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Original Article

Feasibility of using sailfin catfish meal as an alternative to commercial fishmeal in the diets of juvenile guppy (*Poecilia reticulata*)

Raneesha de Fonseka • Kumudu Radampola

Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences and Technology, University of Ruhuna, Sri Lanka

Correspondence
Kumudu Radampola; Department of Fisheries and Aquaculture, Faculty of Fisheries and Marine Sciences and Technology, University of Ruhuna, Sri Lanka
kumudu@fish.ruh.ac.lk

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Abstract
A six weeks feeding trial was conducted to elucidate the effect of fishmeal produced from sailfin catfish (SCM) by replacing imported commercial fishmeal (FM) in the diet of *Poecilia reticulata* to reduce the cost of feed. Twenty one days old guppy fry (1.99±0.09 cm; 0.07±0.02 g) were fed four diets using different levels of SCM; control diet (CD; 0% SCM), 10SCM (10% SCM), 20SCM (20% SCM) and 30SCM (30% SCM). SCM contained higher protein content (69.5%) compared to FM (61%). Final body weight, %ADG, %SGR or FCR (1.77±0.16 – 2.21±0.26) and food consumption (9.3±0.1 – 9.45±0.5) did not influence by inclusion of SCM. Survival (>80%) did not influence by the type and quantity of fishmeal inclusion. Moreover, significantly higher profit index for 30SCM (8.94±1.43) and 20SCM (7.88±4.23) was recorded than CD (5.17±4.43) which contained imported, expensive FM. Overall, the present study revealed that commercial fishmeal can be fully replaced by SCM in the diets of juvenile guppy without any adverse effects on their growth. Therefore, producing fishmeal using sailfin catfish, which is an invasive species in reservoirs in Sri Lanka and an underutilized source, will be a feasible method to overcome the invasive problem.

Keywords: alternative protein source; feed formulation; growth metrics; ornamental fish; sailfin catfish meal

1 | INTRODUCTION

The genus *Pterygoplichthys* commonly known as sailfin catfish belong to the family Loricariidae, is one of the exotic fish groups that widely distributed in many tropical and subtropical regions (Orfinger and Goodding 2018). The fish are originally from Amazon River Basin of Brazil and Peru and transferred to other regions including North and Central America to Southern and Eastern Asia, and also to Indo-Pacific and Caribbean islands through aquarium trade (Nico *et al.* 2012). The intentional and accidental release from aquariums led them dispersed and established in natural environment (Wakida-Kusunoki *et al.* 2007). The likely factors for sailfin catfish invasion are multiple yet highly influenced by the reproductive success (Gibbs *et al.* 2008), high fecundity (Hoover *et al.* 2004), physiological tolerance (Brion *et al.* 2013) and physical robustness (Ebenstein *et al.* 2015). Countries including Indonesia (Patoka *et al.* 2020), India (Raj *et al.* 2020), Thailand (Panase *et al.* 2018), Mexico (Tapia-Varela *et al.* 2021), Bangladesh (Hossain *et al.* 2018) and Vietnam (Yen 2021) have been declared the invasive threat either as an expansion of existing population or as a new introduction. However, once established it is extremely difficult and costly to remove the fish from the ecosystem (Hill and Sowards 2015).

Sailfin catfishes were initially introduced to Sri Lanka in 1994 with the intention of promoting the ornamental fish industry (Marambe *et al.* 2011). The fish is largely used as a janitor fish to feed on the unwanted plant material inside the fish tanks (Wijesinghe *et al.* 2021). The genus *Pterygoplichthys* contains group of species which are often hybridized for domestication and better varieties. Therefore, this paper will use sailfin catfish to refer the whole group unless otherwise specified. Due to the constant removal of oversized fish from the aquariums, a huge population of invaders established in Sri Lankan water bodies including Polgolla Reservoir, Kala Wewa, Victoria Reservoir, Kandalama Wewa, Balalu Wewa and Usgala Siyambangamuwa Wewa (Kumudinie and Wijeyaratne 2005). The invasion threat has become a serious problem in Sri Lanka and the ecological impact has been vastly described elsewhere (Wijethunga and Epa 2008). Exhibiting an omnivorous feeding behaviour, sailfin catfish preys on eggs of cichlids species cultured on lakes and tanks destroying future potentials of the endemic fishery resources (Amarasinghe *et al.* 2006). The sharp spines damage the fishing gears and this adds an external effort and cost on fishing (Wijesinghe *et al.* 2021). Moreover, sailfin catfish have become a regular catch over the indigenous species in many inland reservoirs in Sri Lanka (Sumanasinghe and Amarasinghe 2014; Wijesinghe *et al.* 2021). In Polgolla Reservoir sailfin catfish landings were recorded as 21% out of total landings of food fish (Sumanasinghe and Amarasinghe 2014) and for each Kalawewa and Victoria Reservoir, monthly catch was exceeding 100 fish for three consecutive years from 2015 (Wickramaratnea *et al.* 2020a). Therefore, removal of invaders from the natural water bodies is utterly important to overcome this problem. According to the fishermen in Udawalawe Reservoir, the sailfin catfish has a poor demand as a food fish due to its unpleasant appearance, odour, and the hard bony structure (personal commumication). Therefore, the fish caught in the nets are extensively discarded at the riverbanks by the fishermen or released back to the water unutilised (Sumanasinghe and Amarasinghe 2014).

The management of invasive sailfin catfish has become a major concern in inland fisheries and aquaculture in Sri Lanka (Sumanasinghe and Amarasinghe 2014). One of the best methods of controlling is to establish a commercial value to encourage intensive fishing. Though, sailfin catfishes are not popularised for direct human consumption, studies have considered other alternatives like producing post-harvest and value-added products such as fish biscuits (Ariyarathne *et al.* 2016) , collagen (Herath *et al.* 2020), bioactive fish protein hydrolysates (Wijesinghe *et al.* 2021) and as dried salted fillets (Ariyarathna *et al.* 2014) to establish a demand. Previous studies on species identification, fish biology and population dynamics have suggested utilising sailfin catfish as a fishmeal alternative to effectively eradicate the invasive threat (Sumanasinghe and Amarasinghe 2014; Wickramaratnea *et al.* 2020b; Abesinghe *et al.* 2020) but not currently practicing in Sri Lanka. There is a study initiated by National Aquatic Resources Research and Development Agency (NARA) Sri Lanka to promote sailfin catfish meal (SCM). In their experiment, SCM was compared with locally produced commercial fishmeal in terms of nutritional profile but did not conduct a feeding trial (Weerasingha and Athukorala 2017). However, in Thailand, SCM has been identified as a successful candidate for fishmeal replacement (Panase *et al.* 2018).

Guppy (*Poecilia reticulata*) is one of the popular freshwater ornamental fish varieties and, Sri Lanka exports guppies contributing to 4% of the global demand (EDB 2021). Ornamental fish culture practices largely depend on the imported formulated feeds in Sri Lanka, thus, feed attributes to a major cost component (Kumaratunga and Radampola 2019). Hence, developing a feed for guppy using low-cost, locally available ingredients would be a promising means for developing of ornamental fish rearing sector within the country. Further, preparation of fish feed will provide employments for local community facilitating a win-win solution for the country's economy and the ecology.

Therefore, this study examines the feasibility of using SCM as a novel feed ingredient in fish feed preparation to develop new feed formulations and study the growth and feed performance of juvenile guppy fed with diets with SCM as a replacement for commercial fishmeal component. If this can be used as a low-cost alternative to the expensive imported fishmeal ingredient in the diets for cultured fish in Sri Lanka that would effectively establish a commercial market for unutilised sailfin catfish landings in Sri Lanka.

2 | METHODOLOGY

2.1 Fish collection and processing of sailfin catfish meal (SCM)

Sailfin catfish were caught from Udawalawe Reservoir (6° 26′39.8″N 80°50′07.1″E), Southern Province, Sri Lanka on 4th October 2016. Freshly caught fish were packed in iceboxes, transported to the laboratory of Department of Fisheries and Aquaculture, University of Ruhuna, Sri Lanka and stored at –20°C for 24 hours. Fish were thawed, length and weight of the fish were measured and dissected to remove the visceral organs (Panase *et al.* 2018). Then fish carcases were cut into small pieces and oven-dried at 60°C for 2 days. Completely dried fish were ground and sieved through 125 μm mesh to produce powdered SCM.

2.2 Experimental diets and proximate analyses

The proximate composition of FM (commercial fishmeal) and SCM are shown in Table 1. Basal ingredients were purchased from local markets in Sri Lanka (Table 2). Ingredients were ground and sifted through 125 μm mesh, when necessary, to obtain fine powder before use them in feed preparation. In the control diet (CD), commercial fishmeal (FM-30%) was the main protein source whilst the other three diets FM was replaced one-third (10SCM), two-thirds (20SCM) and all of FM (30SCM) using SCM. Feed formulation and the proximate composition of experimental diets are presented in Table 2. All ingredients were mixed thoroughly by adding slightly warm water (60°C) to form a non- stick dough, steamed for 10 minutes and pelleted using a hand-held pellet machine. Feed pellets (4 mm) were air-dried to remove moisture, packed in airtight feed bags and freeze at –20°C until fed.

Proximate analyses were performed following AOAC (1990). Protein was established (N × 6.25) by the Kjeldahl method; crude lipid by the Folch method (Folch 1957); ash by combustion at 600°C in a muffle furnace for 8 hours; moisture by kept under the oven at 100°C to constant weight. Proximate composition of SCM and the commercial FM are given in Table 2.

TABLE 1 Proximate composition of commercial fishmeal (FM) and sailfin catfish meal (SCM) (g 100g^{-1} dry matter).

Composition	FM (%)	SCM (%)
Moisture	6.1 ± 0.3	6.0 ± 0.2
Ash	20.9 ± 0.4	10.6 ± 0.2
Crude protein	61.1 ± 0.06	69.5 ± 0.04
Crude lipid	4.0 ± 0.02	4.5 ± 0.05

Values are means of triplicate groups ± SD

2.3 Experimental fish and feeding

Twenty-one days old male guppy fish (*Poecilia reticulata*, red- blonde) were purchased from Karandeniya ornamental fish farm, Sri Lanka and packed in aerated polythene bags and transported to the freshwater aquarium, Faculty of Fisheries and Marine Sciences and Technology, University of Ruhuna. Fish fry were kept at 50 L aerated fibreglass tanks for acclimatization for two weeks and fed with commercial Prima diet (43.9% CP and 12.2% L) (Kumaratunga and Radampola 2019). After two weeks, 120 guppy individuals of 1.98 ± 0.03 cm total length and 0.07 ± 0.02 g body weight were randomly assigned to 12 rectangular glass tanks (60 cm × 30 cm × 30cm) at the stocking density of 10 fish tank^{-1}. Fish were exposed to the natural photoperiod (12 h light: 12 h dark) and continuous aeration was supplied to the tanks.

Four diets were randomly assigned to tanks in triplicate and fish were fed manually up to satiation three times daily at 8:00, 12:00 and 16:00 for 42 days period. Feed consumption (g day^{-1}) in each tank was recorded daily. Tanks were cleaned every other day by siphoning out the waste and refilling (1/5 of tank water) with dechlorinated tap water. Water temperature was monitored daily with a standardized mercury thermometer (°C) while pH was measured once per weak using pH meter (EUTECH pH6, UK). Finally, total ammonia nitrogen (TAN) (mg L^{-1}) were measured in every two weeks by using a standard aqua test kit (ZOOLEK, Poland).

TABLE 2 Feed formulations (g 100g^{-1} dry matter) and proximate composition of (g 100g^{-1} dry matter) experimental diets. CD, control with 30% FM; 10SCM, 10% of FM replaced by SCM; 20SCM, 20% of FM replaced by SCM; 30SCM, FM fully replaced by SCM.

Ingredients	CD	10SCM	20SCM	30SCM
Fish meal[a]	30	20	10	-
Soybean meal	19	19	19	19
Coconut meal	20	20	20	20
Wheat flour	14	14	14	14
Rice bran	11	11	11	11
Vitamin & mineral[b]	3	3	3	3
Coconut oil	3	3	3	3
Sailfin catfish meal	-	10	20	30
Proximate analysis (% dry weight)				
Moisture	7.5	7.3	7.6	7.9
Ash	11.0	10.9	10.4	10.7
Crude protein	34.5	34.7	35.0	38.7
Crude lipid	7.43	7.56	7.78	8.01
NFE[c]	39.57	39.54	39.22	34.69

[a] Danish fishmeal
[b] Starter premix B (Nishshanka *et al.* 2021)
[c] NFE = Nitrogen free extracts, calculated as 100 – (%Moisture + %Protein + %Lipid + %Ash + %Fibre). (Thompson *et al*. 2006).

2.4 Growth performance

The total length (cm) and total body weight (g) of individual fish were measured using the measuring board and the analytical balance (OHAUS-Pioneer) at the beginning and in every two weeks. At the end of the study period, fish were sacrificed, and the liver was removed. Liver weight was taken, and hepato somatic index (HSI) was computed. Average daily gain (ADG), specific growth rate (SGR), feed conversion ratio (FCR) and HSI were calculated according to the standard equations (Ricker 1979).

$$\text{Daily feed consumption (\%BW day}^{-1}) = \frac{Daily\ food\ consumption\ (g)}{Body\ weight\ (g)} \times 100$$

$$\text{\%ADG (g day}^{-1}) = \frac{[Final\ weight - Initial\ weight](g)}{Time\ (days)} \times 100$$

$$\text{\%SGR (g day}^{-1}) = \frac{\ln[Final\ weight] - \ln[Initial\ weight]\ (g)}{Time\ (days)} \times 100$$

$$\text{FCR} = \frac{Total\ feed\ consumed\ (g)}{Body\ weight\ gain\ (g)}$$

$$\text{HSI} = \frac{Liver\ weight\ (g)}{Body\ weight\ (g)} \times 100$$

$$\text{\%Survival rate} = \frac{No.of\ fish\ at\ the\ end\ of\ the\ experiment}{No.of\ fish\ stocked\ at\ the\ beginning} \times 100$$

The economic analysis was used to determine the cost-effectiveness of the experimental diets based on the local market price in Sri Lanka (in Sri Lankan rupee, LKR; 1 USD = 199.7 LKR). Profit index and the incidence cost were calculated according to (El-Dakar *et al.* 2007).

$$\text{Profit index} = \frac{Value\ of\ fish\ (Rs)}{Cost\ of\ feed\ (Rs)}$$

$$\text{Incidence cost} = \frac{Cost\ of\ feed\ (Rs)}{Weight\ of\ fish\ produced\ (g)}$$

2.5 Data analysis

All the statistical analyses were performed using the SPSS statistical package (SPSS 16.0) and the data presented as Mean ± SD. For parametric data, Levene's test was used to test the homogeneity of variance. Final body length and weight data of guppy and HSI were subjected to Randomized block ANOVA model. Daily feed consumption, FCR, %ADG, % SGR and survival data were assessed using one-way analysis of variance (ANOVA). Duncan multiple range test was used to distinguish differences between treatments. For non-parametric data, Kruskal- Wallis test was conducted followed by the Dunn's multiple comparison test. An α significance level of 0.05 was used to indicate the significant differences.

3 | RESULTS

3.1 Growth performance and feed utilisation

SCM contained much higher protein content (69.5%) compared to that of FM. The lipid contents of both fishmeal components were comparable (4% and 4.5% for FM and SCM respectively). As FM was replaced by SCM in various proportions, protein and lipid contents in experimental diets were ranged from 34.5 – 38.7% to 7.4 – 8.0% respectively. Table 3 shows the growth parameters and feed performances of guppy fish during the study period. Final body length of guppy was significantly higher in 30SCM treatment in which FM was fully replaced by the SCM when compared to that of CD treatment in which FM was the major protein source. The length and weight variation of guppy during the experimental period are shown in Figures 1 and 2. No significant difference was observed for the other growth indices such as final body weight, %ADG, %SGR and %HSI. Fish accepted the experimental feeds and average feed consumption was ranged between 9.3 and 9.5 %BW (Table 3). Feed consumption or FCR was not affected by the dietary inclusion level or type of fishmeal protein source and FCR ranged from 1.77 – 2.21. Higher survival rates (>80%) was observed in all treatments (Table 3).

TABLE 3 Growth parameters of guppy (*Poecilia reticulata*, as mean ± SD) fed on different diets over the 42 days of the experimental period. CD, control with 30% FM; 10SCM, 10% of FM replaced by SCM; 20SCM, 20% of FM replaced by SCM; 30SCM, FM fully replaced by SCM).

Parameter	Experimental Diet			
	CD	10SCM	20SCM	30SCM
Initial total length (cm)	1.99 ± 0.88[a]	2.01 ± 0.10[a]	1.97 ± 0.84[a]	2.01 ± 0.10[a]
Initial total body weight (g)	0.07 ± 0.02[a]	0.07 ± 0.02[a]	0.07 ± 0.018[a]	0.07 ± 0.02[a]
Final total length (cm)	2.80 ± 0.18[a]	2.83 ± 0.19[ab]	2.82 ± 0.18[ab]	2.91 ± 0.25[b]
Final total body weight (g)	0.29 ± 0.08[a]	0.28 ± 0.06[a]	0.29 ± 0.06[a]	0.29 ± 0.08[a]
% ADG	7.54 ± 0.69[a]	6.75 ± 0.69[a]	8.20 ± 0.88[a]	7.13 ± 1.92[a]
% SGR	3.39 ± 0.16[a]	3.19 ± 0.18[a]	3.55 ± 0.19[a]	3.26 ± 0.48[a]
FCR	2.21 ± 0.26[a]	2.0 ± 0.20[a]	1.84 ± 0.43[a]	1.77 ± 0.16[a]
Food consumption (%BW day^{-1})	9.30 ± 0.10[a]	9.33 ± 0.21[a]	9.45 ± 0.50[a]	9.36 ± 0.71[a]
%HSI	0.5 ± 0.008[a]	0.6 ± 0.002[a]	0.5 ± 0.006[a]	0.5 ± 0.003[a]
% Survival	90.0 ± 10.0[a]	90.0 ± 10.0[a]	86.67 ± 15.27[a]	80.0 ± 20.0[a]

Different lowercase letters indicate the significant difference among treatments (p <0.05).

3.2 Water quality analysis

During the experimental period water temperature, pH, and TAN did not change significantly among the treatments (all $p < 0.05$). Water temperature ranged from 26.9 to 27.0°C while pH varied from 7.0 to 7.1. In addition, at all-time points, TAN levels were closer to zero (Table 4).

3.3 Cost analysis

The cost of per kg experimental diets varied from 109 to 181 LKR. The CD diet which consisted of 30% of FM had the highest cost compared to the diets including SCM (Table 5). Significant profit index was recorded for the diets containing SCM when compared to the CD (Table 5). The opposite trend was observed for the incidence cost where 30SCM yielded the lowest value (Table 5). However, profit index and incidence cost did not significantly differ between 20SCM and 30SCM (Table 5).

4 | DISCUSSION

Invasion of sailfin catfish has been recognised as a serious threat to reservoir ecosystem functioning and the local capture fishery in Sri Lanka (Wickramaratne *et al.* 2017a). As this fish group is not utilised in a productive way, it becomes an unwanted fishery resource as well as an environmental pollutant near the inland freshwater reservoirs within the country (Wijesinghe *et al.* 2021). In the present study an attempt was taken to utilise this under-utilised fishery resource into a valuable commodity in aquaculture industry which may give a practical solution to the problem of invasion. The experiment assessed the potential of SCM as a commercial expensive FM replacement in the diets of juvenile guppy fish, a popular ornamental fish in Sri Lanka. As hypothesised, there was no significant difference observed in growth responses between the levels of fishmeal protein replacement by the SCM.

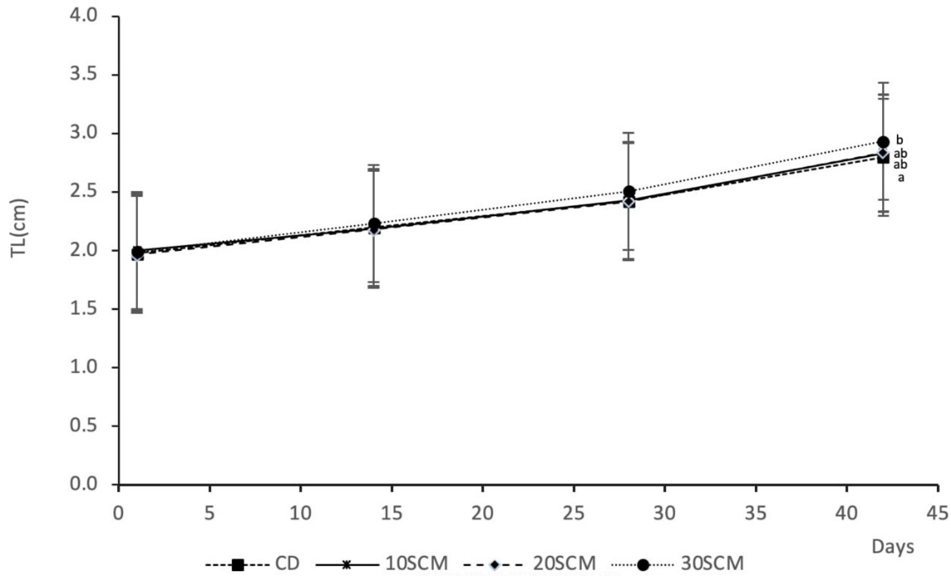

FIGURE 1 Total body length (mean ± SD) of guppy fish in different experimental groups during the 42 days of study period.

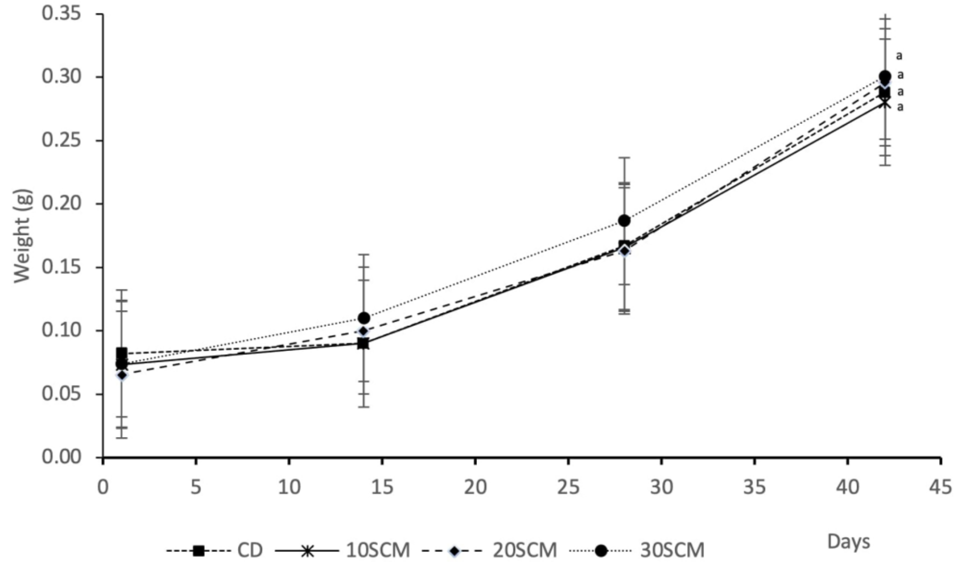

FIGURE 2 Total body weight (mean ± SD) of guppy fish in different experimental groups during the 42 days of study period.

TABLE 4 Water quality parameters in rearing tanks during the experimental period (*n* = 3; mean ± SD). CD, control with 30% FM; 10SCM, 10% of FM replaced by SCM; 20SCM, 20% of FM replaced by SCM; 30SCM, FM fully replaced by SCM.

Parameter	Experimental diets			
	CD	10SCM	20SCM	30SCM
Temperature (°C)	26.97 ± 0.28	26.97 ± 0.01	27.0 ± 0.01	27.0 ± 0.01
pH	7.12 ± 0.01	7.12 ± 0.06	7.12 ± 0.01	7.12 ± 0.01
TAN	0	0	0	0

The results clearly showed that, no significant difference was observed in terms of daily feed consumption, %SGR, %ADG, FCR and final body weight of fish fed experimental diets with SCM. Low FCR indicates the better conversion of protein into the body tissues. The results give positive insights of utilising this novel ingredient of SCM to fully replace the fishmeal in the diets of juvenile guppy fish without any adverse effect on fish growth.

Panase *et al.* (2018) reported that *Pterygoplichthys pardalis* meal contains 54% protein and 6% fat. Present study also represents a close percentage of protein and lipid contents, 69.5% and 4.5% respectively. However, Asnawi *et al.* (2015) stated the protein and lipid contents of sucker mouth armoured catfish as 37% and 16.9% respectively.

TABLE 5 Cost of producing one kg of feed in Sri Lankan Rupees (LKR), profit Index and Incidence cost for different experimental diets (n = 3, mean ± SD). CD, control with 30% FM; 10SCM, 10% of FM replaced by SCM; 20SCM, 20% of FM replaced by SCM; 30SCM, FM fully replaced by SCM.

Parameter	Experimental diets			
	CD	10SCM	20SCM	30SCM
Total cost (LKR kg^{-1})	180.5	130.3	118.3	108.8
Profit index	5.17 ± 4.43^{a}	6.62 ± 2.09^{b}	7.88 ± 4.23^{c}	8.94 ± 1.43^{c}
Incidence cost	0.55 ± 0.01^{b}	0.42 ± 0.01^{b}	0.34 ± 0.02^{a}	0.21 ± 0.02^{a}

Total cost was calculated in Sri Lankan Rupees (LKR), where 199.7 LKR = 1 USD. Total cost = Ingredient cost + Preparation cost (LKR20 kg^{-1}).
Market prices (LKR kg^{-1}): fish meal: LKR.300, soybean meal: LKR.113, coconut meal: LKR.40, rice bran: LKR.30, wheat flour: LKR.97, vitamin-mineral mixture: LKR.1800, Coconut oil: LKR.680. It was assumed that preparation costs (electricity, labour) were same for all and the preparation cost for feed was assumed LKR 20 kg^{-1}.

The differences in composition could be due to the species difference or based on the different laboratory procedures practices in the experiments. It was established that sailfin catfish is a rich source of essential amino acids, calcium and phosphorus (Asnawi *et al.* 2015). The diets used in the present study had 34 – 39% protein and 7 – 8% lipids which is in accordance with the requirements of protein 30 – 40% and lipid 4 – 9% levels for growth of guppy (National Research Council 1993). Comparing our results with similar study, Panase *et al.* (2018) have shown that *P. pardalis* meal can be used to fully replace the FM for Mekong catfish (*Pangasianodon gigas*) besides its decreasing trend in the growth performance after the replacement of 75% fishmeal. As such, fishmeal replacement level is largely depended on nutritional requirement and the physiology of the fish feeding on the test diet. Therefore, future studies for extended period of feeding trails followed by blood parameters to measure the nutritional and health status (Madibana *et al.* 2017) are recommended for guppy fish. Serum biochemical parameters like serum protein, cholesterol, and triglycerides vary with the dietary protein in fish diets and play a key role in defining the health status of fish (Hrubec *et al.* 2001).

Nevertheless, water quality parameters measured were within the range for normal growth of guppy. These are usually known as hardy fish which can survive in harsh environmental conditions (Fernando and Phang 1994). However, the present study experienced drastic weather condition and sudden changes from long sunny days to cold rainy days although fish were reared inside the aquarium. During the first two weeks fish had to undergo with stressful events such as moving from acclimatization tanks to experimental setup, length weight measurements followed by severe weather conditions that can negatively affect the fish health. The caused for the mortalities has been recognised as the post-stress after the initial length weight measurements and experiencing cooler temperature after a heavy rain during the initial phase of the experiment. However, after the first two weeks of the experiment, no death or lethargic behaviour was observed.

Cost analysis revealed that on-farm preparation of SCM can be profitable than buying expensive commercial fishmeal to produce diets for guppy fish. Sailfin catfish are freely available at local fish landing sites near freshwater reservoirs and the drying and grinding of fish to produce SCM can be done with very low cost. On-farm feed preparation is very common practice among most of small-scale ornamental fish farmers in Sri Lanka (Athukorala 2017). Also, powder or dough are found to be effective than feed pellets for guppies (Harpaz *et al.* 2005). On the other hand, if community based SCM processing places can be established around local reservoirs e.g. Udawalawe, the surrounding ornamental fish breeders can get the benefit over it.

Replacement of commercial fishmeal with locally prepared fishmeal is not uncommon in nutrition studies. It was identified as one of the most effective protein sources based on the nutrition profile compared to plant-based foodstuffs. For instance, dried fish powder of minor cyprinids (*Dawkinsia singhala* and *Puntius chola*), which is not a traditional source of preparing fishmeal, has been described as a very promising source for koi carp *Cyprinus carpio* diets (Weerasingha *et al.* 2017). The use of invasive species in fishmeal preparation has been discussed in the literature in terms of mitigating their negative impacts and intensifying the aquaculture practices. For instance, knife fish meal (Abarra *et al.* 2017), Asian carp (Bowzer *et al.* 2014), sucker mouth catfish (Panase *et al.* 2018) and apple snail (Jintasataporn *et al.* 2004) have provided excellent fishmeal substitutes in the diets of food fish species. Literature on the use of SCM as a fishmeal substitute in ornamental fish species in Sri Lanka is scarce. Therefore, future studies are required to explore the current limitations such as revealing the fatty acid and amino acid profile of SCM and importantly, colour additives to enhance the body colouration of ornamental fishes, a lucrative business in Sri Lanka.

5 | CONCLUSIONS

In summary, invasive sailfin catfish meal can be utilised as an alternative to commercial fishmeal in the diets of juvenile guppy fish without any adverse effect on their growth. Therefore, this is a practical solution to encourage the local ornamental fish farmers and simultaneously, eradicating the invasive threat from local reservoirs in Sri Lanka.

ETHICAL APPROVAL

The scientific and ethical responsibility of the animal experiment belongs to the author(s). No committee established on the ethics in the institution at when the experiment was performed. However, fish were killed using MS222 anaesthesia for HSI index, and all efforts were made to minimise suffering.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

Conceptualization, RdF & KR; data curation, RdF & KR; formal analysis, KR; investigation, RdF; methodology, RdF & KR; project administration, KR; resources, KR; supervision, KR; visualisation, RdF & KR; writing - original draft, RdF; reviewing and editing RdF & KR.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author.

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R de Fonseka https://orcid.org/0000-0002-4718-3516
K Radampola https://orcid.org/0000-0003-0292-4576