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Research Article

Effects of Feeding Rates on Growth Performance, Feed Utilization and Body Composition of Asian Red Tail Catfish (*Hemibagrus wyckioides*), Cultured in Northeast Thailand

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Abstract

Two experiments were carried out at the Khon Kaen University, Nong Khai Campus, Thailand during November, 2011 to May, 2012 to search for the most appropriate rates of feeding rations for fingerling and juvenile Asian redtail catfish (*Hemibagrus wyckioides*). A Completely Randomized Design (CRD) with three replications was used for both experiments. Experiment 1 had four treatments, i.e., T1 (2%), T2 (3%), T3 (4%, control), and T4 (5%). The same experimental design was used for the experiment 2, where four treatments were used, i.e., T1 (1%), T2 (2%), T3 (3%, control) and T4 (4%). The percentages of the amounts of rations used for Experiments 1 and 2 were based on body-live weight per day. Fingerling and juvenile fish were used for the experiments 1 and 2, respectively. Each experiment was carried out for 10 weeks. The results showed that a rate of 5% body live weight per day for fingerling fish of T4 of experiment 1 is the most appropriate rate for the fingerling fish. An increase in ration rate highly increased final body live weight. For juvenile fish of the experiment 2, it was found that there were no significant differences in live weights amongst the treated fish yet weight gained and specific growth rates between T1 and the rest were highly significant, whereas the results of the juvenile fish of T2 up to T4 were similar hence, 2% body live weight per day of T2 is the most appropriate rate for juvenile fish.

Key words: Asian redtail catfish, *Hemibagrus wyckioides*, fingerling, juvenile fish

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Asian redtail catfish (*Hemibagrus wyckioides*) is a native of many rivers in the Asian countries, particularly Thailand, Laos, Cambodia, Myanmar and also China (Rainboth, 1996; Kottelat, 1998). Its fleshes gain a high demand among the fish consumers, thus its marketable price is soaring higher than some other kinds of fish such as the Nile tilapia (*Oreochromis* sp.), walking catfish (*Clarias* sp.) and others. The development of cage and pen culture, especially in Asia has substantially increased reservoir fish production (Petr, 1994). In Thailand, *H. wyckioides* is a popular species cultured in cages to attain marketable sizes. Although some techniques in rearing the fish of the *H. wyckioides* have been developed yet the problem concerning the low growth rate is a major hindrance in increasing some further increases in its production (De Silva and Amarasinghe, 2014).

Feeding rate has its significant role on growth performance, feed conversion, nutrient retention efficiency and chemical composition in fish (Mihelakakis *et al.*, 2001). Other factors have also influenced feeding rate in fish culture, e.g., fish size, species and rearing system (Cho *et al.*, 2003). It was found that when individual fish live weight increased then the percentage of the feeding rate being used decreased (NRC., 1993). An optimal feeding rate was relatively helpful in minimizing feed loss, reducing water pollution and a decrease in capital investment in aquaculture production (Du *et al.*, 2006). Several works have shown that the growth of the fish species increased with an increase in feeding rate such as Ng *et al.* (2000) with *Mystus nemurus*; Du *et al.* (2006) with *Ctenopharyngodon idella*; Marimuthu *et al.* (2011) with *Clarias gariepinus*. The optimal feeding rate has its important role in culturing the fish especially with respect to economic returns, where more benefits can be visibly attainable (Okorie *et al.*, 2013).

It may be of tangible value to carry out more experiments on the requirements for dietary crude protein and feeding rate of the fish species in order to optimize investment expenditure. Therefore, this investigation aims to establish some significant information on feeding regime with respect to growth performance, feed utilization and body composition of both sizes, i.e., fingerling and juvenile fish of the *H. wyckioides*. Thus two experiments were separately carried out.

MATERIALS AND METHODS

Fish culture technique: Two experiments were carried out at the Khon Kaen University, Nong Khai campus during November, 2011 to May, 2012 to search for the most appropriate rates of feeding ration for both fingerling and juvenile Asian redtail catfish (*Hemibagrus wyckioides*). The fish were taken from the private hatchery and also the nursery ponds of the Khon Kaen University, Nong Khai Campus, Nong Khai, Thailand. They were acclimated under indoor tanks for a 2-week period with the use of a commercial feed containing 40% Crude Protein (CP). Experiment 1 was carried out with the use of fingerling fish and the Experiment 2 was conducted with the use of juvenile fish. The initial mean values of live weights of the fish ranged between 2.55-2.73 g for fingerling fish and 13.60-14.70 g for juvenile fish. The fish in each replication of both experiments were reared in the plastic tanks of a 100-L with a dimension of $70\times48\times41$ cm in length, width and height, respectively. A density of 25 fish per tank was used for the experiment 1 and 7 fish per tank for the experiment 2.

Experimental design: A Completely Randomized Design (CRD) with three replications was used for experiment 1. The experiment consisted of four treatments, i.e., T1 (fed at a 2% body live weight per day), T2 (fed at a 3% body live weight per day), T3 (fed at a 4% body live weight per day, this treatment was used as control treatment) and T4 (fed at a 5% body live weight per day). The feeding rate of T3 was used as the control treatment which was recommended by Kiriratnikom and Kiriratnikom (2012) for the fingerling catfish (*Clarias nieuhofii*). The fish were fed with a diet of 45.23% crude protein content, 7.21% moisture content with a value of 30.58 mg kJ^{-1} of protein to energy ratio (Table 1). The protein content used for this work is similar to the feeding ration being used for the fingerlings of the Bagrid catfish (*Hemibagrus wyckiodes*) carried out by Deng *et al.* (2011). The preparation for the diet was carried out with the method described by Ai *et al.* (2006) and was modified by Hien and Doolgindachbaporn (2011). The different ingredients were ground into powder then mixed with palm oil, water, vitamins and minerals premixed to produce stiff dough through a 500 μm sieve mesh. The dough was then transformed into a very small pellet to produce a size of each pellet of approximately 2.5×2.5 mm (fish were able to feed without difficulties) with the use of a feed mill then allowed to dry under a ventilated oven at 45°C for 12 h and then kept in sealed polythene bags and stored at -15°C (Table 1). The fish were fed twice daily at 09.00 am and 4.00 pm (Alvarez-Gonzalez *et al.*, 2001). Live weights of all fish in each tank were individually weighed out at a fortnightly interval (Table 2). The fish of all treatments were finally harvested at 10 weeks after rearing. Each replicated tank was supplied with

Table 1: Ingredients and chemicals being used for feed ration preparations for fish culture of the Experiments 1 and 2 (based on dry matter basis)

Ingredients	Experiment 1	Experiment 2
Fish meal (59%)	710.129	480.129
Wheat flour (9%)	100.000	100.000
Rice bran (16%)	142.000	372.000
Palm oil	40.000	40.000
Minerals premix[a]	7.637	7.637
Vitamins premix (Niacin-free)[a]	0.188	0.188
Cellulose (Hi-media, India)[b]	0.046	0.046
Proximate composition (%)		
Moisture	7.21	7.22
Protein	45.23	35.26
Lipid	11.82	13.76
Ash	14.67	12.58
Fiber	3.82	4.35
NFE[d]	24.46	34.05
DE (kJ g^{-c})	14.79	15.63
P/E (mg kJ^{-d})	30.58	22.56

[a]Each kg contents: Vitamin: A 1.0 MIU, D_3: 0.2 MIU, 0.030 g, E: (50%), 0.018 g, K: (50%), 0.011 g, B_1: (98%), 0.004 g, B_2: (80%), 0.008 g, B6: (96%), 0.007; B_{12} (0.1%), 0.045 g, Pantothenic acid: (98%), 0.011 g, Folic acid: (10%), 0.008 g, C: (98%), 0.046 g, $FeSO_4.7H_2O$, 0.03 g, $CuSO_4.5H_2O$: (25.00% copper), 0.006 g, $ZnSO_4.7H_2O$: (22.50% zinc), 0.6 g, $MnSO_4.H_2O$: (31.80% manganese), 1 g, KI: (3.8% iodine), 0.001 g, $CaCO_3$, 6 g, [b]NFE (Nitrogen Free Extract): 100 - (protein%+lipid%+ash%+fiber%), [c]Digestible energy: (DE) calculated based on 16.7 (kJ g^{-c}) for protein and carbohydrate, and 37.6 (kJ g^{-c}) for lipid, [d]P/E: Protein to energy ratio

Table 2: Changes with time in feeding rates (g day^{-1}) being computed at two-week intervals for the fingerling fish of the *Hemibagrus wyckioides* during 10 weeks of the experimental period (Experiment 1)

	Weeks				
Treatments	2nd	4th	6th	8th	10th
T1	1.30	1.65	1.83	1.65	1.70
T2	1.95	2.70	3.09	2.88	2.89
T3	2.73	3.42	3.69	3.64	3.92
T4	3.19	5.09	6.75	7.34	7.91

Table 3: Changes with time in weights of feeding ration (g day^{-1}) given to the juvenile fish of the *Hemibagrus wyckioides*, carried out at two-week intervals of a 10-week experimental period (Experiment 2)

	Weeks				
Treatments	2nd	4th	6th	8th	10th
T1	1.03	1.10	1.24	1.43	1.61
T2	1.94	2.46	2.92	3.17	3.40
T3	2.85	3.43	3.93	4.51	4.92
T4	3.98	5.03	5.69	6.53	6.91

a compressed air via air-stones from air pumps and the fish were held under natural photoperiod throughout the experimental period. Fifty percents of the fish feces of individual plastic tank were siphoned out daily and immediately replaced by a cleaned and well-aerated water of the same amount.

With the experiment 2, again, a Completely Randomized Design (CRD) with three replications was used. Four treatments were used, i.e., T1 (fed at 1% body live weight per day), T2 (fed at 2% body live weight per day), T3 (fed at 3% body live weight per day, this treatment was used as control treatment) and T4 (fed at 4% body live weight per day). The T3 was chosen as control treatment, because 3% body live weight per day gave the best growth parameters of the juvenile bagrid catfish (*Chrysichthys nigrodigitatus*) as reported by Adewolu and Benfey (2009). Therefore, the diet of 35.26% crude protein, 7.22% moisture content and 22.56 mg kJ^{-1} were used for the experiment 2 (Table 1). The diet preparation was carried out as that of the experiment 1. The daily feeding was taken place twice daily at 9.00 am and 4.00 pm throughout the experimental period. The daily feeding rates were adjusted twice a week according to their body live weights gained (Table 3). The cleaning of the tank walls and aeration for each tank were carried out as that of the experiment 1.

Water quality: For experiments 1 and 2, the water samples were collected from water level to the depth of 15 cm from each replicated tank and they were used for the determinations of dissolved oxygen contents, where the work was carried out *in situ* with an oxygen meter (YSI model 52, Yellow Spring Instrument Co., Yellow Springs, OH, USA), and pH values were determined with a pH meter (Digital Mini-pH Meter, 0-14PH, IQ Scientific, Chemo-science (Thailand) Co., Ltd, Thailand). The levels of alkalinity, hardness and ammonia-nitrogen of the water in each replication were measured with the use of the standard procedures (APHA., 1989). All measured parameters were carried out at two-week intervals throughout the experimental period. The mean values of dissolved oxygen concentrations of the experiments 1 and 2 were 7.96 and 8.27 mg L^{-1}, respectively. The pH values and water temperature were 8.41 and 8.43, 19.54 and 19.07°C for experiments 1 and 2, respectively. Mean values of total alkalinity, hardness and ammonia-nitrogen were 310.80 and 297.30 mg L^{-1} as $CaCO_3$, 206.90 and 196.62 mg L^{-1} as $CaCO_3$ and 0.24 and 0.27 mg L^{-1}, for experiments 1 and 2, respectively. The reading values of water quality were within a range for the growth of fish (Boyd, 1992).

Fish sampling and proximate chemical analysis: At the end of the experimental period, the fish were deprived of feed intake for 24 h captured and bulk weighed individually in all treatments used. The numbers of fish samples of 12 and 3 fish were used for experiments 1 and 2, respectively. They were used for the determinations of the whole body and lipid liver compositions. The fish samples were frozen at -20°C and then used for further analysis. The feed ration and the fish samples of each treatment were analyzed for moisture content (AOAC., 1980), ash (AACC., 2000a), crude lipid (AACC., 2000b), crude protein (AACC., 2000c), and crude fiber (AOAC., 2005). Moisture content was determined by drying the fish samples at 105°C under a fan drying oven for 48 h (Memmert, UNE 400, Braunschweig, Germany). Nitrogen content was carried out with the use of a micro Kjeldahl method (VELP, UDK 132, DK 6). Crude protein was attained by multiplying a value of 6.25 to the nitrogen percentages. Lipid content was determined using a solvent extractor, Velp SER 148 (Velp Scientifica, Milano, Italy) with petroleum ether (130°C: this figure stated in the manual being used). Ash was determined by combusting dry samples in a muffle furnace (Thermolyne Corporation, Dubuque, Iowa, USA) at 550°C for 6 h. Crude fiber was analyzed with the use of a semi-automatic analyzer (Fibertec, VelpScientifica, Milano, Italy).

Measurements parameters: The calculated parameters on growth rate and feed utilization were carried out with the use of the various formulae where they include weight gained or WG = final weight, (g)-initial weight (g); specific growth rate or SGR = [(ln (final weight)-ln (initial weight))÷number of days]×100 and survival rate = (number of final fish÷number of initial fish)×100; feed conversion ratio or FCR = total feed used (g)÷total fish biomass being produced (g), and feed efficiency ratio or FER = [(final body weight (g)-initial body weight (g))÷feed intake (g)]×100. The calculations were carried out with the method described by Chiu *et al.* (2013); hepatosomatic index or HSI = liver weight (g) per body×100 and viscerosomatic index or VSI = vicera (excluded liver, g)÷body weight (g)×100 where the calculations were described by Du *et al.* (2006). The collected data were calculated with the use of a SAS computer program where appropriate (SAS., 1998).

RESULTS

For experiment 1, the results showed that initial body live weights were 2.60, 2.60, 2.73 and 2.55 g for T1 up to T4, respectively. The T3 gave the highest and least with T4. There was no statistical difference found amongst the treatments used (Table 4). With final body live weights, the results showed that body live weights were 4.19, 4.36, 4.82 and 6.23 g for T1 up to T4, respectively. The differences were large and highly significant. For average weight gained, weights gained values were 1.59, 1.76, 2.10 and 3.68 g for T1 up to T4, respectively. The difference was large and highly significant. With Specific Growth Rate (SGR), the results showed that SGR values were 0.32, 0.35, 0.39 and 0.60% per day for T1 up to T4, respectively. The difference was large and highly significant. For food conversion ratio, the values attained were 1.01, 1.61, 1.87 and 2.53 for T1 up to T4, respectively. The T4 gave the highest and least with T1. The difference was large and highly significant. With feed efficiency ratio, T1 gave three times greater than T3 (control) and it was the highest and least with T4. The values were 1.51, 1.01, 0.96 and 0.93% for T1 up to T4, respectively. The difference was large and highly significant.

For the results on protein contents, it was found that protein percentage were 74.86, 70.74, 68.58 and 69.38% for T1 up to T4, respectively. The T1 was the highest and the lowest was with T3 (control). The difference was large and highly significant (Table 5). The differences on lipid and ash were not found among the treatments used. The percentages of lipids in livers were 9.53, 9.56, 11.50 and 11.71% for T1 up to T4, respectively. There were highly significant differences found. T4 ranked the highest and the lowest was with T1. There were no statistical significant differences found on Hepatosomatic indices. Similarly, there were no significant differences found

Table 4: Initial body weights, final body weights, weight gained, specific growth rate, food conversion ratio and feed efficiency ratio of fingerling fish of the *Hemibagrus wyckioides*, cultured at the Khon Kaen University, Nong Khai campus, Thailand (Experiment 1)

Treatments	Initial body weight (g)	Final body weight (g)	Weight gained (g)	Specific growth rate (% day^{-1})	Food conversion ratio	Feed efficiency ratio (%)
T1	2.60^{a}	4.19^{c}	1.59^{c}	0.32^{b}	1.01^{c}	1.51^{a}
T2	2.60^{a}	4.36^{c}	1.76^{bc}	0.35^{b}	1.61^{b}	1.01^{b}
T3	2.73^{a}	4.82^{b}	2.10^{b}	0.39^{b}	1.87^{b}	0.96^{b}
T4	2.55^{a}	6.23^{a}	3.68^{a}	0.60^{a}	2.53^{a}	0.93^{b}
F-test	Ns	**	**	**	**	**
CV (%)	8.84	5.99	10.18	9.75	8.36	12.18

[a, b, c]Letters in each column indicated least significant differences of Duncan's Multiple Range Test (DMRT) at probability (p) of 0.01, and Ns: Non significant, CV: Covariant%

Table 5: Percentages (based on fresh weight) of protein, lipid, ash, and lipid contents of the whole body and % of hepatosomatic and viscerosomatic indices of the fingerlings of the *Hemibagrus wyckioides*, cultured at the Khon Kaen University, Nong Khai campus, Thailand (Experiment 1)

	Whole body (%)			Liver		
Treatments	Protein	Lipid	Ash	Lipid (%)	Hepatosomatic index (%)	Viscerosomatic index (%)
T1	74.86^{a}	12.05^{a}	10.91^{a}	9.53^{d}	1.48^{a}	8.61^{a}
T2	70.74^{b}	11.33^{a}	12.28^{a}	9.56^{c}	0.94^{a}	5.86^{a}
T3	68.58^{b}	12.50^{a}	11.54^{a}	11.50^{b}	1.00^{a}	6.87^{a}
T4	69.38^{b}	11.78^{a}	11.08^{a}	11.71^{a}	0.58^{a}	6.53^{a}
F-test	**	Ns	Ns	**	Ns	Ns
CV (%)	1.78	14.58	12.15	0.07	39.20	22.74

[a, b, c]Letters in each column indicated least significant differences of the Duncan's Multiple Range Test (DMRT) at probability (p) of ** 0.01 and * 0.05, Ns: Non significant, CV: Covariant%

Table 6: Initial body weight, final body weight, weight gained, specific growth rate, food conversation ratio and feed efficiency ratio of juvenile fish of the *Hemibagrus wyckioides* being fed at different feeding rates (Experiment 2)

Treatments	Initial body weight (g)	Final body weight (g)	Weight gained (g)	Specific growth rate (% day^{-1})	Food conversion ratio	Feed efficiency ratio (%)
T1	14.70^{a}	24.47^{a}	9.77^{b}	0.34^{b}	0.45^{d}	12.71^{a}
T2	13.86^{a}	25.25^{a}	11.39^{a}	0.40^{a}	0.95^{c}	6.83^{b}
T3	13.60^{a}	24.67^{a}	11.07^{a}	0.40^{a}	1.36^{b}	4.71^{c}
T4	14.21^{a}	25.47^{a}	11.25^{a}	0.39^{a}	1.90^{a}	3.33^{d}
F-test	Ns	Ns	**	*	**	**
CV(%)	7.78	4.49	2.03	5.97	2.54	4.77

[a, b, c]Letters in each column indicated least significant differences of Duncan's Multiple Range Test (DMRT) at probabilities (p) of **, 0.01 and * 0.05, Ns: Non significant, CV: Covariant%

on the percentages of the viscerosomatic indices where the percentages were 8.61, 5.86, 6.87 and 6.53% for T1 up to T4, respectively.

With the changes in the amounts of feeding ration where the computed amounts were carried out at two-week intervals, the results showed that at the first interval T1 gave the lowest and the highest was with T4 with values of 1.03 and 3.98 g day^{-1}, respectively (Table 3). A similar result was found with all advanced intervals, i.e., T1 ranked the lowest and the highest was with T4. At the 8th interval, T1 attained a value of 1.61 whilst T4 had a value of 6.91 g day^{-1}.

The results on initial fish live weights showed that mean values of individual fish were 14.70, 13.86, 13.60 and 14.21 g for T1 up to T4, respectively. The T1 was the highest and the lowest was with T3. There was no statistical significance found among the treatments used (Table 6). With final body live weights, it was found that there were no statistical differences due to treatments and the body live weights were 24.47, 25.25, 24.67 and 25.47 g for T1 up to T4, respectively. For weight gained, the treatments gave the values of 9.77, 11.39, 11.07 and 11.25 g, for T1 up to T4, respectively. The differences were large and highly significant. The T1 gave the lowest and the highest was with T2. There was a significant difference found between T1 and the rest on specific growth rate with values of 0.34, 0.40, 0.40 and 0.39% per day for T1 up to T4, respectively. T2 was similar to T3 and T3 was similar to T4. The results on feed conversion ratio showed that T1 ranked the lowest and the highest was found with T4. The attained values were 0.45, 0.95, 1.36 and 1.90 for T1 up to T4, respectively. The differences were large and highly significant. For the results on feed efficiency ratio, the treatments gave the values of 12.71, 6.83, 4.71 and 3.33%. The T1 ranked the highest and least with T4. The differences were large and highly significant.

With protein contents of the whole body, the results revealed that protein contents were 71.66, 71.28, 66.72 and 68.51% for T1 up to T4, respectively. The T1 ranked the highest

Table 7: Protein, lipid and ash contents of the whole body including lipid contents in the liver, hepatosomatic index and viscerosomatic index of the juvenile fish of the *Hemibagrus wyckioides* (Experiment 2)

	Whole body (%)			Liver		
Treatments	Protein	Lipid	Ash	Lipid (%)	Hepatosomatic index (%)	Viscerosomatic index (%)
T1	71.66^{a}	17.65^{a}	10.66^{a}	5.63^{d}	1.41^{b}	2.74^{a}
T2	71.28^{a}	18.20^{a}	10.52^{a}	5.66^{c}	2.46^{a}	3.93^{a}
T3	66.72^{b}	19.29^{a}	11.73^{a}	6.70^{a}	1.73^{b}	2.60^{a}
T4	68.51^{b}	17.65^{a}	12.26^{a}	6.25^{b}	1.11^{b}	2.87^{a}
F-test	**	Ns	Ns	**	**	Ns
CV (%)	1.49	7.39	3.65	0.21	21.84	30.66

$^{a, b, c}$Letters in each column indicated least significant differences of Duncan's Multiple Range Test (DMRT) at probability (p) of ** 0.01 and * 0.05, Ns: Non significant, CV: Covariant%

and least with T3. The differences were large and highly significant (Table 7). There were no statistical differences found on lipid and ash percentage contents of the treated fish. For the lipid in the liver, the results showed that T3 ranked the highest and least with T1 with values of 6.70 and 5.63, respectively. The differences were large and highly significant. For Hepatosomatic indices, T2 ranked the highest and least with T4 with values of 2.46 and 1.11%, respectively. The differences were large and highly significant. There was no statistical significant difference found on the viscerosomatic indices percentages yet T2 ranked the highest and lowest with T3 with values of 3.93 and 2.60%, respectively.

DISCUSSION

The results of the two experiments of both fingerling and juvenile fish revealed that the fish being used for both experiments did not show any mortality rate throughout the experimental periods. The results indicated that suitable environmental conditions could have been provided for the fish as that of the work reported by Kpogue and Fiogbe (2012) with the fish of *Parachanna obscura*. With the results of experiment 1, in most cases, an increase in the percentages of feeding ration (based on initial body live weights) highly increased final body weights of all treated fish where T4 attained the highest live weight hence the use of 4% body live weight per day of T3 (control) was inadequate for the growth of the fingerling fish. The results agree with the works reported by Khan and Abidi (2010) with *Heteropneustes fossilis* fingerlings, and Marimuthu *et al.* (2011) with *C. gariepinus* fingerlings. Therefore, T4 is considered to be an ultimate rate for growth of the fish although the falling in growth of the fish due to the computed rate of 5% body live weight per day was not achieved. This feeding rate was slightly lower than those reported by Khan and Abidi (2010) where they used 5.9-6.8% body weight per day for *H. fossilis* fingerlings and Marimuthu *et al.* (2011) used 8% body weight per day for *C. gariepinus* fingerlings. The differences may probably be due to the differences in fish species yet Hernandez *et al.* (2003) showed that feed ration size is related to the fish appetite where it started from starvation level till maximum size where the attained results can be used for the establishment of a growth modeling. The increases in body weights due to an increase in the amounts of ration resulted in an increase in live weight gained, specific growth rate and food conversion ratio except that of the feed efficiency ratio where T1 was the highest. This must be attributable to the low value of food efficiency ratio where T1 attained 1.01 whilst others treatments especially T4 attained a value of 2.53 hence a reverse result on growth of the fish was obtained, i.e., the lower the percentages of the feed efficiency ratio the higher the value of feed conversion ratio resulting in an increase in body live weight. The findings were similar to the works reported by Ng *et al.* (2000) with *M. nemurus* and Du *et al.* (2006) with grass carp of the *C. idella*. Therefore, the fish fed with a ration being computed at a rate of 5% body live weight per day of T4 is the most appropriate feeding rate for the fingerling fish of the Asian redtail catfish (*H. wyckioides*) of this current work. Nevertheless, the decline in live weight of the fingerling fish was not found hence some further experiments may be needed in order to justify some further computed rates upon the decline in body live weight of the fingerling fish. It was found that there were no significant differences on protein percentages between T4 and T3 (control treatment) but the lipid percentage of T4 was highly greater than T3, whilst other parameters such as lipid and ash of the whole body, hepatosomatic and viscerosomatic indices were similar. The highest amount of the lipid in the liver of the fish of T4 could possibly have aided the highest final body live weight and at the same time be able to encourage the rapid growth of flesh and omega 3, but unfortunately an analysis on the omega 3 was not carried out.

With the attained results of juvenile fish of the experiment 2, it was found that there were no significant differences found on the final body live weights of the treated fish yet weight gained and specific growth rate between T1 and the rest were highly significant whereas the juvenile fish of T2 up to T4 were similar although live weight of T4 was slightly higher than T3 (control treatment). The results indicated that feeding rates being used with T2 up to T4 did not affect growth of the fish, i.e., feeding rates greater than T2 had no significant effect on growth of the fish. One reason for this may be attributable to perhaps the size of the fish when they have grown up reaching their juvenile stage then the fish were able to survive healthily through their fingerling stage so they were able to take the required diet for their optimal growth. It was found that some surplus amounts of the diet were left out as a waste. With the results on specific growth rate, it revealed that T2 was similar to T3 (control) hence the diet of T2 may be considered as a suitable rate as to avoid some excessive amounts of the diet even though the percentages of food conversion ratio and feed efficiency ratio were relatively lower for T3 than T4. It was also found that percentages of lipid in liver and heppatosomatic indices were significantly higher for T2 than T1 hence the diet rate of 2% body live weight per day of T2 can be used as the ultimate rate for Asian redtail catfish (*Hemibagrus wyckioides*). Thus the attained results did not confirm the work reported by Adewolu and Benfey (2009) where they used the computed ration rate of 3% body live weight per day for their juvenile bagrid catfish of *C. nigrodigitatus*. The differences may be attribu to the differences in fish species and perhaps due to the differences in culturing environments.

CONCLUSION

To sum up, the results on fingerling fish of the experiment 1 revealed that an increase in the ration rate significantly increased live weight gained, specific growth rate and food conversion ratio. The rate of 5% body live weight per day of T4 was considered to be the most suitable rate of the diet for use in culturing the fish of the Asian redtail catfish (*H. wyckioides*). The low rate of the computed ration of T2 (2% body live weight per day) which was lower than T3 (3% body live weight per day, control) of the experiment 2 for the juvenile fish was considered to be the most appropriate rate of ration for the growth of the Asian redtail catfish (*H. wyckioides*).

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