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Sustainable Aquaculture in Ganjam District, Odisha: A Study on Locally Sourced Plant-Based Fish Feed

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Abstract
Nutrition is the primary crucial factor determining the potential of cultured fish to exhibit its genetic capability for growth and reproduction. Using inexpensive live feed supplements as feed additives is broadly accepted and embraced due to its eco-friendly nature. It has proved that medicinal plants have positive potential as feed additives. The herbs increased the growth and usage of fish feed and decreased diseases by regulating pathogens. A combination of medicinal plants is applied and found to be effective, has the potential to combat disease problems, and could supplement the insufficiency of nutrients and phytochemicals. There is an urgent need to research more on novel feed additives like the inclusion of herbs in fish feeds, which reduce feed costs and maximum digestibility and prevent residual effects of hormones and antibiotics on fish muscles, which in turn affect the human that consumes them. Various processing methods were employed, and suggestions were made on how aquaculture growth can reach its maximum potential in fish production by utilising locally available fish feed ingredients.
Keywords: Plant-based feed ingredients, Aquaculture, Fish, Pathogens

INTRODUCTION

Global fish production reached more than 171 million tonnes by 2016, of which 88% were directly used for human consumption, and 12% (20 million tonnes) were used for producing fishmeal and fish oil in aquaculture [1]. Fish and fishery products are an important source of essential nutrients in the human diet, and demand is growing in line with the increasing world population [2]. Aquaculture is the fastest-growing food industry, and the intensification of production depends on utilising resources other than fishmeal for aquafeeds, for which exploitation is reaching an unsustainable level. Therefore, crops, mainly legumes, cereal grains and oilseeds, have been introduced steadily into fish feeds, entirely or partially replacing marine protein sources [3]. Plant protein sources mainly include soy, pea, lupine, alfalfa, wheat, corn, rape seeds, sunflower seeds, cotton seeds, sesame seeds, mustard oil cake, and white lead tree leaves [4]. Moreover, proteins from insects, microalgae, krill, and single-cell proteins have been explored as replacements for fishmeal, but plant proteins are by far the most used ingredients in aquaculture feed. The considerable changes in the diet composition of farmed fish include ingredients with physicochemical properties that could potentially lead to challenges regarding fish health and welfare and product quality [5]. However, new processing technologies for plant protein extraction of undesirable components such as fertilisers, pesticides, persistent organic pollutants and heavy metals have allowed the transition from marine to agricultural sources [6]. The growth performance of plant-fed fish is adequate in short-feeding studies [7], but concern about potential adverse health effects from natural toxins and anti-nutritional factors, including phytoestrogens, remains [4,8]. Some anti-nutritional factors are considerably resistant to heat and digestion and have the potential for carry-over into the food chain. Several studies have shown that bioactive compounds may affect physiological functions in animals and humans, including adverse effects on intestinal health [9]; however, information on fish is limited [4]. The potential transfer of undesirable substances from new sources of aquafeeds might thus lead to possible health risks for consumers of fish products [10]. The assessment of transmissibility requires analytical methods that can be reliably applied for detecting relevant natural contaminants in crops, and the considerable prevalence of mycotoxins and phytoestrogens makes them

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priority target analytes. However, few recent studies have surveyed mycotoxin levels in fish feed or farmed fish, and phytoestrogens are even less investigated [11].

Aquaculture is defined as the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. Farming implies some form of intervention in the rearing process to enhance production, such as regular stocking, feeding and protection from predators [3]. Current aquaculture production showed rocketed growth; production reached 184.6 million tons, and the market reached a value of USD 41.45 billion with a CAGR of 10%.

Aquaculture and fisheries provide livelihood support to 820 million people worldwide and provide food and nutritional security to far greater numbers of the world's population. Aquaculture systems can be extensive, semi-intensive, or intensive [4].

Odisha is a maritime state with a coastline of 450 km. It is the fourth largest fish producer among the states of India, producing 8.73 Lakh. Metric tons of fish in the year 2020-21. Among different coastal Districts of Odisha, Ganjam is regarded as a potential District for aquaculture production due to the vast stretch of water resources, including 11580ha of freshwater, 4023.04ha of salty water and 60 Km. of coastline. The substantial water resources boost pond aquaculture and reservoir fisheries and contribute immensely to employment generation, food and livelihood security. However, the intensification of aquaculture to increase production is causing environmental concerns in certain regions [6].

Despite the enormous potential benefits of aquaculture development, there are always concerns about its environmental impacts [5]. Recently, concerns about both fish feed quality and the effects of fish feed on the aquaculture water environment have been elevated to a new level [8-10]. Uneaten fish feed is probably the primary nitrogen input to the aquatic environment [11]. Our study encompasses four blocks of the Ganjam districts, namely Aska, Rangeilunda, Sorada, and Ganjam, to study the intensification of aquaculture and its results—observation in six different ponds concerning feed use, water quality and fish growth.

MATERIALS AND METHODS

Research site- Six different Blocks in Ganjam District between March 2022-23. In total, 12 ponds were selected for studies. A structured questionnaire was used for data collection regarding the types of feed used.

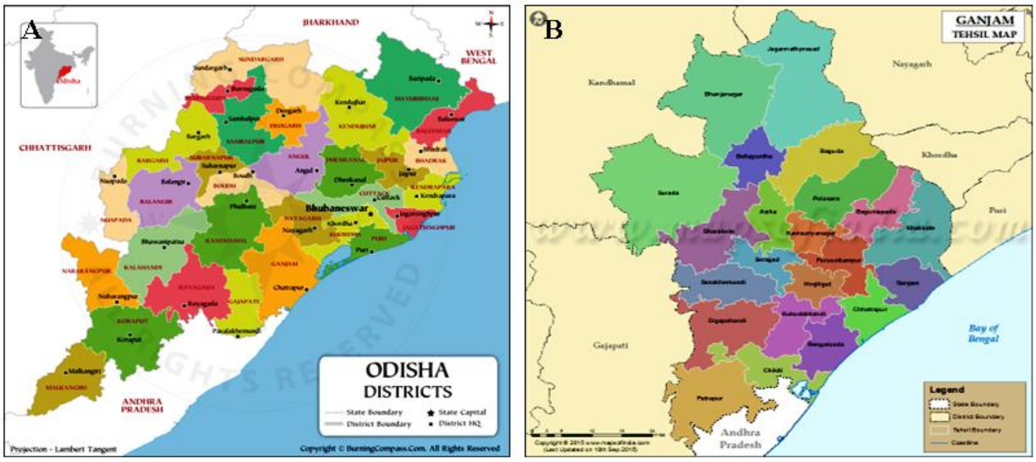

Fig. 1 Map of Odisha (A) and Ganjam (B) for collection of the samples of different regions.

DATA COLLECTION

Fish farmers are interviewed to conclude the use of different types of fish feeds along with the species cultivated. Three fish species as Rohu (Labeorohita), Catla/Bhakur (Catlacatla) and Mrigal carp (Cirrhinusmrigala) were mentioned in 3 Months, 6 Months, 9 Months and 12 Months interval (Fig. 1). Intervention in six cultures ponds were done with application of homemade mixture of fish feeds made from rice flour, rice bram, rice polish, wheat flour, coconut oil cake, mustard oil cake, sesame oil cake along with kitchen organic wastes and cow dung. Further interventions in six different ponds were made using imported fish feeds.

The results obtained when interviewing people of different blocks regarding the type of feed used are as follows. Depth of water, stocking density, and other farm management practices, including frequency of application of fish feeds, were kept uniform across all culture ponds, and both cultures performed in semi-intensive mode. Planktonic growth, pond water quality, fish growth (SGR and MBW), and production were closely monitored from both types of interventions. This concerns the different water quality parameters.

RESULTS AND DISCUSSION

Economics of feed use with fish production.

About 30% of the investment in total fish production is seen in homemade fish feed applications compared to 60% in total fish production in the case of imported fish feeds. Fish growth donors show any variation, but in successive years, water quality deteriorated in intensive culture ponds due to deterioration of water quality impacted by increased organic load, fall in DO, and blooming of the water body (Fig. 2).

Farm-made organic fish feed taken for application, Recording fish production in different under different feed application.

Fig. 2 Commercial fish feeds and applications (A, B), Commercial fish feeds, Excess of commercial floating feeds accumulation altering water quality (C, D).

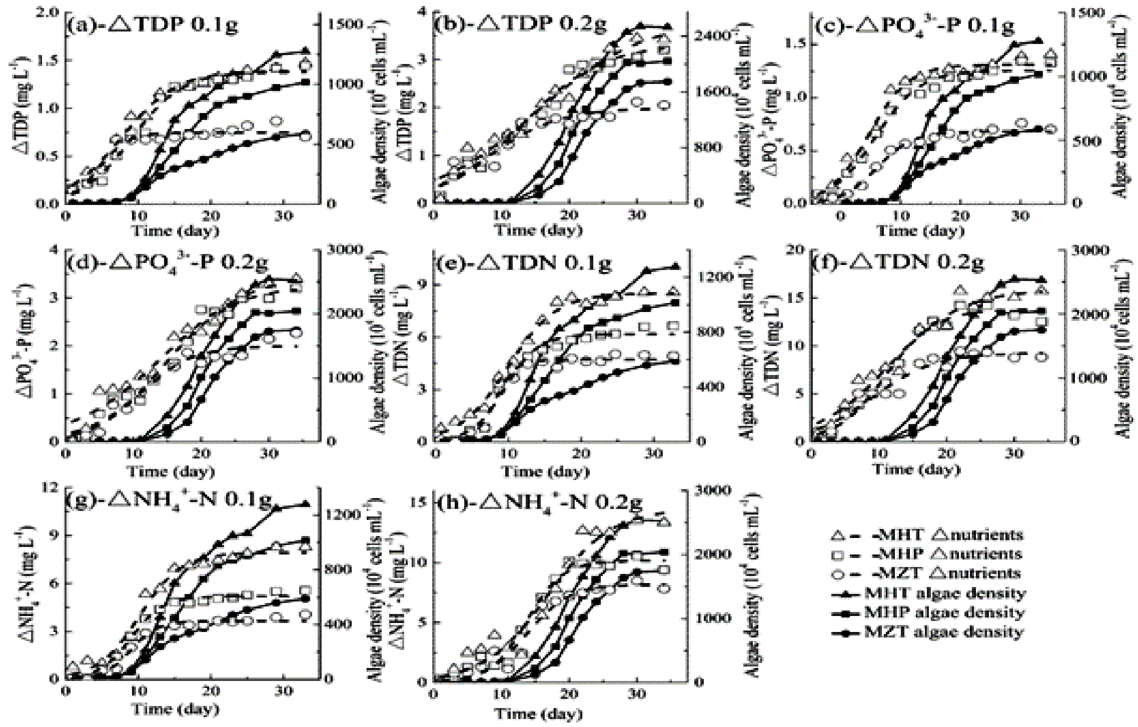

Fig. 3 Variations of consumed TDP, PO4 3—-P, TDN and NH4 +-N concentrations with time (MHT, M. aeruginosa+fsh feed of HT; MHP, M. aeruginosa+fsh feed of HP; MZT, M. aeruginosa+fsh feed of ZT). The data shown is the mean±SD of two independent measurements.

Algal growth with nutrient loads

Selected commercial compound fish feeds, HT, HP and ZT, demonstrate different effects on released nutrient concentrations and M. *aeruginosa* growth because of their other qualities.

In treatments without M. *aeruginosa* (HT, HP, ZT), released P (TP, TDP, PO4 3—P) and N (TN, TDN, NH4 +-N) concentrations from different fish feeds are significantly different in general ($p<0.05$) (Fig. 3). In treatments with M. *aeruginosa* (MHT, MHP and MZT), fish feed quality affects TP and TN concentrations significantly in general ($p < 0.05$). In addition, for most forms of consumed nutrient concentrations, the differences among all treatments, excluding the lag phase, are significant in most comparisons (PMHP>MZT with the exact dosage (Fig. 4).

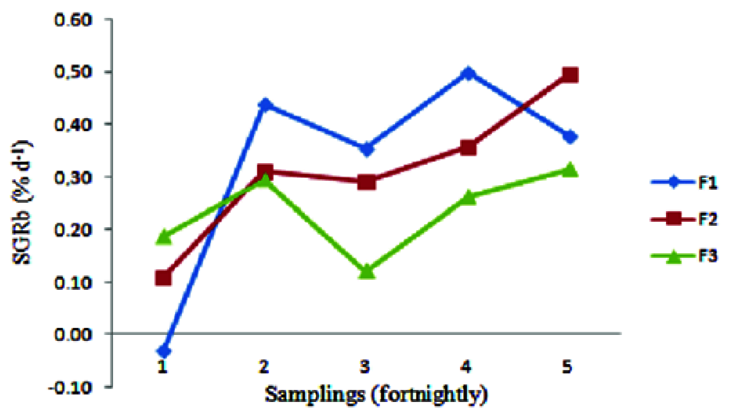

Fig. 4 SGR variation in a fortnight sampling.

CONCLUSION

Generally desirable socio-economically, aquaculture development has considerable implications for water resource use. Integration of aquaculture with other activities is likely to be the most effective means of development. This enables water use to be shared or enhances its value sufficiently to allow investment in improved water supply or treatment. In any aquaculture development, the potential environmental effects must be considered at the planning stage. It is essential to choose aquaculture methods and sites for development to minimise negative environmental impact. One of the most important aspects is the availability of water. However, through integration with agricultural practices, existing resources can be used efficiently, increasing the supply of protein to the rural population without causing adverse environmental effects.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability: The datasets generated and analysed during the current study are not publicly available [Due to institutional policy] but are available from the corresponding author upon reasonable request.

Author Contributions

All authors contributed to this research through conception and design, material preparation, data collection, and analysis, or the first draft of the manuscript. All authors read and approved the final manuscript.

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