cm. Then, the lowest was gained from treatment 'control/ without prebiotic,' which was 1.09 cm. The result of length growth in this experiment is shown in Figure 2 below.

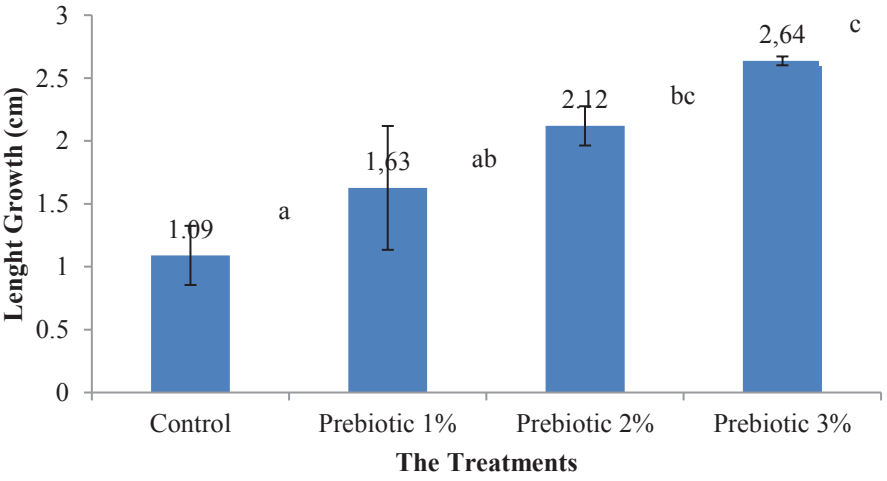

Fig 2. Lenght Growth of Freshwater Crayfish (*Cherax quadricarinatus*)

Based on the experimental results above, prebiotic sweet potato extract added to feed could encourage the growth of freshwater crayfish in weight and length. Prebiotics in feed might increase oligosaccharide content and indeed become a nutrition for intestinal bacteria or 'probiotics' in the intestinal tract of freshwater crayfish. Oligosaccharide could support

the cell growth of intestinal bacteria, secreting the appropriate enzyme for catabolizing macromolecules of feed nutrition to be macromolecules. Therefore, the absorption of feed nutrition became optimal, and it certainly supported the growth of freshwater crayfish as a host. In this experiment, the prebiotic 3% in feed was the optimal dosage that could support the growth of freshwater crayfish. Adding prebiotics in feed indeed increased the growth of freshwater crayfish, which was better than control or without adding prebiotics.

A similar prebiotic effect on aquatic organisms' growth is also shown in an experiment by [10]. The experiment used purple sweet potato extract as a prebiotic for papuyu fish (*Anabas testudineus* Bloch). The results showed that the purple sweet potato significantly affected the relative growth of papuyu fish. The best concentration of purple sweet potato was 3 ml/kg of feed.

The feed efficiency of freshwater crayfish during the experiment also obtained a significant effect ($p<0.05$) from the implementation of prebiotic sweet potato extract. Freshwater crayfish's best feed efficiency value was gained at treatment 'prebiotic 3%', which was 69.02%. The worst was obtained from treatment 'control/ without prebiotics with a value of 33.33%. Based on the Tuckey test, the feed efficiency value of the treatment 'prebiotic 3%' differed from the treatment 'control.' The comparison of the feed efficiency value in this experiment is shown in Figure 3 below.

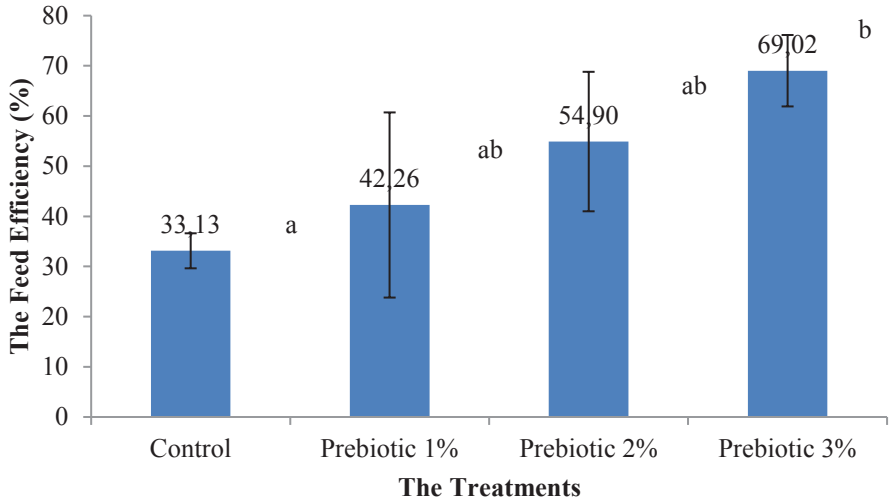

Fig 3. The Feed Efficiency of Freshwater Crayfish

The graph of feed efficiency showed that feed with the addition of prebiotics had better results than without prebiotic addition. The best feed efficiency was prebiotic extract at 3%. This result was caused by sweet potato prebiotics contained oligosaccharides in the form of raffinose, stachyose, fructooligosaccharide, and inulin, which could not be digested but would be utilized by bacteria probiotics as nutrients for bacterial growth in crayfish intestine. Bacteria probiotics worked in breaking down the complex molecules into simple molecules that would be easily digested and absorbed by the crayfish body.

Sweet potato (*Ipomoea batatas* L.) shoot powder and extract, which were implemented in the diet of *Oreochromis niloticus,* could increase the feed efficiency ratio (FER) of that fish [11]. This study proved that sweet potato (*Ipomoea batatas* L.) shoot powder and extract could improve the growth of *Oreochromis niloticus* and its profitability.

4 Conclusion

The study found that sweet potato extract added into freshwater crayfish feed as a prebiotic could significantly affect ($p<0.05$) freshwater crayfish's growth and feed efficiency. The best result was shown by treatment D (sweet potato extract 3% in feed) with weight growth of 3.155±0.078 g and length growth of 2.64±0.035 cm, while the feed efficiency value was 69.023±7.118%. The water quality parameters during the research were optimal for crayfish cultivation. The recommended sweet potato extract for freshwater crayfish was 3% as a prebiotic.

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