**SUBSTRATE BASED AQUACULTURE**

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**Aquaculture**

Aquaculture contributes significantly to global food security and protein supply and supports many livelihoods. It is the fastest increasing subdivision of animal production, as well 50 portion of seafood caused for human consumption arises fisheries. Still, the increase of aquaculture has influenced to the growing use of miscellaneous drugs and chemical compound that are harmful to maritime environments. The current flow in aquaculture growth is the growing increase and commercialization of aquaculture. Growing plants in liquid is not only deliberate an main initiator of growth, but more an main tool to increase meal freedom. Country aquaculture, containing embellished fisheries and idea-based fisheries, has donated considerably to want relief. This was done straightforwardly by limited ranchers who nurture marine structures for domestic use and earnings production. Indirectly, this was accomplished by providing labor and furnishing low fish to local markets. Skilled are many space for the weak to integrate growing plants in liquid into their existent land wholes, and thus skilled is still range for progress in aquaculture result, most of that must come into being through the efforts of the weak.

**Heterotrophs in Aquaculture**

Autotrophs, heterotrophs and detritus are typical natural nutrients for fish in aquatic ecosystems. Aquatic macrophytes, periphyton and phytoplankton are the main components of autotrophic food. These autotrophic and heterotrophic microorganisms are the two main functional units of the microbial food web due to their central role in nutrient cycling and carbon flow in the water column. However, because aquatic macrophytes compete with algae for nutrients, they are less important in fertilized ponds. The main constituents of heterotrophic food are bacteria, protozoa, fungi, zooplankton and benthic animals (micro- and macro-invertebrates). Most of the litter consists of living organic fragments of dead autotrophic and heterotrophic organisms.

Fish in aquaculture systems can be fed by three different feeding processes: direct feeding with feed produced by the fish; autotrophic feeding, where primary producers use solar energy to convert carbon dioxide into organic matter that fish can use; and heterotrophic nutrition, in which heterotrophic organisms break down organic matter that can be used by fish (Schroeder, 1978). The flow of organic and inorganic nutrients largely depends on the connection between these three pathways. Most extensive and semi-intensive ponds have two main sources of food for all organisms: (1) primary algal productivity and (2) organic matter added as feed or fertilizer. Secondary trophic level feeders (zooplankton, benthic organisms, invertebrates, etc.), including fish, use organic matter produced by algae through photosynthesis. In the latter case, organic matter used as supplementary feed or fertilizer increases primary productivity and fish production through direct or indirect consumption of fish. In both cases, heterotrophic microorganisms are important parts of the food web because they break down organic matter and release nutrients that can be used by algae or consumed by fish. In most cases, heterotrophic food production is greatly influenced by the nature of the organic matter, bacteria, and environmental variables such as dissolved oxygen, temperature, etc. Because it is light-independent and able to supply the necessary chemicals as well as the organic compounds that act as an energy source, the entire water column can be heterotrophically productive. By spreading fertilizer in divided doses at frequent intervals instead of a single dose, the production of heterotrophic food can be increased. Thus, using periphyton technology, the production of heterotrophic food in the pond can be encouraged even at night.

**Periphyton Based Aquaculture**

Periphyton is a general term for microorganisms that thrive in any underwater substrate, consisting of algae, bacteria, fungi, aquatic invertebrates, protozoa, and debris. In microbiology, periphyton are often referred to as "biofilms" (Shankar and Mohan, 2001). Van Dam et al. (2002) explain that the assemblage of attached organisms on an underwater surface, including associated non-attached fauna, is called the periphyton. While both autotrophic and heterotrophic pond food webs are traditionally influenced by phytoplankton, which is an important part of natural food production, periphyton, on the other hand, serves the same purpose as phytoplankton and is more stable, making it more beneficial to many fish. who lives at the bottom of the food chain. The periphyton community consists of bacteria, fungi, protozoa, phytoplankton, zooplankton, benthic animals and many different invertebrates and their larvae. This microbial mat develops naturally on underwater surfaces in the presence of light and nutrients. The diverse microbiota of the periphyton (primary photoautotrophs) have different metabolisms for nutrient utilization (Anand, 2013). The interaction of all these microorganisms, including phytoplankton, results in a natural food source for farmed fish or crustaceans. In addition, periphyton bacteria have various naturally occurring bioactive substances that can increase the resistance of fish to stressful situations such as overcrowding. Periphyton can also act as a probiotic or vaccine, as well as an antibiotic against several contaminating bacteria. The idea of ​​periphyton-based aquaculture originally originated from a traditional method (testing bush traps) locally known as "paddle fishing", a unique fishing method used in the Ashtamudi Delta, Vambanad, Kerala (South India). Here, branches of locally available trees such as mango, mangrove and bamboo poles are placed in the shallow open water. These branches are known as podals, which act as a link between the shrimp and the fish.

**Indigenous periphyton Aquaculture Practices**

**Acadja**

In a West African coastal lagoon, a dense group of branches artificially planted on the muddy bottom of shallow water (1-1.5 m deep). About 1 package/m2 of bundles and piles is applied in these lagoons. Such acades are kept without fish for 6 months to 1 year. After this period, these components attract fish and collect them. Acadja yield is known to be 4-20 tons of fish/ha/year. Algal dry matter (DM) content increased fivefold and chlorophyll eightfold in acadjas, the researchers reported, multiplying the number of periphytic species on growth branches compared to lagoon water.

**Samarahs**

In Cambodia, floating waterweed (Eichhornia crassipes) is used along with the branches and shoots. Sixty days after substrate application, fish were collected. Andquot;Samarahsandquot produced approximately 4 tons/ha/year of fish; every season. In addition, Cambodian farmers use palm fronds and paddy straw to remove turbidity from water, which also increases productivity by acting as a substrate for periphyton growth.

**Katha**

In rivers and canals trees like mango, Barringoronia sp., Eugenia sp., Acacia sp. etc., the branches of the bushes act as a natural substrate for algae to attach to. This is a traditional fishing method where branches are attached to bamboo bones, which also act as a driving force in the colonization of algae populations. Katha can increase biological production in three different ways: 1) by creating safer and more diverse spawning grounds for some species, thereby increasing reproductive success; 2) reducing the number of predators and increasing the survival of young and offspring; and 3) creation of large food reserves through the cultivation of periphyton, a high-quality natural food, thereby increasing fish growth and fitness. An analysis of the Katha fishery showed that fish production increased by about 33 percent.

**Phum**

Submerged aquaculture methods are commonly used in the Lok Tak Lake in the state of Manipur, India, which is located in the northeastern part of the country. The lake is covered with floating islands that act as natural aggregation structures for fish. These islands are formed by a dense growth of water-rich weeds and grasses. These floating islands are made by bending the cut leaves of the grass mats into circles after cutting them to a width of 1-2 meters. Bamboo and ropes are used to secure the two ends. After the circle is completed, it is dragged to a designated spot in the lake where it is secured with bamboo. Trees are harvested every one to two months. The production of these dust areas is said to be about 300-1000 kg per smoke.

**Xeng fishery**

In Assam of northward-east India, bamboo arms (regionally called Xeng), exceptionally from Bambusa balcooa, B. pullida, B. arundinecia, etc. are intermittently implemented for home of age fish ponds. Aforementioned Xeng the chase can produce at least 25% more find result than conventional Xeng free ponds.

**Roles of Periphyton**

**Food source and nutrition**

Periphyton is an important food source for many fish in both wild and cultured ponds. According to several studies, periphyton can be used as a natural feed source for caged tilapia, which would significantly reduce the need for supplemental feeding and increase profitability. Additionally, farmed fish can graze quite well on attached periphyton compared to scavenging small planktonic algae from the water column. Compared to phytoplankton, periphyton algae are more stable and produce more per unit water surface. Compared to filtering algae from a three-dimensional planktonic environment, periphyton are better suited for grazers and scavengers due to their two-dimensional structure. Periphyton can provide up to 75% of metabolic energy to fish when used as feed in aquaculture, helping to increase fish productivity. Indian large carp, tilapia, common carp and shrimp prefer periphyte as natural food. Many fish and benthic invertebrates, including snails, chironomids, butterflies, oligochaetes, and several groups of crustaceans, include periphyte in their diet. Periphyton growing on the substrate in freshwater ponds can be one of these additional sources of nutrients. Periphyton algae not only act as a food source, but also help improve the nutritional value of cultured species.

**Water quality**

More supplements are moved to higher trophic levels in periphyton-located plans rather than growing in bureaucracy rather than in feed-conducted ponds. They have happened used in growing plants in liquid to upgrade species result and water characteristic. Periphyton-based arrangements still have greater nitrogen memory at taller trophic levels that maybe used by bob variety. As a result, these systems have the ability to improve nutrient efficiency, which reduces waste accumulation and improves overall water quality. In aquaculture systems, biofilm formation on substrates can act as an in situ biofilter and filter; reduces the amount of toxic ammonia. The environmental temperature of the natural substrate shows the opposite tendency with the vegetation growth. The transparency of a water body usually indicates its productivity, while; there was always an inverse relationship between periphyton growth and water clarity, which is mostly due to leaching of the natural substrate. Periphyton can bind organic waste, remove nutrients from the water column and help regulate the dissolved oxygen concentration and pH of the surrounding water. In traditional aquaculture ponds, nitrification occurs primarily at the sediment surface and is limited by both surface area and oxygen availability. In addition, the area required for slow-growing chemoautotrophic nitrifying bacteria may be limited by fast-growing heterotrophic bacteria. Therefore, periphyton microorganisms increase nitrification, keeping ammonia levels low. Water purification is facilitated by periphyton and #039 nutrient recycling, as some algae can consume ammonia and help remove phosphates from the water column. Bacteria attached to the substrates undergo nitrification, the final product of which is nitrate-N, which promotes an increase in the number of autotrophs in the water column, leading to a decrease in ammonia-N and nitrite-N in the substrate-based treatments compared to others treatment. In addition, the biofilm formed on the substrates increases the assimilation of nitrogen molecules, generating large amounts of dissolved oxygen. Several studies have shown that periphyton has a positive effect on nitrification, resulting in a reduction of ammonia concentrations. Similarly, phytoplankton and periphyton used available nitrate and phosphate mixtures on the substrate for green growth, reducing their levels in the water segment.

**Productivity and Nutrient Transfer**

Periphyton compounds have several functions that contribute to nutrient retention. They can first remove nutrients from the water column and lead to a net flow of nutrients towards the sediments. Thanks to this, less phosphates will be transported from the sediments in the future. Second, they can slow water exchange across the sediment or water column boundary. Third, they can prevent the spread of aging macrophytes or nutrients from bottom sediments. Finally, they are able to trap particles in the water column. They can also provide biochemical conditions that favor phosphate deposition. Periphyton-based systems have shown higher nutrient use efficiency compared to traditional substrate-free systems, so it is assumed that the optimal fertilization of traditional substrate-free ponds is sufficient to maximize fish production in periphyton-based systems. Periphyton act as a nutrient store and remover in water bodies, being able to actively regulate the transport and transformation of nutrients between the water and soil/sediment interface.

In periphyton based ponds, competition and interactions between periphyton and phytoplankton interfere with the link between phytoplankton productivity and nutrient concentrations, which can be positive in ponds and lakes. Greater grazer biomass results from increased nutrient levels, which shows that nutrients are effectively transferred to higher trophic levels. Low nutrient concentrations limit periphyton biomass, but when nutrient supply increases, competition for light, both within the periphyton and with other primary producers, becomes more important.

**Economics of Periphyton based technology**

Periphyton based monoculture has an benefit of being economically tenable hence can without difficulty be married by weaker bait growers. Installation of depressed- cost substrates in the idea scheme acts better than the traditional non-augment or augment arrangements, in two together environmental and profitable points of view. Interesting studies have proved by means of what this science is comparatively depressed in agreements of cost of production while the returns are much state-of-the-art than systems that forbiddance use periphyton educated electronics. Insemi-intensive culture systems, installation of artificial substrate increases the profitable return. In a study by Huda and welcome batch, estimated the relative appropriateness of periphyton restricted monoculture two together on- station and on ranch position. The judgments of the study displayed fairly lower device cost distinguished to that of being extract product practice( additional augmenting). Jha and others (2018) concluded diminished feed movement accompanying increased periphyton bettering efficiently outdid profit when upholding fish yields agreeing to those of usual polyculture plans with thorough augmenting in farming of complaint polyculture in Nepal. Hoque *et al*. (2018) proved that regulating periphyton growth on bamboo poles to increase fish product will be economically profitable and it helps to minimized vastly product cost. Keshavanath *et al*.( 2012) revealed that use of cheap biodegradable substrates for the growth of periphyton can greatly ameliorate profitable viability of complaint monoculture.

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