Growth and yield of Asian catfish *Clarias macrocephalus* (Gunther) fed different grow-out diets

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In the Philippines, catfish farming is a growing industry and one of the species being cultured is *Clarias macrocephalus,* a highly esteemed food fish because of its meat. Many studies have been done on breeding, hatchery and nursery of *C. macrocephalus,* but information on its culture is limited.

Previously, *C. macrocephalus* culture in the Philippines did not prosper due to lack of efficient diet. Catfish are carnivores and catfish growers commonly use pelleted diet, chicken entrails, fish by-catch, rice bran or any combination of these. However, the supply of chicken entrails and trash fish are limited and seasonal.

The study was undertaken to evaluate the efficiency on growth, survival, feed conversion ratio (FCR) and production of Asian catfish fed four grow-out diets.

The experiment was conducted in a freshwater fishpond in Dumangas, Iloilo, Philippines. Twelve pens were installed in a 440 m^2 pond. The pond was prepared by sun-drying the pond bottom for five days until the soil cracked. Hydrated lime [$Ca(OH)_2$] and chicken manure were then applied at 1 ton per ha each. The pond was then filled with water to an initial depth of 10 cm. After seven days, the water depth was increased by 5 cm every two days until it reached 30 cm. Next, urea (45-0-0) was applied at 25 kg and ammonium phosphate (16-20-0) at 50 kg per ha and the water level was raised to 60 cm. The pens were installed in two parallel rows, 1 m apart. Each pen was created by enclosing a 5 x 5 m area with B-net (2 mm mesh) held in place by a bamboo framework and round ipil-ipil wood (10 cm diameter). The bottoms of the net were buried 30 cm into the pond bottom. To prevent leaching and mixing of feed, the walls were lined with plastic sheet (gauge #2.6). A bamboo catwalk was constructed between the rows for ease of feeding and management.

Two days before stocking, 2 kg (wet weight) of swamp cabbage *Ipomea aquatica* (locally known as "kangkong") and four kg of water hyacinth *Eichornia crassipes* were put into each pen to serve as shelter for catfish. The plants were limited to 20-30% of the pen area throughout the experiment to allow space for feed input.

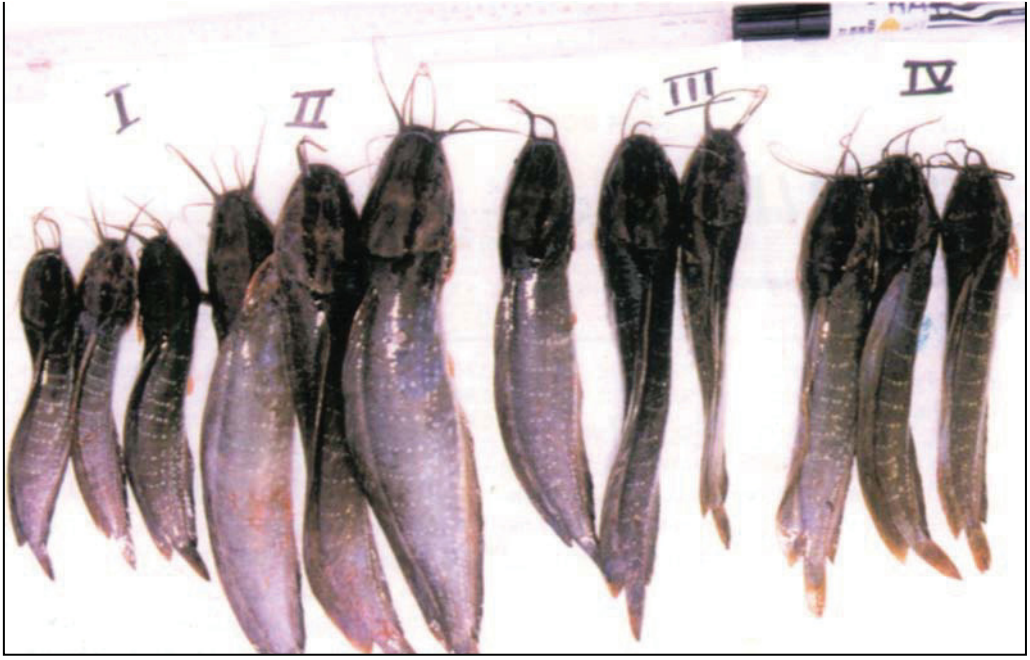
Hatchery-bred *C. macrocephalus* fingerlings with initial weight of 3.6 g and total length 78.0 mm were stocked at 10 fish per m^2. Four diets (Table 1) were tested in a completely randomized design (CRD) with three replicates per treatment for 120 days. Diets 1, 2 and 3 were given at 5.0, 4.5, 4.0, and 3.5% of the fish biomass per day for four months, respectively. They were fed in crumble form for the first two months and in pellet form (2.5 mm diameter) in the third and fourth. Diet 4 was a combination of chicken entrails (80%) and rice bran (20%) and fed to catfish following industry practice: 10% of the fish biomass per day during the first two months and then 8% thereafter. Chicken entrails were blanched in a nylon screen bag in boiling water for a few seconds, then chopped finely and mixed with rice bran (sieved through a 1-mm mesh). Feeds were given twice daily at 8 AM and 4 PM.

The water level was maintained at 60 cm for the first 15 days of culture and raised to 90-105 cm for the remainder of the experiment. During the first two months, 30-40% of the pond water volume was drained, and replenished by pumping water from the reservoir pond once a week. From the third month, the same amount of water was exchanged twice weekly.

TABLE 1 **Composition (%) and proximate analysis (% dry matter basis) of experimental diets for *Clarias macrocephalus* juveniles**

	Diet 1[a]	Diet 2[a]	Diet 3[b]	Diet 4
Composition				
Chilean fish meal	6	20		-
Soybean meal	5	30		-
Rice bran	70	31		20
Bread flour	9	9		-
Soybean oil	5	5		-
Mineral mix[c]	1	1		-
V-22[c]	1	1		-
Dicalcium phosphate	3	3		-
Chicken entrails	-	-		80
Proximate analysis				
Moisture	10.4	8.5	8.8	72.7
Crude protein	19.0	34.2	28.9	31.7
Crude fat	12.8	9.5	11.1	29.7
Nitrogen-free extract	53.0	36.4	48.4	4.6
Crude fiber	5.8	5.8	4.7	7.2
Ash	9.4	14.2	8.4	6.8
Gross ME (kcal kg^{-1})[d]	4032	3679	4091	4910
Protein to energy ratio (P/E)[e]	47	93	71	64

Analysis was done according to AOAC (1990): [a]SEAFDEC/AQD-formulated diets. [b]Commercial feed pellet. [c]Commercial pre-mix. [d]Metabolizable energy values (kcal-kg^{-1}): protein, 4; fat, 9; nitrogen-free extracts, 4. [e]P/E = mg protein/kcal



Size differences in native catfish fed different diets. Roman numerals refer to type of diet

TABLE 2 **Growth, survival, feed conversion ratio (FCR), condition factor, production, ALR and PER of *Clarias macrocephalus* fed four diets for 120 days. Initial body weight 3.6±0.1 g, and total length 78.0±0.1 mm. Values are mean of three replicate pens, ± SEM**

	Diet 1	Diet 2	Diet 3	Diet 4
MBW (g)	30.2 ± 0.9^{c}	108.9 ± 2.7^{a}	58.3 ± 2.7^{b}	67.4 ± 2.4^{c}
MTL (mm)	154.3 ± 0.0^{c}	232.8 ± 0.7^{a}	190.8 ± 0.6^{b}	203.2 ± 0.3^{b}
SGR (% day^{-1})[1]	1.8 ± 0.0^{c}	2.9 ± 0.1^{a}	2.3 ± 0.1^{b}	2.4 ± 0.1^{b}
Daily weight gain (g day^{-1})[2]	0.2 ± 0.0^{c}	0.9 ± 0.1^{a}	0.5 ± 0.1^{b}	0.5 ± 0.1^{b}
FCR: As fed	3.4 ± 0.3^{b}	2.5 ± 0.3^{a}	2.3 ± 0.1^{a}	5.0 ± 0.3^{c}
Survival (%)[3]	73.1 ± 3.1^{a}	67.7 ± 8.4^{a}	81.2 ± 4.0^{a}	72.4 ± 6.3^{a}
Condition factor (K)[4]	0.8 ± 0.0^{ab}	0.9 ± 0.0^{a}	0.8 ± 0.0^{ab}	0.8 ± 0.0^{b}
ALR (%)[5]	78.0 ± 6.4^{b}	131.7 ± 14.5^{a}	95.0 ± 4.3^{b}	89.6 ± 5.3^{b}
PER[6]	1.7 ± 0.2^{a}	1.3 ± 0.2^{a}	1.6 ± 0.1^{a}	2.4 ± 0.1^{b}
Production (kg 25 m^{-2} pen)	5.5 ± 0.3c	18.4 ± 1.1a	11.8 ± 1.1b	12.2 ± 0.3b

Means within a row with different superscripts are significantly different (P>0.05)
[1]Specific growth rate (% day^{-1}) = ln (final wt) - ln (initial wt)/days fed × 100
[2]Daily weight gain = mean weight gain/days fed
[3]Arcsin transformed
[4]Condition factor = weight (g)/length (cm)^{3} × 100
[5]Apparent lipid retention = final body lipid - initial body lipid/total lipid fed × 100
[6]Protein efficiency ratio = weight gain (g)/protein fed (g)

Soil samples from the pond bottom were collected before and after the experiment to analyze the levels of organic matter (OM). pH. available iron, phosphate and sulfate. The water quality parameters were monitored twice weekly. Water temperature and dissolved oxygen (DO), turbidity. pH. nitrite-nitrogen (NO_2-N) and ammonia-nitrogen (NH,-N) were determined between 8-9 AM.

Twenty-five fish were sampled for weight using a seine net every 15 days to monitor growth and adjust the feed ration. During sampling, fish were anaesthetized with 400-500 ppm (4 to 5 ml per 10 liters water) ethylene glycol monophenyl ether. Catfish after harvest were sampled and graded according to size in terms of the body weight.

The proximate composition of experimental diets and fish carcasses were determined before and after the experiment. Taste test was conducted on odor, flavor and general appearance or texture of steamed, salt-less fish samples taken from each replicate and pooled for each treatment. The fish samples were held in 60 1 fiberglass tank with aeration for about 36 hours and then cleaned and steamed for 15 minutes before the taste test.

After 120 days of culture, the mean weight, total length, daily weight gain, specific growth rate, condition factor and production of fish fed Diet 2 were significantly higher than fish fed Diets 1,3 or 4 (Table 2). The FCR of Diet 3 was better but not significantly different from Diet 2. Survival rates were similar in all treatments. Catfish fed Diet 2 had highest apparent lipid retention but their protein efficiency ratio did not differ from those of fish fed with Diets 1 and 3.

Catfish fed Diet 1 weigh less than 80 g (Fig. 1). In catfish fed Diet 2,93 % of the fish weighed above 80 g. In catfish fed Diet 3. 92% weighed less than 81 g and in catfish fed Diet 4.82% were below 81 g.

Crude protein level in fish fed Diets 2 and 3 were higher than in fish fed Diets 1 or 4 (Table 3). Catfish in all treatments became fatty at the end of the experiment: crude fat was highest in fish fed Diet 4 and lowest in Diet 3. Ash content was highest in fish fed Diets 1 and 2. and nitrogen-free extract was highest in fish fed Diet 3.

Soil quality after harvest did not differ among treatments. pH was 7.5. organic matter was 0.74%, available phosphate was 481 ppm, available iron was 0.02 ppm and available sulfate was 0.28 ppm. Compared to the initial values, the organic matter and available phosphate increased, while available iron and sulfate decreased. The increase in organic matter and phosphate in the soil after harvest maybe due to increased organic loading of pens caused by the feeding. The decrease in the available mineral components such as iron and sulfate may be due to assimilation by *E. crassipes*, *I. aquatica* or other algae, or by trapping in the pond sediment.

The pond water quality varied little throughout the experiment in all treatments and within the optimum ranges. The lowest

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TABLE 3 **Proximate whole body composition* (% on dry matter basis ± SEM) of *C. macrocephalus* fed four diets for 120 days (means of three replicates)**

	Initial value	At harvest			
		Diet 1	Diet 2	Diet 3	Diet 4
Crude protein	65.4	51.8 ± 1.0^b	54.5 ± 0.6^a	56.1 ± 0.4^a	49.8 ± 1.5^b
Crude fat	9.7	27.8 ± 0.5^b	28.3 ± 0.3^b	22.0 ± 0.2^c	34.5 ± 1.5^a
NFE	10.0	5.8 ± 0.9^b	3.0 ± 1.2^b	9.4 ± 0.6^a	5.1 ± 1.2^b
Moisture	91.1	70.9 ± 0.9^a	71.0 ± 0.5^a	73.7 ± 0.5^a	60.7 ± 1.5^b
Ash	14.7	14.5 ± 0.2^a	14.2 ± 0.3^a	12.4 ± 0.1^b	10.6 ± 0.3^c

Means within a row with different superscripts are significantly different ($p<0.05$).
*Crude fiber was 0.14% at the start of the experiment; levels were lower than 0.05% in all treatments at the end

D.O. recorded was 1.3 ppm, but *Clariid* catfishes have arborescent organ for breathing air that could increase tolerance to adverse D.O. conditions.

Taste test analysis showed that odor, flavor and appearance were "slightly like" by the panel, and were not significantly different among treatments.

C. macrocephalus fed a diet of 34.2% crude protein attained the best growth and yield with 93.3% of the harvested catfish weighing more than 80 g. Average body weight of catfish fed Diet 2 was 72%, 46% and 38% higher than catfish fed Diets 1, 3 and 4, respectively. Catfish harvest is usually 5 to 6 months of culture, but using Diet 2 can shorten the culture period with the same average weight and therefore beneficial to farmers.

The significantly higher growth of catfish fed Diet 2 may be attributed to the composition of Diet 2 that could have approximated the nutritional requirement of *C. macrocephalus* juveniles. Among the treatments. Diet 2 had the highest amount of crude protein, the lowest amount of energy and the highest P/E ratio. The P/E in Diet 2 could have explained the good growth and feed efficiency in catfish fed this diet. Catfish are carnivorous and require great amount of protein for growth. Furthermore, survival rate of 68-81% is not influenced by the diets used. One way to increase survival of catfish is to select bigger and uniform-sized fingerlings to minimize cannibalism.

Diet 1 was formulated as a protein supplement to the natural food in the pond. The amount of natural food in the pond may not have been enough to compensate for the protein deficiency in Diet 1 that had resulted in slow growth and low yield.

The catfish fed commercial fish pellets (Diet 3) had similar growth to those fed chicken entrails and rice bran (Diet 4) but catfish fed Diet 4 contained the higher amount of crude fat and yielded fattier fish. Fattiness in catfish has been identified as a major problem in commercial catfish industry. An increased in fat content is responsible for the poor keeping quality and decreased yield of processed products. Using chicken entrails as feed has many disadvantages such as. storage and availability, difficulty in preparation and blanching may not sufficient to eliminate bacteria. Although the taste test showed no off-flavor

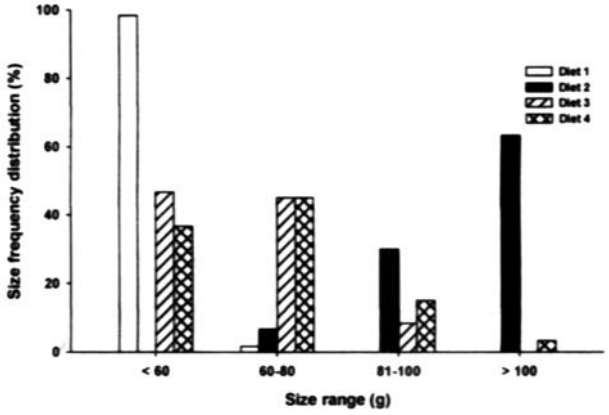

FIGURE 1 **Size distribution of Asian catfish *Clarias macrocephalus* fed four different diets for 120 days**

in fish fed Diet 4. or in any diet, the use of chicken entrails maybe practical for a backyard fishpond operation but not in intensive commercial culture. Under experimental conditions, a diet of about 34% crude protein resulted in the best growth and yield of *C. macrocephalus* in a relatively shorter period. ####

MUDCRAB ... FROM PREVIOUS PAGE

Fisheries and population dynamics

In addition to crab culture in pens or ponds, stock enhancement has been proposed to compensate for declining wild catches. However, baseline information on crab population dynamics is needed before interventions can be implemented. Wild populations in natural (Ibajay, Aklan) and planted (Kalibo) mangroves were monitored monthly using catch data from two native gears - crab dip net ('bintol') and bamboo trap ('tapangan'). Consisting predominantly of *S. olivacea* in both places, crab populations showed smaller sizes but greater numbers in Kalibo compared to Ibajay. *S. tranquebarica* and *S. serrata* were rare inside the mangroves but *S. tranquebarica* comprised 5-65% in a channel draining the Kalibo mangroves. Females with attached egg mass and small crabs (1-3 cm CW) were caught mainly in Ibajay starting September and later in November, respectively. ####

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