ARTICLE TYPE

Evaluation of Periphyton Quantity on Different Natural Substrates in Freshwater

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Abstract

The present study was conducted to evaluate the periphyton quantity in different natural substrates for natural feed production in fibreglass reinforced plastics (FRP) tanks under freshwater. Experiments were conducted in outdoor FRP tanks (1500 litres) to observe periphyton quantity on three types of natural substrates such as split bamboo pole, coconut coir and coconut shell, which were placed inside the FRP tanks filled with freshwater for duration of 45 days. Observations were made in every 15th day for growth of periphyton both qualitatively and quantitatively on the three natural substrates. The mean value of periphyton quantity recorded for different substrates reared in freshwater showed highly significant positive correlation ($p < 0.001$) with days of culture. Student's 't' test analysis confirmed that mean values of periphyton quantity recorded in freshwater with duration showed significant differences ($p < 0.05$) between different substrates. From this study, it was observed that among the different substrates used for natural periphyton growth, split bamboo pole exhibited higher periphyton quantity than coconut coir and coconut shell.

Keywords: Freshwater, Natural substrates, Periphyton quantity.

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Introduction

Periphyton based aquaculture system is a modern concept and eco-friendly approach in closed water aquaculture. The term 'periphyton' in classical limnology refers to the micro floral community living attached to the surfaces of submerged objects in water (Wetzel, 1983). Periphyton serves as an indicator of water quality because naturally high number of species, fast response to changes, easy to sample and known for tolerance /sensitivity to change. Periphyton plays a major role in adopting feeding strategy of 'as and when needed' type of food in aquaculture, especially for herbivorous and periphytophagous fish species for last one decade. Production of attached algae per unit water surface area is also higher than phytoplankton (Wetzel, 1964). The possibility of consuming periphyton by fish is more, especially the algae. This could be due to the attached algae which are generally more stable than phytoplankton and the risk of collapse is much lower (Westlake *et al.*, 1980). To minimize costs, little attention was given to the periphyton-based food web. Azim *et al.* (2001) reported that minimum 2 weeks to allow periphyton to develop on the substrates before stocking fishes. Keshavanath *et al.* (2001) observed that fish production based on periphyton depends on artificial substrate type and preferred to use bamboo rather than poly vinyl chloride (PVC) pipes or sugarcane bagasse bundles when culturing mahseer (*Tor khudree*) fingerlings. Some workers have compared the natural and artificial substrates for periphyton growth and found more periphytic growth on the natural substrates (Amisah *et al.*, 2008; Keshavanath *et al.*, 2012; Dutta *et al.*, 2013). No or less work has been done on the periphyton growth on different types of natural substrate in freshwater/seawater line system or ponds. Hence, the present study was undertaken to observe the periphyton growth on different types of natural materials such as split bamboo pole, coconut coir and coconut shell in freshwater.

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Materials and Methods

A total of five lines of split bamboo poles (area of 1.1 m x 0.9 m) were planted vertically (1 m total length/0.9 m exposed length with 0.1m free board). In each line, 2 split bamboo poles were erected. The space between each split bamboo pole was 10 cm. These poles were joined with nylon ropes of 5mm thickness. The mean diameter of each of the split bamboo pole is 6.3 cm. The coconut coir's were tied in 5mm thick nylon ropes and vertically immersed. The space between each of the coconut coir given was 10 cm. The mean diameter of each of the coconut coir is 2.5 cm. In the case of coconut shell, 1.3m length nylon twine was taken and six coconut shells were arranged in each line and hanged vertically (12 coconut shell x 7 nylon ropes).The mean diameter of each of the coconut shell is 6.3 cm. Before erecting, all the three substrates were soaked in water for 48 hours in order to eliminate naturally occurring inhibiting substances.

The field trial was carried out in FRP tanks (2 m x 1.05 m x 1 m with mean water depth of 0.8 m) at Freshwater Fish Farm, Department of Aquaculture, Fisheries College and Research Institute, Thoothukudi for a period of 45 days for the growth of periphyton. All the FRP tanks were also cleaned well and disinfected with NaOCl.

From each type of substrate, place was selected by randomly and composite samples of periphyton were taken with substrate area from 2 × 2 cm^2 area. These areas were carefully scraped with a scalpel blade to remove all periphyton visually without affecting the substrate. After sampling, the substrate were placed in their original positions and marked to exclude from subsequent sampling. Periphyton samples were collected on 15^{th}, 30^{th} and 45^{th} day between 11.00 to 12.00 hours. Pooled samples from three depths of each substrate were re-suspended in 50 ml distilled water and preserved in 5% buffered formalin in sealed container. After vigorous shaking, 1 ml of sub sample was transferred to a Sedgewick-Rafter cell (S-R cell) divided in 1000 squares, upon which, the number of colonies was counted in 1000 squares field of chamber under binocular microscope. Periphyton numbers were estimated using the following formula by Azim *et al*., (2002).

$$N = (P \times C \times I00)/S$$

Where,

N = number of periphyton cells or units per cm surface area;

P = number of periphytic units counted in ten fields;

C = volume of final concentrate of the sample (mL);

S = area of scraped surface (cm^2).

Based on the information derived from biological data, individual statistical relationship such as Correlation, two way ANOVA, Students 't' test of different experimental shrimps juvenile and red strain tilapia fingerlings maintained on different dietary regimes were analysed following the Bio-statistical Method of Christenson (1996) and Microsoft Excel.

Results and discussion

The types of phyto and zoo-periphyton recorded from different natural substrates immersed in freshwater FRP tanks for different periods (Table 1). A total of nine different phyto periphytic and two different zoo-periphytic microalgae have been identified on split bamboo pole, coconut coir and coconut shell.

After 45^{th} day, the total periphyton quantity recorded in split bamboo pole, coconut coir and coconut shell were 1,21,975 ± 6098 cells/cm^2, 106475 ± 5323 cells/cm^2 and 103900 ± 5195 cells/cm^2 respectively.

The periphyton quantity (Number of cells/cm^2) of different substrates immersed in freshwater for different periods is given in Table 2.

The periphyton quantity of different substrates immersed in freshwater for different periods depicted in Figure 1.

The mean value of periphyton quantity recorded for different substrates reared in freshwater showed highly significant positive correlation ($p < 0.001$) with days of culture (Table 3). Student's 't' test analysis confirmed that mean values of periphyton quantity recorded in freshwater with duration showed significant differences ($p < 0.05$) between different substrates (Table 4).

The quantity of periphyton varied significantly with substrate type, fertilization level, environment conditions and taxonomic

Table 1: Types of phyto and zoo-periphyton recorded from different natural substrates immersed in Freshwater FRP tanks

Sl.No	*Parameters*	*15th Day*			*30th Day*			*45th Day*		
		SBP	*CC*	*CS*	*SBP*	*CC*	*CS*	*SBP*	*CC*	*CS*
Phyto - periphyton										
Chlorophyta										
1	*Chlorella sp*	+	+	+	+	+	+	+	+	+
2	*Ulothrix sp*	-	-	-	+	+	+	+	+	+
3	*Volvox sp*	-	-	-	-	-	-	+	+	+
4	*Scenedesmus sp*	-	-	-	-	-	-	+	+	+
5	*Selenastrum sp*	-	-	-	-	-	-	+	+	+
Cyanophyta										
6	*Oscillatoria sp*	-	-	-	+	+	+	+	+	+
7	*Microcystis sp*	+	+	+	+	+	+	+	+	+
Bacillariophyta										
8	*Navicula sp*	+	+	+	+	+	+	+	+	+
Euglenozoa										
9	*Euglena sp*	-	-	-	-	-	-	+	+	+
Zoo -periphyton										
Rotifer										
10	*Brachionus*		-	-	-	-	-	+	+	+
Polychaeta										
11	*Glycera*	-	-	-	-	-	-	+	+	+

SPB – Split Bamboo Pole / CC – Coconut Coir / CS – Coconut Shell

Table 2: Periphyton quantity (number of cells/cm^2) of different substrates immersed in freshwater for different periods

Days	*Periphyton quantity (Number of cells/cm^2)*
Split bamboo pole (SBP)	
15	63,550 ± 3,177
30	94,475 ± 4,723
45	1,21,975 ± 6,098
Coconut coir (CC)	
15	61,950 ± 3,097
30	85,375 ± 4,268
45	1,06,475 ± 5,323
Coconut shell (CS)	
15	59,325 ± 2,966
30	85,200 ± 4,260
45	1,03,900 ± 5,195

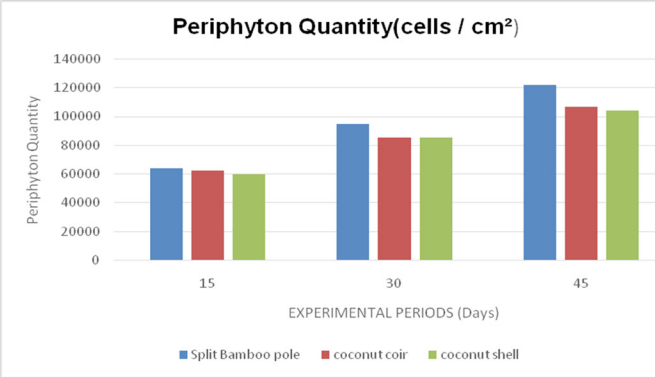


Figure 1: The periphyton quantity (g / cm^2) of different substrates immersed in freshwater for different periods

Table 3: Correlation between different substrates on periphyton quantity under freshwater with days of exposure

Sl.No	*Days of culture (X)*	*Mean weight gain (Y)*	*df*	*Intercept value (a)*	*Slope (b)*	*Correlation coefficient (r)*	*P Value*	*LS*
Split Bamboo Pole	30	9333	1	34908	1947.50	0.9994	P < 0.001	S
Coconut coir	30	84600	1	40015	1484.17	0.9995	P < 0.001	S
Coconut shell	30	82808	1	38233	1485.56	0.9957	P < 0.001	S

Table 4: Student's t-test analysis of the data relating to periphyton quantity between different substrates and days of exposure under freshwater

Parameters	X_1	X_2	*DF*	*Student's 't' value*	*p value*	*LS*
Split bamboo pole/Coconut coir 15/30/45 days	93333	84600	2	2.17	p < 0.05	S
Split bamboo pole/Coconut shell 15/30/45 days	93333	82808	2	2.61	p < 0.05	S
Coconut coir/Coconut shell 15/30/45 days	84600	82808	2	2.22	p < 0.05	S

composition (Makarevich *et al.,* 1993 and Keshavanath *et al.,* 2001). Keshavanath *et al.* (2012) made the Periphyton growth comparison study for four natural substrates such as bamboo mat, sugarcane bagasse, coconut leaf and palm leaf and reported that the periphyton growth was better on coconut leaf than other tested materials. These reports are similar to the present study.

Anix *et al.* (2017) reported that the periphyton quantity observed for coconut coir (34562 cells/cm^2) was higher than the split bamboo pole (33104 cells/cm^2) and coconut shell (21194 cells/cm^2) and suggested that Coconut coir was found to be best substrate than split bamboo pole and coconut shell, which can be utilized by fishes as natural food. Dutta *et al.* (2013) compared the substrate palm leaf and nylon net for periphyton growth and found that the palm leaf had better periphyton growth than nylon net. The substrates from organic origin attract more periphytic growth on them. The quantity of periphyton varied significantly with substrate type, fertilization level, environment conditions and taxonomic composition (Makarevich *et al.*, 1993 and Keshavanath *et al.*, 2002). Amisah *et al.* (2008) and Saikia and Das (2011) compared the biodegradable and non-biodegradable substances for periphyton based aquaculture to enhance fish production. Keshavanath *et al.* (2012) made the Periphyton growth comparison study for four natural substrates such as bamboo mat, sugarcane bagasse, coconut leaf and palm leaf and reported that the periphyton growth was better on coconut leaf than other tested materials.

Worldwide traditional fish culture practices based on periphyton have been well reported (Van Dam *et al.*, 2002). With tilapia, *Sarotherodon melanotheron*, Acadja can make 60–80% enhanced production by weight than substrate free conventional fishery (Welcomme, 1972). Many trials have demonstrated that fish production from the ponds provided with substrate for periphyton is higher than that of substrate free ponds (Keshavanath *et al.*, 2004; Uddin *et al.*, 2007). These studies showed that some species such as rohu (*Labeo rohita*), mahseer (*Tor khudree*) and tilapia (*Oreochromis niloticus*) are suitable for periphyton based aquaculture.

Conclusion

From this study, it was observed that among the different substrates used for natural periphyton growth, split bamboo

pole exhibited higher periphyton quantity than coconut coir and coconut shell. Periphyton grown on the natural substrate is an important natural food source and the quantity of artificial feed can be reduced substantially for the fishes in aquaculture system.

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