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Effects of soybean lecithin on growth and survival of tropical tin foil barb

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ABSTRACT

Soybean lecithin as a source of phospholipid has some positive effects on growth and survival of both marine and freshwater fish species. The aim of the 70-day long research was to evaluate the effects of soybean lecithin on growth and survival of tropical tin foil barb, *Barbonymus schwanenfeldii*. Four iso-nitrogenous and iso-lipidic diets were formulated by supplementing 0, 2, 4 and 6% of dietary granular soybean lecithin while 0% PL supplemented diet served as control. Diets were named as D1, D2, D3, D4 re spectively. Homogenous sized 20 juveniles with an initial weight of 8.8±0.08g (mean ± S.E.) were stocked in ready-to-stock 12 tanks in triplicates for each dietary treatment. Results showed that mean final weight FW, WG and SGR values were higher in groups fed soybean lecithin treated diets than the control diet. The survival of juveniles in different treatment groups ranged from 75% to 90% having significantly ($P<0.05$) higher in D3 and D4 diets. The SGR values of 4% PL supplemented group (D3) was higher ($P<0.05$) followed by groups D4 and D2 while lowest in D1 diet. Growth in 4% PL supplemented diet was higher because of the enhanced feed intake. Condition factor in the present study supports the weight gain, SGR and final weight of experimental fish. HSI and VSI values were also evident in the high growth attributing fish groups. Based on growth performance parameters, this study suggested that 4% granular soybean lecithin supplemented diet could satisfy the requirement of phospholipid for better growth of juvenile *B.schwanenfeldii*.

Key words: Phospholipid, Tin Foil Barb, Soybean lecithin.

INTRODUCTION

Barbonymus schwanenfeldii is a tropical freshwater fish inhabiting river and lakes and widely distributed in Malaysia. Popularly, this fish is called as tin foil barb having a local name of *ikan lampam*. Being a very tasty fish, it is gaining attention to aquaculturists for the culture and breeding of this fish. *B. schwanenfeldii* may reach up to 1000 gm if they are provided with a good and balanced nutrition. Usually this fish feed on debris, microalgae, filamentous algae as well as insects, which make them an ideal omnivorous fish (Isa et al., 2012). As a Cyprinid fish, it does have value in aquaculture as food and ornamental purposes in aquarium industry.
Nowadays, this species is getting attention for its value and popularity in the tropical regions. Very few studies have been conducted on its life history traits, growth and distribution like features (Sugama et al., 2004) but still lacking basic nutritional requirements except some pioneer works (Mansour et al., 2017; Khalil et al., 2017).
On the other hand, soybean lecithin as a source of phospholipid (PL) has been considered as an important nutrient in some cultured fish from both marine and freshwater species. Noteworthy, it is recommended in early life stages of fish for better growth, survival and nutritional delineation (Cotteau et al., 2002; Tocher et al., 2008). As a pioneer attempt, this work was done to estimate the effects of PL on this incipient tropical cyprinid. Additionally, the current investigation was done with an intention to validate the effects of dietary soybean lecithin supplementation on its growth, survival and development.

MATERIALS AND METHODS

Feed formulation and preparation of experimental diets

The formulation and proximate composition of experimental diets are presented in **Table 1**. All the dietary ingredients were obtained from commercial sources. Four iso-nitrogenous and iso-lipidic diets were formulated by supplementing 0, 2, 4 and 6% of dietary granular soybean lecithin while 0% PL supplemented diet served as control. Diets were named as D1,

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D2, D3, D4 respectively. All the dietary ingredients were pulverised through a sieve (500-μm mesh). The dietary ingredients were thoroughly blended with the lipid sources and water in a food mixture. Then the diets were pelleted with a pelletizer and were oven-dried for 4-5 h at 60ºC, bagged and stored at -20ºC until further use. All the diets were isolipidic and isoenergetic except the levels of phospholipids (Table 1).

Rearing of fish and commencement of feeding trial

Juvenile *B. schwanenfeldii* was collected from commercial traders at Kuala Terengganu, Malaysia and reared in the Freshwater Hatchery, School of Fisheries and Aquaculture Sciences, University Malaysia Terengganu, Malaysia. Immediately after arrival in the hatchery, fish were acclimatized in a big circular tank for 48 hours with mild water flow and sufficient oxygen. Then fish were reared and adapted to the laboratory condition for 10 days and fed with a commercial pelleted diet (Cargill Malaysia Sdn Bhd, Port Klang, Malaysia; Crude Protein 43%, Crude Fat 3%, Crude Fiber 3%, Ash 16% and Moisture 11%). The feeding experiment was conducted in 150 L fibre-glass tanks with a closed water system connected to the biological filtration. All the tanks were covered with fine wire to prevent fishes from jumping out of the tanks. Each tank was equipped with an inlet, outlet and continuous aeration. The tanks were maintained under natural light and dark regime. After acclimatization, the homogenous sized 20 juveniles with an initial weight of 8.8±0.08g (mean ± S.E.) were stocked in ready-to-stock 12 tanks in triplicates for each dietary treatment. The

Table (1): Proximate composition of experimental diets fed for 70 days.

Ingredients (g/kg.)	**PL 0 (D1)**	**PL 2% (D2)**	**PL 4% (D3)**	**PL 6% (D4)**
Fish meal[a]	200.00	200.00	200.00	200.00
Soybean meal[a]	350.00	350.00	350.00	350.00
Shrimp meal[b]	20.00	20.00	20.00	20.00
Wheat flour[c]	250.00	250.00	250.00	250.00
Fish oil[a]	20.00	20.00	20.00	20.00
Palm oil[c]	60.00	40.00	20.00	0.00
Soybean lecithin[a]	0.00	20.00	40.00	60.00
Vit. Mix[d]	20.00	20.00	20.00	20.00
Min. mix[e]	20.00	20.00	20.00	20.00
Vit. C[d]	2.00	2.00	2.00	2.00
CMC[a,f]	20.00	20.00	20.00	20.00
Cellulose[a]	38.00	38.00	38.00	38.00
Total	**1000**	**1000**	**1000**	**1000**
Proximate composition				
Protein	36.01	36.35	36.20	36.25
Lipid	10.9	10.99	11.01	11.02
Ash	12.00	13.02	11.90	11.9

[a] Sri Purta Trading, Alor Setar, Kedah.
[b] Raw materials collected from local market, oven dried and made shrimp meal in laboratory
[c] Collected from the local market in Terengganu
[d] Rovithai, DSM Nutritional Products Ltd. Scotland; composition (IU/g/mg per kg): vitamin A 50 IU, vitamin D3 10 IU; vitamin E130 g, vitamin B1 10 g, vitamin B2 25 g, vitamin B6 16 g, vitamin B12 100 mg, biotin 500 mg, pantothenic acid 56 g, folic acid 8 g, niacin 200 g, anticake 20 g, antioxidant 0.2 g and vitamin K3 10 g
[e] Rovithai, DSM Nutritional Products Ltd. Scotland; composition (g per kg): copper 7.50 g, iron 125.0 g, manganese 25.0 g, zinc 125.0 g, cobalt 0.50 g, iodine 0.175 g, selenium 0.300 g and anticake 10.0 g
[f] Carboxymethyl cellulose

fish were hand fed with the respective test diets at visually near satiation, twice a day at 8.00 am and 16.00 and seven days per week for 70 days. All the fish were weighted in bulk at every two weeks interval to determine growth and health condition.

Table (2): Growth and feed utilization parameters of *B. schwanenfeldii* juveniles fed phospholipid supplemented diet for 70 days.

TR/Par.	PL0% (D1)	PL2% (D2)	PL4% (D3)	PL6% (D4)
FW[1]	15.26±0.08[a]	15.90±0.60[a]	17.84±0.57[b]	17.43±0.63[b]
WG[2]	76.23±2.3[a]	77.88±3.54[a]	103.49±4.86[b]	95.18±7.47[ab]
SGR[3]	0.81±0.02[a]	0.82±0.03[a]	1.01±0.03[b]	0.95±0.05 [ab]
FI[4]	1.77±0.00[a]	1.89±0.01[a]	1.94±0.00[b]	1.95±0.01 [b]
FCR[5]	1.21±0.01[a]	1.15±0.04[a]	1.20±0.06[a]	1.18±0.04 [a]
Survival[6]	75.67±0.33[a]	80.67±0.33[a]	90.00±1.00[b]	90.00±0.58[b]

Values are means ± S.E.M. Within a row, means with the same letters are not significantly different ($P > 0.05$).
[1]Final weight (g)
[2]Weight gain (%) = (final weight – initial weight) × 100 / initial weight
[3]Specific growth rate (% day^{-1}) = {Ln (final weight) – Ln (initial weight) / duration in days} × 100
[4]Feed intake (g fish^{-1} 70 days^{-1}) = (dry diet given – dry remaining diet recovered) / no. of fish
[5]Feed conversion ratio = total dry feed fed (g) /wet weight gain (g)
[6]Survival (%) = 100 × (final no. of fish / initial no. of fish)

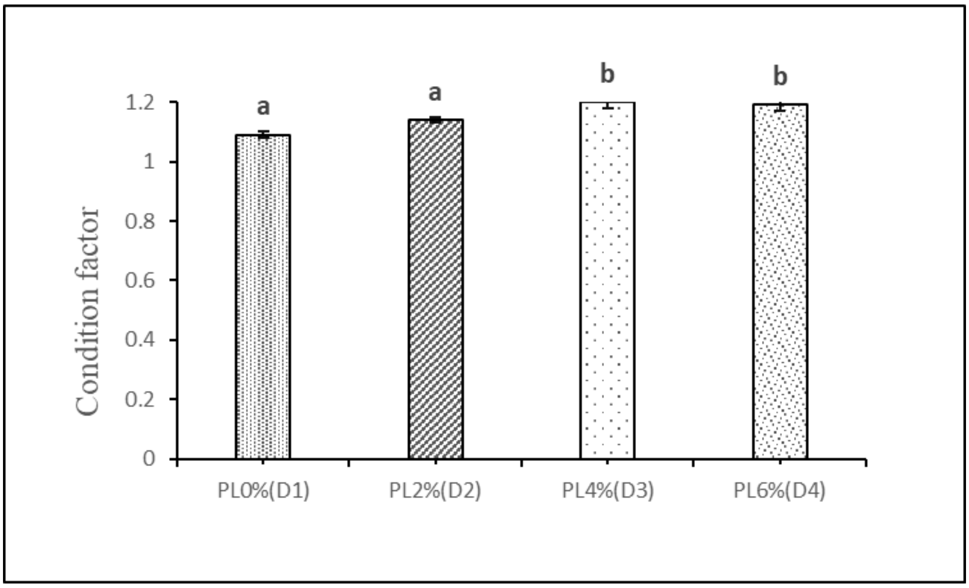

Fig. 1: Condition factor of *B. schwanenfeldii* juveniles fed experimental diets for 70 days.

The water quality such as water temperature, pH, and dissolve oxygen (DO) was measured and recorded every day during feeding trials. During the feeding trial, the temperature, pH and DO were varied between 29 to 30 °C, 7.1 to 8.9 and 5.3 to 7.3 mg l^{-1}, respectively.

Collection of samples

Fish were starved for 24 hours before final sampling. All the fish were anaesthetized by using overdose of MS-222, method described by Ng and Andin (2011). Body length and weight of individual fish were taken as well as the number. Fish were dissected out to collect liver and viscera from three fish in each replicate tank and weighted to calculate hepatosomatic index (HSI) and viscera somatic index (VSI) respectively.

Proximate composition

The proximate compositions of the feed ingredients and experimental diets were analysed using standard methods (AOAC, 1997). Moisture content was determined by drying the samples to a static weight at 105 °C. The crude protein was estimated by computing nitrogen (N×6.25) using the Kjeldahl method (2300-Auto-analyzer, FOSS, Denmark), crude lipid content by ether extraction using Soxhlet method (36680-analyer, BUCHI, Switzerland), ash content by combustion at 550 °C for 12 h.

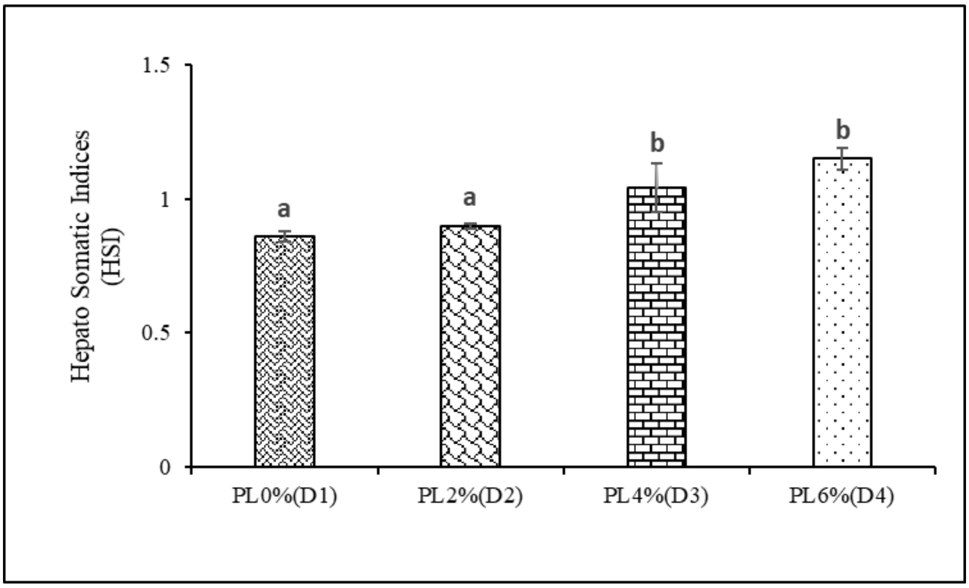

Fig. 2: Hepato somatic indices of *B. schwanenfeldii* juveniles fed experimental diets for 70 days

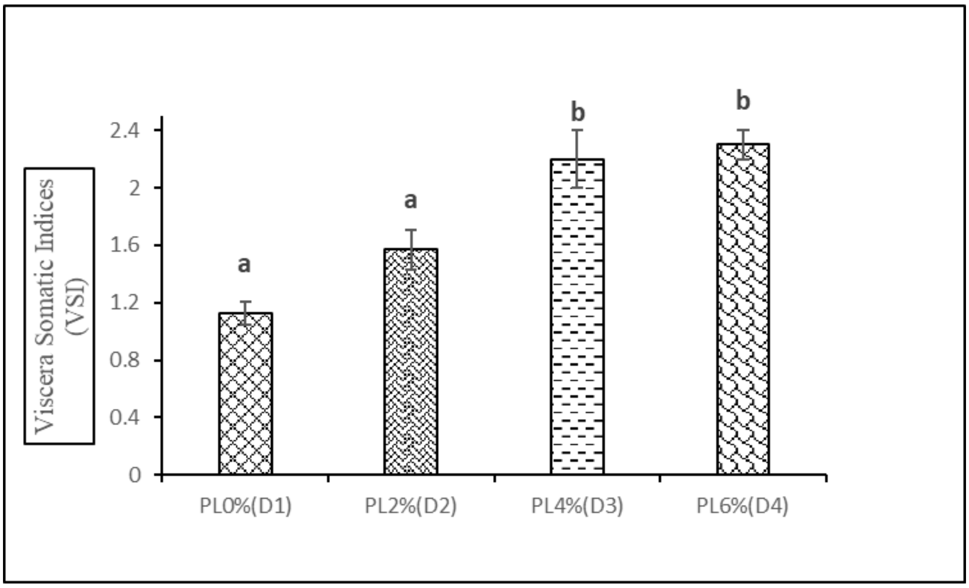

Fig. 3: Viscera somatic indices of *B. schwanenfeldii* juveniles fed experiment diets for 70 days

Calculation of growth indices

The following variables were evaluated:

Weight gain (WG, %) = (final weight – initial weight) × 100 / initial weight

Specific growth rate (SGR %, day^{-1}) = {Ln (final weight) – Ln (initial weight) / duration in days} × 100

Survival (%) = 100 × (final no. of fish / initial no. of fish)
Feed intake (g fish^{-1} 70 days^{-1}) = (dry diet given – dry remaining diet recovered) / no. of fish
Feed conversion ratio (FCR) =total dry feed fed (g) /wet weight gain (g)
Condition factor (CF, %) = weight of fish / (length of fish)^3 × 100
Hepatosomatic index (HSI, %) = weight of liver / weight of fish × 100
Viscera somatic index (VSI, %) = weight of viscera / weight of fish × 100

Statistical analysis

All the data were subjected to one-way analysis of variance (ANOVA) followed by Duncan's multiple range test. The statistical analyses were performed in SPSS 21.0 for Windows (SPSS Inc., Chicago, IL, USA). A significance level of 5% (P<0.05) was used for all comparisons.

RESULTS

Survival and growth performance

The *B. schwanenfeldii* juveniles readily accepted the experimental diets except some troubles at very beginning of the trial but immediately after that, maintained standard behaviour throughout the rest of the growth trial. The growth performances of *B. schwanenfeldii* fed different experimental feeds are presented in **Table 2**. The mean final weight FW, WG and SGR values were higher in groups fed phospholipid treated diets than the control diet. The survival of juveniles in different treatment groups ranged from 75% to 90% having significantly (P<0.05) higher in D3 an D4 diets. Juveniles fed control diet had significantly (P<0.05) lower WG, SGR and final weight (FW) compared to those of other groups. The SGR values of 4% PL supplemented group (D3) was higher (P<0.05) followed by groups D4 and D2 while lowest in D1 diet.

However, FCR values did not show any specific trend and no variations were evident among the PL supplemented groups. HSI showed some variations and higher PL supplemented groups (D3 and D4) had significantly (P<0.05) higher HSI in comparing with the other treatments. VSI in group fed D4 showed significantly higher values followed by D3 and lowest in D1. Significantly highest condition factor (CF) was attributed in the fish fed D3 followed by D4 and lowest in group fed control diet

DISCUSSION

The present research was intended to govern the consequences of dietary soybean lecithin as a phospholipid on *B. schwanenfeldii* juveniles. The finding of the current study illustrates that PL has some positive impacts on growth performance of juvenile *B. schwanenfeldii* fish. It was observed that 4% granular soybean lecithin attributed a significant increase in juveniles' final weight, specific growth rate and weight gain compared to control group. Furthermore, the survival of juveniles in different treatment groups ranged from 75% to 90% and interestingly increasing with the increment of PL in diets but up to a certain level. Four percent PL attributed better growth-related parameters including the survival of fish.

In an earlier study, Paul et al., (1998) suggested that the inclusion of 4% dietary phospholipid was effective for better growth and survival of Indian major carps like *Labeo rohita*, *Cirrhinus cirrhosus* and *Catla catla*. The current investigation also revealed that 4% supplementation of PL was sufficient for suitable growth and development without affecting the normal growth-related parameters for *B. schwanenfeldii*. Moreover, another tropical fish *Tor tambroides* showed very good growth and survival fed with a 4% phospholipid (Mian et al., 2018; Mian et al., 2020). Phospholipid supplemented diets lead to accelerated growth and survival of early life stages of fish species from both freshwater and saline water fishes (Tocher et al., 2008). Poston (1990) also recommended soy lecithin for the enhancement of growth and survival in juveniles of freshwater fish. Kasper & Brown (2003) have identified phosphatidylcholine as growth promoting component in soy lecithin and recommended level was 1.5% PC for Nile Tilapia.

In the current study, FW of juveniles fed diets with 4% and 6% PLs were higher than those of juveniles fed no PL enriched diet. On the contrary, SGR was significantly higher in fish group fed diet D3 and D4. Juveniles fed control diet had significantly ($P<0.05$) lower WG, SGR and final weight (FW) compared to those of other groups. The SGR values of 4% granular PL supplemented group was significantly higher ($P<0.05$) than those of other PL supplemented groups and the control group. It is noted that PL is a good source of nutrient in the early life stages of fish and crustaceans from both marine and freshwater (Coutteau et al., 1997). Several studies exhibited that PL supplemented diets enhanced the efficiency of lipid utilization and supply phosphatidylcholine for good growth (Sánchez et al., 2012; Tocher et al., 2008). PL supplemented groups showed higher growth and was accredited to the stimulatory effect of PL on intestinal lipoprotein secretion accordingly (Fontagne´ et al., 2014; Geurden et al., 2008). Improvement in dietary lipid transportation (Fontagne´ et al., 2000; Hadas et al., 2003) along with FA absorption in the intestine (Geurden et al., 2008). Likewise, current study revealed that WG significantly increased with 4% PL supplementation ($P <0.05$), but there was a slight decreasing trend at higher PL supplementation. Earlier studies testified the deleterious effects of excessive dietary PL supplementation (Coutteau et al., 2002; Sanchez et al., 2012). Moreover, higher supplementation of PL exhibited poorer growth performance in crab (Li et al., 2014). Condition factor in the present study supports the weight gain, SGR and final weight of experimental fish (**Fig 1**). HSI and VSI values were also evident in the high growth attributing fish groups (**Fig 2, Fig 3**).

The significantly enhanced growth in *B. schwanenfeldii* was elucidated by the boosted FI (**Table 2**). Juvenile Japanese flounder exhibited enhanced growth and FI due to supplementation of PL in dietary treatments (Uyan et al., 2007). Positive effects of dietary PL supplementation were documented and FI of juvenile *S. dumerili* increased and growth was augmented (Uyan et al., 2009). In consequence, a growth-stimulating influence of providing supplementary phospholipid-bound 22:6n-3 vs. 18:2n-6 give the impression a trustworthy elucidation of the current outcomes.

CONCLUSION

B. schwanenfeldii juveniles responded quite well with the supplementation of PL in their diets. Feed utilization and growth-related parameters showed positive response to the formulated diet for *B. schwanenfeldii* in experimental conditions. In the end, a 4% PL supplemented diet is recommended for this fish. PL synthesis and dietary mechanism of this fish is warranted for future studies.

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