Research Article

LOW COST FISH FEED FORMULATION WITH NUTRITIONAL GOLDMINE, SERI-PUPAE WASTE AND CONVENTIONAL AGRICULTURAL BYPRODUCTS FOR BETTERMENT OF FISH FARMER OF MANIPUR

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ABSTRACT

Manipur being a sericulture state, produces all the four traded silkworms viz. Eri, Mulberry, Muga and Tasar with a total production of 615.45 MT. Silkworm pupa which contributes 70% of cocoon biomass is a seri-waste. However, seri-waste, both spent and unspent pupae are complete nutritional package rich in protein (~41%), micro nutrients such as Iron (111 mg/ 100 gm), Magnesium (622 mg/ 100 gm), Calcium (~30.51 mg/ 100 gm) and also posses antioxidant property (IC 50%, 68µg/ml, eri pupae). The state have immense scope for aquaculture development but availability of fish feed is a limiting factor. Feed cost covers 60-80% of the total production of which protein cost accounts 15%. Therefore, efficacy of three different feed formulations (T1, T2 & T3) incorporated with defatted silkworm pupae waste (DSPW) at 25%, 50% and 75% respectively replacing Mustard oil cake (MOC) were evaluated including conventional feed as control on carp fingerlings (*Labeo rohita*). T3 showed significant effective growth rate indicating more than double the size (36.60 ± 0.56 gm) then the initial day (16.66 ± 0.56 gm) at the end of 90 days. Relative Growth Rate (RGR) of different formulated feeds indicated approximate increase of 45-50% with respect to the proportion of DSPW incorporation. Hence, fish feed of DSPW as protein supplement revealed double the relative growth rate compare to control feed. Low cost fish feed formulation with locally available materials are more cheaper than the conventional protein feed sources such as groundnut cake, fish meal and soybean meal, which do not permit profit maximization in aquaculture ventures. Hence, silk industry waste can be an alternative low-cost protein supplement for effective fish feed formulation in the state.

INTRODUCTION

Manipur is an important sericulture state in India contributing all the four traded species of silkworms viz. *Samia Cynthia ricini* (Eri), *Bombyx mori* (Mulberry), *Antheraea assamensis* (Muga) and *A. proylei* (Tasar) with a total annual production of 615.45 MT (2017-18). Enormous volume of silkworm pupa is discarded as seri-waste every year (about 70% of silkworm cocoon biomass). However, both spent and unspent pupae are complete nutritional package, rich in protein (~41%), micro nutrients such as Iron (111 mg/100gm), Magnesium (622 mg/100gm), Calcium (~30.51 mg/100gm) etc and also antioxidant property (IC_{50} %, 68µg/ml, eri pupae) (Lokeshwori *et al*., 2019). Thus, seri-pupae considered as nutritional goldmine have immense scope for good quality protein that can be used for animal feed, especially in aquaculture, petfood industry or poultry feed thereby generating additional income in the silk industry. Profitable conversion of by-products to high value utilities through post harvest/cocoon technologies could reduce the production cost and maximize utilization of the bioresources to cater the ever-growing population and their demanding wants. Fish is an essential and culturally inseparable food item for the people of Manipur. The current annual fish production of the state is approximately 32,000 metric tons (MT) while the estimated fish requirement is of about 52,000 MT (Indian Express, 2018). Huge quantity of fish is being imported annually from other states like Andhra Pradesh and West Bengal to meet the deficiency of 20,000 MT. Fish in various forms such as fresh/frozen, dried and semi-fermented also imported from other parts of the country. Concerted efforts are required in fish production to ensure nutritional security of the people. Of the 300 plus species of fishes reported from the state, only 27 species are being cultured commercially. Thus, scope for aquaculture

development in the state is huge. However, availability of fish feed is a limiting factor in aquaculture development in the state owing to absolute dependence of feed supply from outside the state. Land locked geographical location of the state; frequent landslides on the national highways, high transportation cost are some of the factors affecting feed import to the state. Fish yield from aquaculture is also hindered by scarcity and fluctuating quality and quantity of feed resulting in high production cost and irregular supply. Fish farming will be sustainable only when fish feeds are formulated using feed ingredients that are abundant locally. These ingredients include protein rich seri-pupa (65-75%), mustard oil cake, rice brand, aquatic biomass of plants and incorporation of vitamins and minerals. Feed cost covers 60-80% of the total production cost and protein cost accounts 15% of feed cost in livestock farming. Hence, these types of formulation will be cheaper than the conventional protein feed sources such as groundnut cake, fishmeal and soybean meal which does not permit profit maximization in aquaculture ventures. Above all, fishmeal is the only conventional animal protein source for fishery and that fish meal is scarce and expensive (Karimi, 2006). Therefore, fish growth rate of different low cost fish feed formulation in relation to varying proportion of spent silkworm pupae utilization along with locally available agro-byproducts were evaluated in this study.

MATERIALS AND METHODS

Locally available agricultural byproducts waste such as Rice Bran (RB), Mustard oil cake (MOC) etc and seri-waste, Silk worm pupae (SWP) were collected in bulk from different local sources and used for fish feed formulation. Silkworm pupae as animal protein source is incorporated at various level against the farmer's conventional feed (rice bran: mustard oil cake @ 1:1) which is treated as controls.

Formulation of Different Feeds at Varying Composition

Three different experimental feed formulations and one conventional control feed were prepared as given below;

1) T_1 = RB + (MOC: SWP; 1:1)
2) T_2 = RB + (MOC: SWP; 1:2)
3) T_3 = RB + (MOC: SWP; 1:3)
4) C = RB + MOC; 1:1, (Control)

In all the diets (control and tests), binder mix (Tapioca flour + Maida + Rice Flour; 6+3+1) and Vitamins & minerals mix were incorporated @ 5% and 2% respectively.

Feeding Efficacy of the Formulated Feeds

Wet lab experiments were carried out at the Aquatic laboratory of Institute of Bioresources and Sustainable Development, Imphal, Manipur to determine the feeding efficacy of three formulated feeds against the control feed with carp fingerlings (*Labeo rohita*) of 15-16gm in weight. Twelve FRP Tanks were stocked with10 fingerlings per tank (at a stocking density of 6000/ha) and fed with the control and test feed formulations for 120 days @ 5% of the body weight maintaining triplicates. Feeding was done two times a day, one half in mornings and another half in evening. Before supplying each feeding to the tank, fecal matter and uneaten feed were siphoned out and 20% water exchange was done daily. At every ten days interval, sampling was conducted to record fish growth and to adjust the feed quantity. Water quality parameters such as temperature, pH and DO were monitored daily while total alkalinity and ammonia levels was determined weekly following the methods of APHA, 2005. At the end of the experiment, all the fish was collected, counted and weighed and feed conversion ratio (FCR), periodic weight gain, relative growth rate, protein efficacy ratio (PER), specific growth rate (SGR) and survival rate were determined to find out the best formulation. Statistical tests were carried out on SPSS ver. 16 for windows.

RESULTS AND DISCUSSION

Out of the total cost of fish production, feed constituent 50-60% of the operational cost. Of the estimated potential of fish production of 62,000 tones, the state is able to utilize only 20.5%. At present, only conventional feed consisting of rice bran and mustard oil cake (50:50) is used in fish culture and use of formulated fish feed is still in a nascent stage due to high cost involved. Production of low cost fish feed is a necessity for increasing the productivity to meet the requirement of the state. Silkworm pupae meal (SWPM) is a protein-rich feed ingredient of animal origin with a high nutritional value. On dry matter (DM) basis its crude protein content ranges from 50% to more than 80% (defatted meal). Waste silkworm pupae (SWP) generate vast resources of nutrients for livestock and fish farming. SWP is one of the unconventional top class proteins (65-75%) and lipid feed. Among many alternative protein sources, SWP are considered as an important dietary protein source for fish culture. Therefore, with the scope to utilize the seri-pupa waste of the state, present study evaluated efficacy of three different fish feed formulations (T1, T2 & T3) incorporated with silkworm pupae at varying level on carp fingerlings (*L. rohita*) (Plate. 1). Defatted silkworm pupae waste (DSPW) was incorporated at 25%, 50% and 75% as replacement of MOC respectively. The feeding experiments were conducted for three months and their efficacy was compared against the control feed (C) which is farmer's conventional feed where no DSPW is incorporated (rice bran: mustard oil cake @ 1:1) (Figure 1). Among the test feeds, T1, where MOC and SWP are incorporated at same ratio, showed non-significant difference on growth ratewith C. However, T3 showed significant effective growth rate indicating more than double the size (36.60±0.56gm) then the initial day (16.66±0.56gm) at the end of 90days experiment. Relative Growth Rate (RGR) of different formulated feeds indicated that with respect to the proportion of DSPW incorporation, approximately 45-50% increases in feed formulations (Figure 2).

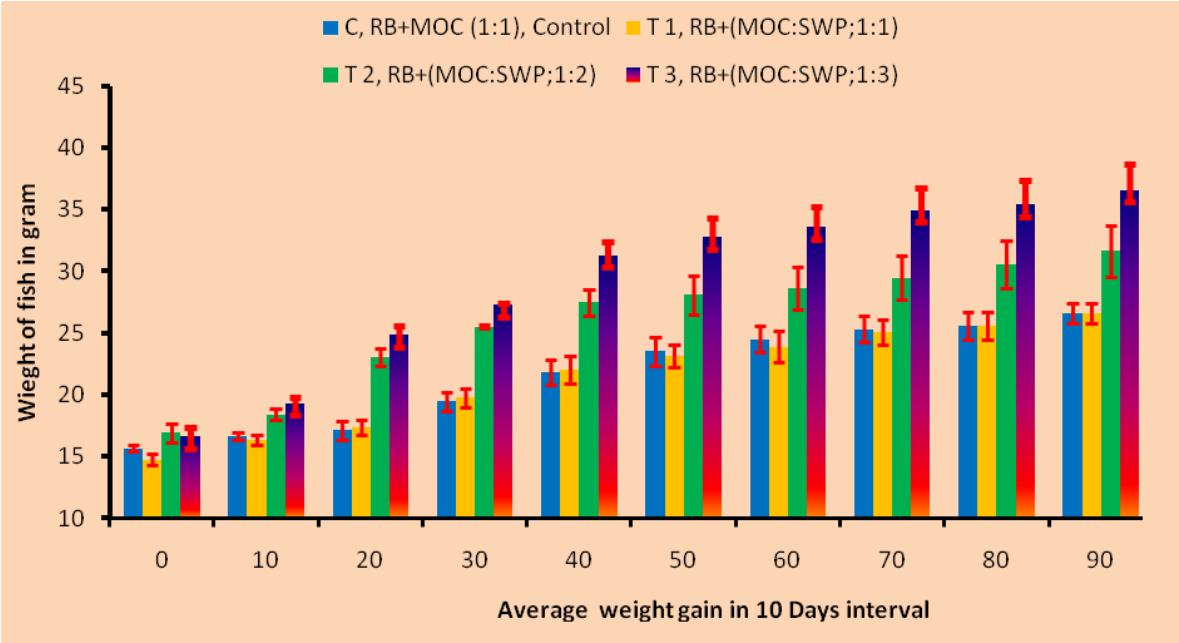

Figure 1: Efficacy of three different seri-pupae fish feed formulations against control feed on the growth of *Labeo rohita* fingerlings

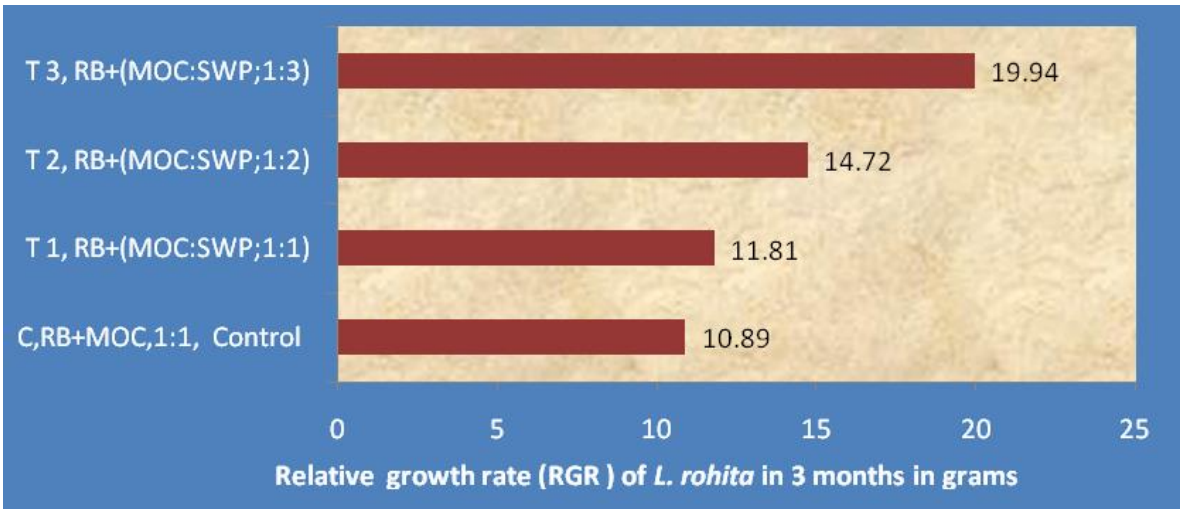

Figure 2: Relative Growth rate of carp fingerlings fed with three different feed formulations and conventional control feed

Hence, experiment on the *in-vitro* utilization of DSPW as protein supplement along with mustard oil cake (MOC) and rice bran in fish feed revealed double the relative growth rate of fish in three months compare to control feed. Sasmal *et al*, (2018) also revealed that used of different proportion of silkworm pupae as protein sources (25%, 30%, 35%, and 40%) with rice bran, mustard oil cake-based control diet (25% protein), showed the best performance in the fish with the diet having 40% protein level incorporation. Specific growth rate (SGR), feed conversion (FCR), protein efficiency ratio (PER) and protein and lipid deposition in the muscle showed highest with the maximum incorporation of silkworm pupae. In an earlier study conducted by Nandeesha, *et al*. (2000), it was shown that feeding common carp with diets containing upto 30% silkworm pupae resulted in progressive increase in growth with increasing level of pupae as compared to a fishmeal based 30% protein diet and the highest weight was recorded at 30% of pupae incorporation. Further, it was also mentioned that the cost of production was lowest with silkworm pupae incorporated feed than control without silkworm pupae.

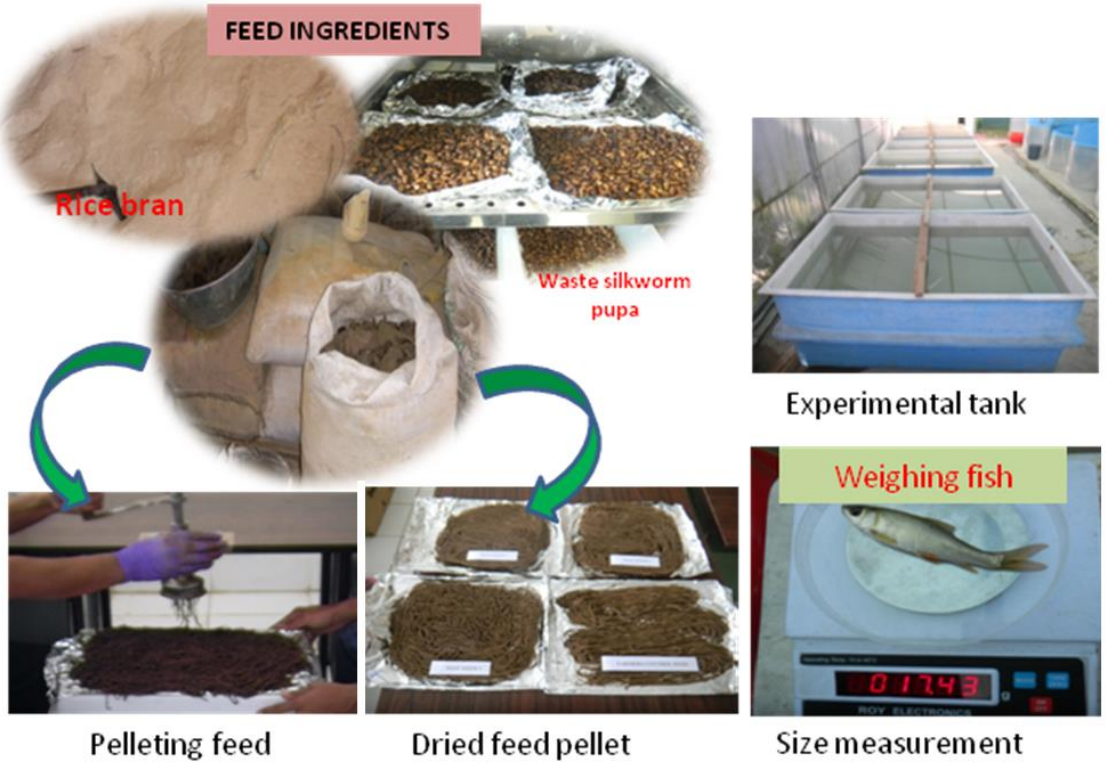

Plate 1: Utilization of Silkworm Pupa in Low Cost Fish Feed Formulation

Therefore, these types of low cost fish feed formulation with locally available materials will be more cheaper than the conventional protein feed sources such as groundnut cake, fish meal and soybean meal, which do not permit profit maximization in aquaculture ventures. Above all, fish meal is the only commercially available costly and conventional animal protein source for fish feed. Hence, silk industry waste of Manipur can be an alternative low-cost protein supplement for effective fish feed formulation in the state.

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