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Effect of sea purslane (*Halimione portulacoides*) as feed additive on larval rearing of red tilapia (*Oreochromis aureus* × *Oreochromis mossambicus*)

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Abstract

Sea purslane (*Halimione portulacoides*) is a potential feed additive due to its vitamin C, fatty acid content, dietary fiber, protein, and natural minerals. Sea purslane as feed additives on tilapia larvae were evaluated at different treatments that correspond to different concentration levels for treatment 1 is 1%, treatment 2 is 3%, treatment 3 is 5%, and control that contains no concentration of sea purslane, focusing on growth, survival rates, and proximate analysis of ingredients used. In terms of mean final weight, all treatments have increased their weight. Treatment 3 recorded the highest gain with a mean final weight of 530mg, followed by treatment 2 with 350mg, treatment 1 with 290mg, and control 290mg. Treatment 3 recorded the highest gain with a specific growth weight of 4.83%day^{-1}; this was followed by treatment 2 with 3.98%day^{-1}, treatment 1 with 3.62%day^{-1}, and for negative control 3.62%day^{-1}. The one-way ANOVA showed significant differences between the treatments regarding their mean specific growth rate (P>0.05). Treatment 3 shows significantly higher SGR with 4.83 day^{-1} from all treatment means. High survival rates were observed in all treatments, ranging from 86-95%. In the culture of red tilapia, it is evident that sea purslane as a feed additive helps in the growth of the larval stage of red tilapia. Another study should also be conducted on the effectiveness of sea purslane at other stages of red tilapia.

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Introduction

Aquaculture has become vital in supplying the world's expanding seafood demand. Still, the aquaculture sector faces complex challenges despite its substantial contributions to global economic development and food security (FAO, 2022). The primary obstacle among these is the increasing expense of feeds for aquaculture, along with a need for more appropriate feed ingredients (FAO, 2024). Aquaculture's reliance on costly feeds drives production costs and undermines the industry's sustainability and competitiveness as demand for its products rises (Yue *et al.*, 2022). Moreover, the long-term sustainability of aquaculture operations is threatened by the need for more necessary feed components.

Sea purslane (SN) is a good candidate for feed additive because it is a good source of vitamin C and fatty acids, is rich in the naturally occurring steroid ecdysterone, and is a good source of dietary fiber, protein, and natural minerals in fish food (Alberta *et al.*, 2023) Moreover, different methanolic extracts were obtained from the leaves, and several methods assessed the antioxidant activity. The sea purslane leaves showed a high content of phenolic compounds and considerable antioxidant activity (Pires *et al.,* 2021). From a nutritional point of view, this halophyte plant is a good source of dietary fiber, protein, and natural minerals such as calcium, magnesium, manganese, copper, and potassium.

The study aimed to determine the effects of the different concentrations of sea purslane as a feed additive on larval rearing of red tilapia cultured in tanks.

Materials and methods

The study used an experimental method of research to manipulate one or more variables and to control and measure any changes in other variables. The study used three (3) treatments with three (3) replicates and was arranged in a Completely Randomized Design (CRD). This was used to assess the ideal concentrations of sea purslane as a feed additive in the growth performance of red tilapia in 7-week culture period.

Feeding of fish

The researchers fed the red tilapia 2 times a day (9 am & 3 pm). Red tilapia were subjected to feeding with satiation, which means they were not restricted in quantity and could consume as much food as they wanted. In aquaculture, ad libitum is a typical practice in intensive farming.

Feeds formulation

Sea purslane, rice bran, and fish meal have been subjected to laboratory analysis in the Department of Agriculture Regional Field Office III, San Fernando, Pampanga. Based on the result of the laboratory analysis, sea purslane has 8.6+0.4 crude protein, while the rice bran and fish meal have 9.1+0.1 and 57.2+0.6 of crude protein, respectively. In relation to feed formulation, the Pearson square method was used to determine the concentration of each ingredient. The crude protein concentration for all feeds was set to 35%. The test concentrations of 1%, 3%, and 5% of sea purslane were set for definitive tests (Table 1).

Table 1. Feed formulation percentage

Ingredients	Treatment 1	Treatment 2	Treatment 3	Control
Fish meal	53.85%	57.85%	53.88%	53.85%
Rice Bran	45.60%	43.87%	43.29%	46.15%
Sea purslane	.54%	1.68%	2.84%	n/a

Sampling

Every seven days, the researchers removed the red tilapias from the treatment tank and counted the remaining to determine mortality. Then, the samples were put in a clean container jar and poured into the small filter to ensure that the water was removed. The researchers put the samples again in another container jar with water on top of the scale that had been used to weigh the samples. The scale must be on TARE so that the water in the container jar cannot be included in the weight of the sample.

Measuring of physico-chemical parameters

Water quality parameters in pH, TDS/EC, refractometer, and water temperature were monitored and examined to investigate water quality that could affect red tilapia's growth performance and survival.

Statistical analysis

A model I one-way analysis of variance with three replications, was used to determine the effects of various concentrations of liquid fertilizer on the growth performance of red tilapia. It had been set on the 5% significance level. Tukeys Test was used as a post hoc test.

Growth of red tilapia was determined based on the following equations:

Absolute Growth (wt gain) = wf-wi

Where: wf= final weight, wi= initial weight

Relative Growth (% wt. gain) = (wf-wi)/ (wi) × 100

Specific Growth Rate = {(ln final wt (g) - ln initial wt (g))/ Days of Culture (DOC)}×100

Where:

ln final wt = logarithm of final weight

ln initial wt= logarithm of initial weight

Results and discussion

Growth and survival rate of red tilapia (Oreochromis mossambicus)

Table 2 and Fig. 1 show the mean weights of red tilapia cultured in tanks for 49 days that were fed with different sea purslane concentrations (1%, 3%, and 5%). All of the treatments have an initial weight of 50mg.

Table 2. Growth and survival

	Mean			
	Treatment 1	Treatment 2	Treatment 3	Control
Initial weight (mg)	50	50	50	50
Final weight (mg)	290±89 *	352±106*	534±171*	294±90*
Absolute growth (mg)	245*	302*	484*	244*
Relative growth (%)	489.47*	604.21*	967.52*	488.57*
Specific growth (%)	3.62**c	3.98**b	4.83**a	3.62**b
Survival rate (%)	95*	95*	93.3*	86.65*

** significant *not significant (*P*>0.05) Tukey's test

In terms of mean final weight, all treatments have increased their weight. In addition, treatment 3 recorded the highest gain with a mean final weight of 534mg, followed by treatment 2 with 352mg, treatment 1 with 294mg, and control 294mg. However, one-way ANOVA failed to show significant differences among the four treatments regarding their mean weight (*P*>0.05). Several studies showed that the growth of fish was improved when it was supplemented with plant-based materials due to their nutritional content. Results from Dhara, 2024 stated that the use of papaya leaf powder showed significant improvement in weight gain at 20% inclusion of papaya leaf. In addition, the result from Sorokin *et al.*, 2023 states that using microalgae improved the growth of red tilapia. In this study, the result shows higher mean weight gain in treatment 3. However, it fails to show a significant difference. This may be due to the short duration of the study.

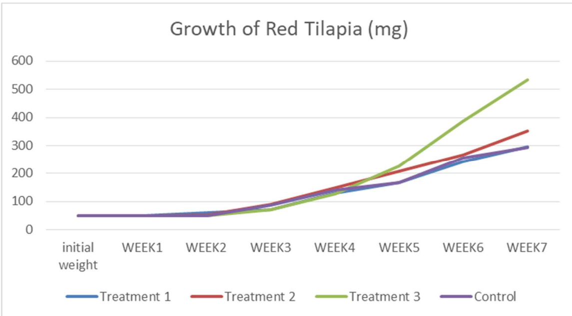

Fig. 1. Growth of red tilapia

The absolute growth is measured in terms of weight gain. The results of the study are presented in Table 2. The table shows the highest final weight of red tilapia in tanks during 49 days of the culture period. Considering the absolute growth, treatment 3 recorded the highest gain with an absolute growth of 484mg, followed by treatment 2 with 302mg, treatment 1 with 244mg, and control with 244mg. Relative growth is measured in terms of percentage weight gain. Regarding relative growth, treatment 3 recorded the highest gain with a relative growth of 967%; this was followed by treatment 2 with 604%, treatment 1 with 489%, and control with 488%. In relation to the result of the study, the high relative growth observed in the fry stage of fish is due to the metabolic rate of the early stage of fry to synthesize proteins (Conceicao *et al.*, 2003). With this, high growth can be observed in the early fish stage.

In terms of specific growth rates, all treatments have increased their weight. In addition, treatment 3 recorded the highest gain with a specific growth weight of 4.83 day^{-1}; this was followed by treatment 2 with 3.98% day^{-1}, treatment 1 with 3.62% day^{-1}, and for control 3.62% day^{-1}. The one-way ANOVA showed significant differences between the treatments regarding their mean specific growth rate (P>0.05). Treatment three shows significantly higher SGR with 4.83 day^{-1} from all treatment means. In addition, treatment two also shows significantly higher SGR than treatment one and control. Results from Kesan *et al.*, 2015 stated that mushroom supplementation has an SGR range of 1.63-1.74% day^{-1}. This study shows a higher SGR with a range of 3.61-4.83% day^{-1} when fed with feeds with sea purslane as an additive. Thus, sea purslane can be used as a feed additive to improve the growth of red tilapia.

Table 3. Proximate analysis of fish meal, rice bran and sea purslane

Laboratory code	Sample description	Parameter	Result
FCAL 2024-0013	Sea purslane	Moisture content	41.9+0.4
		Crude protein	8.6+0.4
		Ash content	23.8+0.5
		Crude fat	0.7+0.3
		Crude fibre	5.2+0.3
FCAL 2024 -0290	Rice bran	Crude protein	9.1+0.1
FCAL 2024- 0289	Fish meal	Crude protein	57.2+0.6

Table 2 shows the survival rates of red tilapia for 49 days cultured in tanks for 49 days that were fed with different sea purslane concentrations (1%, 3%, and 5%). Survival rate ranged from 86-95%. These high survival rates were observed in all of the treatments. However, less mortality was observed in treatment three, with 6.7%. Mortality has also been observed in control. The one-way ANOVA showed that there were no significant differences between the two treatments in terms of their mean survival rates (P>0.05). A higher SR was also observed in this study with a range of 86-95%, compared to Kesan *et al.*, 2015 who used mushroom supplementation with a survival range of 73.33-93.33%. This may be due to the high nutritional content of sea purslane. This halophyte contains minerals like calcium, magnesium, manganese, copper, potassium, dietary fiber, and protein. The primary sugar in sea purslane leaves is maltose, followed by sucrose, glucose, and fructose (Pires *et al.*, 2021). Main and Waldrop 2020 also stated that sea purslane is a plant rich in omega-3 fatty acids, vitamin C And B complex, minerals, vitamin A, Dietary Fiber, and protein. It also contains therapeutic properties like an antibiotic, like oil.

Proximate analysis of fish meal, rice bran and sea purslane

Based on the result in Pampangga, these are the values for Feed Chemical Analysis Laboratory Region 3. The sea purslane parameters are moisture content, crude protein, ash content, crude fat, and crude fiber. For rice bran parameter is crude protein, and the fish meal parameter is crude protein. For the result of sea purslane, the moisture content is 41.9+0.4, crude protein is 8.6+0.4, ash content is 23.8+0.5, crude fat is 0.7+0.1, and crude fiber is 5.2+0.3. For the rice bran result, crude protein was 9.1+0.1, and for the Fish meal result, 57.2+0.6. The study shows that the fish meal used was at 57.02% crude protein, and according to Cho and Kim (2011), the fish meal used was classified as of good quality because it contains nearly in the range of 60% to 72% crude protein by weight.

Table 4. Water quality parameters

Treatments	Water quality parameters			
	pH	Salinity (ppt)	Temperature (°C)	TDS/EC
Treatment 1	7.78±0.85	0	25.41+.70	96.50±12.89
Treatment 2	7.72±0.95	0	25.36+.94	103.13±16.47
Treatment 3	8.22±0.72	0	25.70214+1.04	67.08±13.10
Control	7.68±0.76	0	25.40286+.92	97.54±13.14

In relation to the rice bran, in this study the rice bran that have been used have a crude protein of 9.1, that is within the range of from the commonly used feed ingredients in feeds that is 7.82-11.80 (PCAARD, 1984; Yamazaki *et al.*, 1988; Philippine Society of Nutritionists., 1990). In terms of sea purslane, the crude protein percentage is 8.6. However, no related studies can be compared on the crude protein content of sea purslane. Yet, there were available studies that have stated that sea purslane contains essential nutrients like maltose, followed by sucrose, glucose, fructose, omega-3 fatty acids, vitamin C and B complex, minerals, vitamin A, dietary fiber, and protein (Pires *et al.*, 2021; Main and Waldrop, 2020).

Water quality parameters

Table 4 shows the mean salinity, pH, temperature, and tds/ec of the culture area from 49 days of study. The mean salinity was 0 ppt and its pH level ranges from 7.678571-8.215714 with a mean of 7.8467855. The temperature taken from the different time of the day ranged from 25.36286-25.70214 °C with a mean of 25.4703575 °C. Other water parameter such as tds/ec remained at 67.08429-103.1336 throughout the study. According to Kausar and Salim (2006) and FAO (2011), the preferred temperature range for optimum tilapia growth in ponds is between 25 and 36 °C. In this study, the water temperature range is 25.3-25.7 degrees Celsius, which is within the desirable range for culture. According to Russell *et al.* (2011), water conductivity (TDS/EC) between 150 and 500 µS/cm is ideal for fish culture. Stone *et al.* (2013) also stated that the desirable conductivity range for fish ponds is between 100 and 2000 µS/cm. Thus, it shows that treatment is below the desirable range for the culture of fish because the water comes from the deep well, which may cause the water to have less total dissolved solids. Makori *et al.*, 2017 reported a pH between 6.5 and 9, which is the ideal range for tilapia culture. Based on the result of this study, the pH reading is within the ideal range with a recorded value of 7-8, which means it is in the range for the tilapia culture. In terms of salinity, the recorded salinity in culture tanks is 0.05 ppt, classified as freshwater with salinity levels of 0.5 ppt or less (Montagna *et al.*, 2013).

Conclusion

Sea purslane showed effectiveness in the larval rearing of red tilapia in terms of absolute growth, relative growth, specific growth, and survival rate. The results of this study prove that sea purslane can be a good feeding additive. Hence, it is recommended that future studies should be conducted on the effectiveness of sea purslane at other stages of red tilapia.

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