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by Indra Suharman

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The use of cricket (*Gryllus bimaculatus*) meal as protein source for snakehead fish (*Channa striata*)

N Prachom[1,2*], I Suharman[3]

[1]Department of Aquaculture, Faculty of Fisheries, Kasetsart University, Bangkok, Thailand
[2]Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand
[3]Department of Aquaculture, Faculty of Fisheries and Marine Science Universitas Riau, Pekanbaru 28293 Riau - Indonesia

[*]Corresponding Author: noratat.p@ku.th

Abstract. The potency of the cricket meal (CM) as fish meal (FM) alternative in diets for snakehead (*Channa striata*) (initial average weight 15.0 g) was evaluated for eight weeks. Two isoproteic (42%) and isolipidic (10%) diets were formulated to contain FM and CM as source of protein. Experimental diets were given to the tested fish two times in a day at 08:00 and 16:00 hours until satiation in the semi-recirculating system with the water temperatures ranging from 28–29ºC and the dissolved oxygen levels ranging from 8.0–9.0 mg/L. Fish were sampled at the end of the research to determine their proximate composition, growth and feed utilization. The results showed that no adverse effect of CM on growth, feed intake and survival rate of fish ($P < 0.05$). A group of fish fed with CM at 45% showed better in the weight gain (WG) (43.4 g/fish), FCR (1.35), and ANPU (31.0 %) than a CD ($P > 0.05$). It was concluded that the CM could be used in diet of *C. striata* with no deleterious effects on growth and feed performance. Moreover, improvement on WG, FCR and ANPU of *C. striata* fed with CM was observed in this study.

1. Introduction

Because of its high protein content, fishmeal (FM) is the primary ingredient in aquaculture diets. Global aquaculture production has been increasing year by year, while annual fish meal production has remained steady [1]. FM prices have risen over the years as fish landings have decreased and the aquaculture demand has increased [2,3]. The rising cost of FM, combined with the doubtful provision of supplies, compelled nutritionists or feed manufacturers to seek out cheap, plenty, and easily obtainable alternate source of protein as a substitute.

Insect meals have recently gained popularity as a suitable candidate stuff for aquaculture feeds, and it could even be utilized during beginning phases of fish development [4,5]. The

primary benefits of using insects are their ease of producting, fast growth and short reproductive cycle [6]. Several researches have also been published on the potential use of insects such as CM as a FM substitution [7,8].
The cricket (*Gryllus bimaculatus*) meal has potenty to substitute FM in fish feeds because of the nutritional quality are high. The cricket meals have been used as aquafeeds for some fish species [9,10]. However, there have been very few studies that have examined *G. bimaculatus* in the feed of fish, particularly juvenile snakehead fish (*Channa striata*). This research aims to examine the effects of the CM in diet on growth of fish and the utilization of feed.

2. Materials and Methods

2.1 Test ingredients and preparation

The crickets were cultured, dried, and manufactured at the Faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang (KMITL), Thailand. Briefly, crickets were harvested and washed into filled ice and water bucket. Then, they were cooked using hot water and air-dried for 2 hours prior to storage at -20^{o} C. Before drying, frozen crickets were thawed and dried by oven at 65 C for 2 days. After drying, crickets were then sieved to remove adulterants (*i.e.* sand and soil) and were ground by food-grinding machine. Cricket powder was sieved once again to reduce the particle size of the powder to 250 μm of diameter by using 60 mesh screener and kept in the -20^{o} C refrigerator until use. Fishmeal, dried whole cricket, and cricket powder were sampled for the proximate analysis. The proximate analysis of fish meal, dried whole cricket, and cricket meals are shown in Table 1.

Table 1. The proximate analysis of FM, dried whole body of cricket and cricket meal (%)

	Fish meal	Dried whole body of crickets	Dried cricket meals
Moisture	10.8	8.6	7.4
Crude protein	56.0	58.5	60.7
Crude lipid	10.0	12.0	19.9
Ash	22.5	19.9	4.9

2.2 Experimental feeds and proximate composition

Two experimental feeds were formulated to isoproteic (42%) and isolipidic (10%). All the ingredients were weighed and mixed regarding to the formulation (Table 2). All mixed powder (mash feeds) were then extruded to be a floated pellet (4.5–5.5 mm diameter) using single-crew extruder at a feedmill, pilot plant, KMITL. Finally, all diets were dried at 100-120° C by a column drum dryer for 15 minutes and packaged in the bag. All the diets were sampled for the proximate analysis and kept at the room temperature in bag before used for feeding trials.

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Table 2. Formulation and proximate analysis of tested diets (%)

Ingredients	D1 (control diet/CD)	D2
Fish meal	45.0	0.0
Cricket powder	0.0	45.0
Soybean meal	24.0	24.0
Wheat flour	23.0	23.0
Fish soluble extract	2.0	2.0
Fish oil	2.0	2.0
Vit-Min premix	1.0	1.0
Monocalcium phosphate	2.0	2.0
Antimold	0.5	0.5
Antioxidant	0.5	0.5
Proximate analysis		
Moisture	7.5	7.2
Crude protein	42.5	42.4
Crude fat	10.6	10.5

2.3 Fish and feeding conditions

Snakehead juveniles weighing an average of 15.0 g/fish were purchased from a commercial farm and delivered to KMITL. Fish were acclimated and fed to CD diet for two weeks. Snakehead juveniles were distributed into semi-recirculating aquariums (30x38x30x24 inch) at the density of 25 fish/aquarium. The experimental diets were fed to the tested fish twice daily until satiation. Throughout the experiment, all of the fish were taken a weight every fourteen day for calculation purposes.

2.4 Sample and data collection

Fish were sampled at the beginning (three fish/tank) and the end of experiment (fish fish/tank), then, analyzed for the initial and final whole body composition analysis. Fish were dissected and removed the visceral organs for calculation of the body index values.

2.5 Growth performance analysis and body index values

Fish growth performance, feed utilization and body index values were analysed in terms of weight gain, specific growth rate, feed conversion ratio, apparent net protein utilization, hepatosomatic index and viscerosomatic index.

2.6 Chemical and statistical analyses

The proximate composition was analysed by following the AOAC [11]. The student's t-Test was applied for data analysis. The significant difference was defined by $P < 0.05$.

3. Results and Discussions

All fish well accepted experimental feeds. The water temperature between 28–29 ˚C and the dissolved oxygen between 8.0–9.0 mg/L. The fish growth performance parameters and the whole-body composition and apparent net protein utilization were showed in Tables 3 and 4, respectively.

Table 3. Growth performance parameters and body index values of juveniles, snakehead fish (*C. striata*) fed experiment diets

Parameters	D1 (control diet/CD)	D2	SEM.	*P*-value
Initial weight (g. fish^{-1})	15.00	15.00	0.02	0.545
Final weight (g. fish^{-1})	55.50 ^{b}	57.80 ^{a}	0.13	0.014
Feed intake (g. fish^{-1})	58.00	57.80	0.09	0.221
Weight gain (WG) (g. fish^{-1})	40.00 ^{b}	43.40 ^{a}	0.10	0.015
Feed conversion ratio (FCR)	1.43 ^{b}	1.35 ^{a}	0.01	0.007
Specific growth rate (SGR) (g. day^{-1})	1.64	1.69	0.01	0.075
Survival rate (SR) (%)	84.40	86.70	0.16	0.066
Viscero-somatic index (VSI, %)	5.21	5.19	0.08	0.078
Hepato-somatic index (HSI %)	0.90	0.86	0.02	0.226

The different superscripts in same row indicates significantly differences

Table 4. Whole-body composition and apparent net protein utilization (ANPU) (%) of snakehead (*C. striata*) juveniles fed the experiment diets

Whole-body composition and ANPU	D1 (control diet/CD)	D2	SEM.	*P*-value
Moisture	72.5	72.2	0.20	0.706
Protein	15.9	16.4	0.04	0.005
ANPU	28.2 ^{b}	31.0 ^{a}	0.06	0.003

Initial fish whole-body composition: 82.8% moisture and 12.5% protein.
The different superscripts in same row indicates significantly differences

There were no significantly different in the feed intake, SGR and SR among the group of fish fed to both of the diets (P>0.05). No negative effects of dietary cricket powder on VSI or HSI in fish fed inclusion level of cricket at 45 g. 100 g $^{-1}$ diet (P> 0.05). In addition, there was no found significantly of the VSI and the HSI for in European seabass fed with different inclusion level of the black soldier fly larvae meal [12,13,14,15]. Moreover, a group of fish fed the dietary fishmeal replacement by cricket meal showed higher in ANPU compared to the CD (P< 0.05). Cricket meal could be effectively used in the diet of snakehead fish (*C. striata*) and could completely replace the dietary fishmeal. Furthermore, cricket meal could substitute fishmeal up to 100% in diets of African catfish fingerlings without deleterious effects to the growth performance [16]. In addition, Taufek et al. [17] found that African catfish fed diets contained cricket meal significantly improved growth performance and feed efficiency.

4. Conclusion

The current experiment demonstrates that the CM could be applied in diets for snakehead with no deleterious effects on growth performances or feed utilization. Moreover, the improvement on weight gain, feed conversion ratio and ANPU of *C. striata* fed the dietary cricket meal was observed in this study.

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