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Development of Aquatic Weed-Based Feed for Sustainable GIFT Tilapia Culture

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Abstract : Genetically Improved Farmed Tilapia (GIFT) holds significant promise for aquaculture in India due to its rapid growth, high yield, and desirable taste. However, the high cost of commercial feeds hinders its widespread adoption by small-scale farmers. This study aimed to develop a low-cost, sustainable feed for GIFT tilapia using locally available aquatic weeds, Azolla and Eichhornia. A comparative feeding trial was conducted with commercial soybean meal as a control. Results indicated that both aquatic weed-based diets promoted growth, with Eichhornia demonstrating superior performance in terms of growth rate and feed conversion efficiency. The use of aquatic weeds significantly reduced feed costs compared to commercial feed. Moreover, incorporating aquatic weeds into fish feed offers a dual benefit by controlling weed proliferation, a persistent agricultural challenge. This study provides a viable, eco-friendly, and economically feasible approach to enhance GIFT tilapia culture and support the livelihoods of small-scale farmers.

Index Terms **- GIFT Tilapia, Growth performance, Azolla, Eichhornia, aquatic weed management**

I. INTRODUCTION

Aquaculture has a great potential to meet the protein need for global population and has a significant contribution to the raising global fish production, reaching about 82 million tons in 2018 (FAO, 2020). Genetically Improved Farmed Tilapia (GIFT) is a superior strain of Nile tilapia (*Oreochromis niloticus*) developed through selective breeding by WorldFish and partners in 1988. Renowned for its significantly faster growth rate compared to traditional varieties, GIFT represents a groundbreaking achievement in aquaculture. This pioneering project established the world's first selective breeding program for a tropical fish species. GIFT culture is providing small-scale farmers with an income and households with a sustainable source of food and nutrition. Water hyacinth (*Eichhornia crassipes*), a prolific aquatic weed native to South America, has become a significant environmental and socioeconomic scourge worldwide. Introduced to India as an ornamental plant in 1896, it rapidly proliferated in the country's water bodies. Classified within the Pontederiaceae family, this invasive species poses a formidable challenge to aquatic ecosystems, agriculture, and transportation. Water hyacinth consists of high biomass, fibrous tissue, high energy and protein content that can be used for a variety of useful applications like waste water treatment, compost and fertilizer, animal feed etc (Pandey.A. 2020) The incorporation of aquatic weed in aquaculture feed will open up the new horizon for sustainability of aquaculture feed industry (Kabir M.A et al. 2023).

II.NEED OF THE STUDY.

Intensifying aquaculture, or raising more fish in a smaller space, requires providing a proper and balanced diet. While commercial fish feeds offer convenience, their high cost can be a major hurdle for small-scale farmers. Locally available, low-cost resources offer a promising solution. Household and agricultural wastes, like rice bran, oil cakes, and vegetables, can be transformed into nutritious fish feed. This not only reduces production costs but also helps manage waste effectively. While various agricultural byproducts hold potential as fish feed ingredients, information on their consistent availability and cost is often limited. This research specifically investigated the potential of utilizing aquatic weeds as a sustainable and economical fish feed source. Aquatic weeds pose a significant challenge for farmers, hindering crop growth and requiring control measures. By converting these weeds into fish feed, farmers can achieve two goals simultaneously: managing weed growth and obtaining a low-cost, readily available feed ingredient. This approach has the potential to minimize production costs and boost profitability for small-scale aquaculture.
Study Period: The study was carried out in a 5-month feeding trial from January 2023 to June 2023.

III.RESEARCH METHODOLOGY

Experimental Unit

The experiment was carried out in glass aquariums with continuous water supply and water exchanging. The aquariums were aerated by Aerator.

Experimental Feeds

Three homemade feeds and one commercial feed (Grow well) were used as experimental feeds. Experimental feeds were formulated from Aquatic weeds (Eichhornia, Azolla pinnata and Soya bean. Azolla is a fern Pteridophyta seen in association with

blue green algae anabaena. It fixes atmospheric nitrogen into ammonia that can be utilized by rice plant. Eichhornia classiest, commonly known as common water hyacinth is a wild freshwater fern belonging to Pontederiaceae family. Other ingredients for feed preparation include poultry waste, rice bran and rice flour. The composition of feeds are as follows.

Feed Formulation and Processing

Feed preparation includes collection of aquatic weeds, mixing, pelleting and drying.

a) Sourcing: It involves the collection of aquatic weeds (Azolla , Eichhornia) from fields. Other ingredients were bought from shop at cheap rate.

b) Grinding of feed ingredients: After collection of aquatic weed it was allowed for sun drying for 1 week to remove the moisture content. The feed ingredients are grinded using mixer grinder to improve pellet quality; increase feed acceptance and ingestion by fish.

c)Weighing and mixing: The grinded feed ingredients are weighed using weighing balance. It is properly mixed together with suitable amount of water.

d)Pelleting of feed: This is done by using sieve machine.

e)Drying of feed: It is done immediately after pelleting to remove the moisture in feed. This is done by sun drying for 4-5 days.

Experimental design

The experiment was conducted in glass aquarium using four feeds with two cages in each aquarium. All the fishes of aquarium 1 were fed with Azolla and aquarium 2 was fed with Eichhornia, aquarium 3 with Soya bean and aquarium 4 feed with commercial feed. The fingerlings of Eichornia were grown in aquariums and the fish were fed daily twice. The water was refilled weekly to avoid accumulation of unutilized feed and other wastes. During the study period, the physicochemical parameters such as water temperature, pH and turbidity were measured.

GROUPS	CONTENTS
Azolla (A1)	Azolla feed + 10 fish + 15 liters of water
Soyabean (A2)	Soya bean feed + 10 fish + 15 liters of water
Eichhornia (A3)	Eichhornia feed + 10 fish + 15 liters of water
Control(A4)	Grow well + 10 fish + 15 liters of water

Table 1. Experimental design

Measurement of mortality and survival rates

After 123 days of feeding experiment, fishes were counted to determine the survival and mortality percentage according to following formula.

1) Survival rate (%) = $\frac{\text{No of fishes at the end of experiment}}{\text{No of fish at the beginning of experiment}}$

2) Mortality rate (%) = $\frac{\text{No of fish that died during the experiment}}{\text{No of fish at the beginning of experiment}}$

Data Analysis

Data were coded and analysed in SPSS version 23. The results of the treatments were presented as tables of Mean and SD. ANOVA test was performed for length weight relationship study at significance level $p>0.05$.

IV. RESULTS AND DISCUSSION

Length of Fishes

Among the three feeds treated, mean length of fishes was higher for those fed with Azolla. This was followed by the feed made of Eichhornia. The feed made from Soya bean showed lower growth compared to the feeds formulated from aquatic feeds

Descriptive Statistics					
FEED	N	Minimum	Maximum	Mean	Std. Deviation
Azolla	40	8.0	10.0	9.050	.5444
Soya bean	40	6.5	9.7	7.585	.9558
Eichhornia	40	7.0	9.6	8.183	.7236
Control	40	7.0	11.1	9.115	1.1773
Valid N (listwise)	40				

Table-II. Descriptive analysis on length of fishes fed with trail feeds and control feed.

Weight of fishes

The descriptive analysis of weight shows that the GIFT tilapia fishes fed with Azolla and Eichhornia showed increased body weight in comparison to control feed.

Descriptive Statistics					
FEED	N	Minimum	Maximum	Mean	Std. Deviation
Azolla	40	9.0	11.0	10.000	.5774

Soya bean	40	6.4	9.7	7.495	.9698
Eichhornia	40	8.0	10.5	9.248	.6152
Control	40	7.0	10.6	8.702	1.0219
Valid N (listwise)	40				

Table III Descriptive analysis on weight of fishes fed with different feed.

Length Weight relationships

One-way Anova performed to test the significant difference on the length weight relationship of Gift tilapia shows that feed with Eichhornia and Soya bean as ingredients showed significant difference (p=0.00) while feed with Azolla do not show significant difference. This indicates that although three feeds used for the experiment showed growth performance, the length and weight of fishes were not proportionately increased in the case of feed developed from Azolla. While the other two feeds exhibited growth proportionately (Eichhornia and Soya bean). That is, weight of fishes is increased in concordance with the length of fishes.

Feed		Sum of Squares	df	Mean Square	F	Sig.
Azolla	Between Groups	5.767	17	.339	1.288	.284
	Within Groups	5.793	22	.263		
Eichhornia	Between Groups	18.943	21	.902	11.008	.000
	Within Groups	1.475	18	.082		
Soya bean	Between Groups	30.291	17	1.782	7.340	.000
	Within Groups	5.340	22	.243		
Control	Between Groups	51.742	23	2.250	15.588	.000
	Within Groups	2.309	16	.144		

Table- IV ANOVA showing the length weight relationships of fishes fed with different feeds

Cost of Feed

Feed	Ingredients	Cost	Total Cost (100gm)
AZOLLA	Azolla(14g)	Rs 0	Rs 3.5
	Poultry waste(16g)	Rs 0	
	Peanut meal(24g)	Rs 1	
	Rice bran(30g)	Rs 0.45	
	Rice flour (15g)	Rs 1.05	
	Vitamins and minerals(1g)	Rs 1	
SOYA BEAN	Soya bean(14g)	Rs 1.04	Rs 4.95
	Poultry waste (16g)	Rs 0	
	Peanut meal (24g)	Rs 1	
	Rice bran (30g)	Rs 0.45	
	Rice flour (15g)	Rs 1.05	
	Vitamins and minerals (1g)	Rs 1	
EICHHORNIA	Eichhornia (14g)	Rs 0	Rs 3.5
	Poultry waste (16g)	Rs 0	
	Peanut meal (24g)	Rs 1	
	Rice bran (30g)	Rs 0.45	
	Rice flour (15g)	Rs 1.05	
	Vitamins and minerals (1g)	Rs 1	
CONTROL			Rs. 8

Table V- Production cost of feeds (in Indian Rupees)

Survival Rate

Survival rates were lower for the soybean-based feed (50%) compared to those for feeds developed from Azolla and Eichhornia, which exhibited similar rates (70%) as the control feed.

The use of water hyacinth (Eichhornia) as feed is effective for controlling weeds and producing low-cost feed. This finding is supported by Fouzi and Deepani (2018), who recommended that water hyacinth could be used to replace conventional sources in Tilapia feed successfully in the future. It may help encourage farmers in the aquaculture industry to increase profit margins. The use of water hyacinth in fish feed could be beneficial for controlling the spread of this weed in water bodies. Sarkar (2020) stated that the incorporation of Eichhornia (water hyacinth) meal in fish feed can reduce costs without affecting growth rate. The use of water hyacinth would reduce the cost of formulated feed. Feeds prepared at a small-scale level can lead to employment generation in rural areas. According to Okoye et al. (2002), the proximate analysis of five different parts of the water hyacinth plant was determined at the NIFRR central laboratory. Most aquatic plants have good potential as animal feed. It includes Azolla and Lemna species also. The water hyacinth seems to be very nutritive based on this study since the protein content is higher than some feed ingredients used in fish feed formulation. Their regular harvesting for feed formulation could aid their removal from water bodies where they obstruct navigation or where they are regarded as a nuisance. The petioles and leaves of water hyacinth could be tried as one of the non-conventional feedstuffs. Mahmood et al. (2016) concluded that *Eichhornia crassipes* meal has an optimistic nutrient utilization effect on fish growth. Farmers can use water hyacinth to formulate cost-effective fish feeds. Water hyacinth leaf meal is more appropriate for fish production than whole plant meal. Efforts are now being directed in different parts of the globe to find alternative protein sources of good quality without affecting fish growth performance. Further, such aquatic weed-based feeds are cheaper compared to conventional feeds, and supplementation of aquatic feeds in carp diets would also be economically viable. The significant relation in length and weight exhibited by fishes fed with Eichhornia in this study confirms that aquatic weeds are a good source of nutrients for fishes.

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