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Harmonious Harvest: Exploring Integrated Shrimp and Gracilaria Culture for Sustainable Aquaculture

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The integration of shrimp and Gracilaria culture offers a sustainable approach to aquaculture, leveraging the complementary biological and environmental requirements of these species. Gracilaria, a euryhaline red seaweed known for its rapid growth and high nutrient uptake, serves as a bio filter, improving water quality by absorbing nitrogen and phosphorus. This seaweed is not only a nutritious food source for humans but also a valuable feed in aquaculture due to its rich protein, fiber, and calcium content. Shrimp farming, a significant contributor to the economy, particularly in coastal and inland saline areas of India, can benefit from the integrated multi-trophic aquaculture (IMTA) system, where shrimp waste supports Gracilaria growth, reducing feed costs and enhancing water quality. This system increases shrimp survival rates, reduces production time, and allows for multiple harvests annually. Furthermore, Gracilaria possesses various pharmacological properties, adding value to its cultivation. While the integrated system presents economic and environmental benefits, challenges such as high initial investment and the need for technical expertise remain. Continued research and innovation are essential to fully realize the potential of this sustainable aquaculture practice.

Source: www.etsy.com

Keywords: Integrated aquaculture, Shrimp farming, Gracilaria, Sustainable aquaculture, Nutrient uptake, IMTA, Aquaculture feed, Pharmacological properties, Resource utilization, Waste management

Introduction

Gracilaria is euryhaline red seaweed which is capable of rapid growth and having high nutrient uptake (nitrogen and phosphorus) as they used as bio filters to improve water quality. It consists of moisture (19.045%), protein (10.86%), fat (0.18%), carbohydrates (63.13%) and dietary fibers (27.48%) calcium (429.11mg/100g), sodium (290.89mg/100g), PUFA (palmitic acid -0.08%, oleic acid -0.05%). Due these nutritional qualities Gracilaria is used for human consumption as well as feed in aquaculture. With increasing population and declining natural resources, integrated culture of shrimp and Gracilaria can be an innovative idea for sustainable use of brackish water and saline land resources (6.74 million hectares) which includes coastal saline land (5.54 million hectares) and inland saline land (1.2 million

hectares) and this integration can help in generating extra income to the farmer by reducing the culture inputs and increasing the production outputs. (FAO, 2019)

Gracilaria culture

Culture of Gracilaria in ponds require salinity of about 25-33ppt (optimum for best growth). The optimum temperature ranges from 20-30 ^{0}C and pH required is about 8.0, soil texture of sandy clay is suitable. Water depth of 0.3-0.5mt and nitrogen concentration should be less than 100mg/cm^3. The culture is done pond preparation which includes by scattering the sporeling (which are collected from the sea) in the pond with optimum water conditions required for the growth. Gracilaria later grows naturally in the pond is harvested when there is optimum increase in the quantity of seaweed in the pond. Seaweed washing is done during the harvest to remove the dirt and mud present on it. It is not completely harvested some are left in the pond for next harvest. The harvest Gracilaria is sundried for 1 to 2 days (depending upon the sunlight present). The sundried seaweed is marked by the black colored appearance with salt granules on the surface of seaweed. After sun drying it is cleaned to remove the dirt present on it and later packed in plastic bags to sell in the market. The weight of Gracilaria decrease by nine-time dafter drying.

Source: www.globalseafood.org

Shrimp culture

Similarly shrimp farming which in domination in brackish water adulate in the country, is the economic backbone of Indian aquaculture (shrimps contributing more than 65% of total export earning of countries fish and fisheries products). It is the significant contributor in the sector of food production and employment generation. Shrimp farming is mainly practiced in in coastal states from Gujarat to West Bengal and in emerging inland saline areas of Punjab, Haryana, and Rajasthan. Shrimp culture requires salinity of 25-35ppt, temperature range of 28-32^{0C} and it requires pH of 6.5-8.5.the nitrogen concentration should not exceed more than 1ppm. Shrimp culture requires 60-120 days depending upon the species and culture environment for market sized growth and require soil with moderately heavy texture (sandy clay, sandy clay loam and clay loam). Major inputs in shrimp farming are seed and feed (about 60% of total expenses), new innovative ideas like Gracilaria feed could be revolutionary in shrimp culture because seaweed is a very good source of natural protein, fibers and calcium which are required for growth of shrimp.

Integration of Gracilaria culture with Shrimp Culture

By comparing the culture requirements of gracilaria and shrimp it is be observed that these two culture species can be used in integrated multi tropic aquaculture (IMTA) i.e., a farming

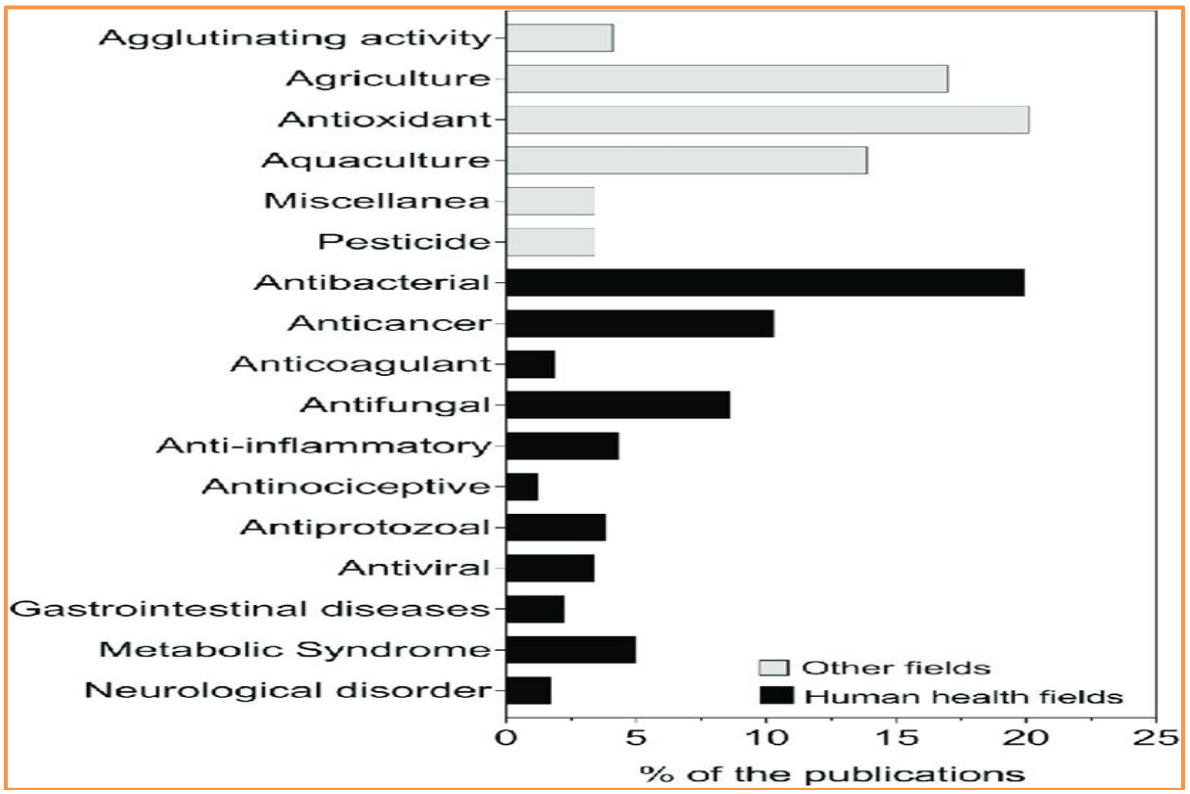
technique in which waste of one species (here shrimp) is used as feed by other (Gracilaria). The integrated culture is done initially by selection of site which has required water resource, transportation facilities, optimum type of soil and water for the integrated culture. After selection of site for culture pond is constructed with required depth, slope towards the drainage doors, facilities for water exchange and for the harvest of produce, strong embankments with no leakage problem. The next is pond preparation which is done before the culture of Gracilaria and shrimp. it includes repair of embankments if pond is used prior for any culture, removal of black mud (contains toxic hydrogen sulphide), drying of pond which leads to the oxidation of pond bottom and detoxification of pond, pre-eradication of any type of weeds or pest is done, this could also be done by use of organic pesticides like saponins which on later acts don't have adverse effects on the pond culture. Later fertilization of the pond is done for initial growth of the seaweed. After pond preparation water is filled in the pond and after two weeks of fertilization seaweed seeds (15-20 days old) are scattered evenly in the pond by broadcasting the seed this helps in reduced use of power and cost. Gracilaria starts growing in the optimum environment and later shrimp post larvae are released in the pond. The growing seaweed use shrimp waste (nitrogen) for its growth. If required nutrients are also added from outside. The clumps of growing seaweed are spread evenly during the growth. Harvesting could be done after 40-42 days, and some seaweed is left of further growth and for next harvest. During this time shrimps grows and moults continuously to further life stages and reach the marketable size. This integrated culture also increase the survival rate of shrimp (83-98% in integrated polyculture ,90% in biofloc RAS system) which cannot be achieved in monoculture of shrimp (survival of 60%). This integrated system also helps in achieving high algal and shrimp growth in shorter period of time which reduce the time of crop and helps in multiple culture in a year. The reason for high survival of shrimp is the high nutrient (N & P) uptake of gracilaria, which is excreted by shrimp as excreta and uses the waste for growth and acts as a bio filter improving the water quality. The ratio suitable for culture is found out be 3:1, for example – 600g gracilaria and 200g shrimp. The seaweed is able to utilize 25% ammonia, 22% of nitrate, and 14% of phosphate from the waste excreted by shrimp. The survival is also increased because gracilaria provides hideouts to the molting shrimp. It also acts as source of food for the shrimp (omnivorous) and in the reduction of feed supply (80-20%) and value of food conversion ratio could be reduced to 26% to70%. this is very helpful in reducing the feed cost and ultimately helps in controlling the wastage of feed which degrade the water quality.

Practice of this integrated system of culture could be very economic for the farmers of the country as multiple crops of both the species could be cultured in a year, less consumption of expensive artificial feed by shrimp which decrease the input cost. High individual price of shrimp and gracilaria which increase the output cost and high profit. The profits could be increased by organic certification labelling as very less or no addition artificial inputs are added to gain the final product. Gracilaria also prevents or reduce diseases in the shrimps due to its antibacterial properties. It provides crop insurance and helps to survive economically if any one of the crop faces production failures. But with all these benefits there are some challenges also like requirement of high investments, more technical knowledge and skills to the farmer and management of integrated culture.

Source: fishconsult.org

Pharmaceutical properties of Gracilaria

There are other applications of gracilaria apart from nutritional properties, scientific investigations have unveiled a plethora of pharmacological activities associated with Gracilaria extracts, including antioxidant, antibacterial, antiulcer, and wound healing, antifungal, antiprotozoal, antiviral, anticancer, anticoagulant and hepatoprotective properties.



Source: researchgate.net

Culture Grounds of Gracilaria

Gracilaria culture is practiced in the coastal regions of the country like Gujarat where harvesting is done four times a year and shrimp culture which is practiced in coastal as well in northern states like Punjab Haryana and Rajasthan with large salt affected land is present is an evolving sector, while integrated culture of shrimp and gracilaria is in nascent stage in India and is under experimental trail. Although it is in practice in countries like China where seaweed is cultured near the fish net pens and also with bivalves which has shown high production. Research on integration of seaweed gracilaria with marine fish culture in going for over a decade in countries like Canada, Australia, New Zealand, USA, and Scotland.

Conclusion

In conclusion, the integration of shrimp and gracilaria culture represents necessary road toward sustainable aquaculture. The co-cultivation of these species pot only addresses the challenges like resource utilization and waste management but also crucial step to environmentally conscious food production. as highlighted the benefits like high production from natural food with low-cost inputs, there are many hurdles also which could be overcome by continuous research and innovation to unlock the full potential of shrimp and gracilaria culture.