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Specific growth rate and food conversion efficiency of freshwater crab *Barytelphusa lugubris* in Kathmandu, Nepal

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Abstract
Experiment was conducted from 17th June, 2007 to 25th07 August with an average room temperature 25.7^0 c and water temperature of all aquaria was 24^{0}c for 70 day son *Barytelphusa lugubris* to know specific growth rate, food conversion ratio and food conversion efficiency. Twenty four crabs were equally categorized into three groups (A, B and C) based on their weight and carapace width. The initial total weights and carapace widths of each group were 63.17g, 79.50g and 92.97g; 33.80mm, 35.1mm and 37.5mm respectively. Chicken liver thawed in water was supplied to feed the crabs, siphoning of excess food and cleaning of aquaria were done thrice a week. The total amounts of food provided for 70 days were 248 g, 248 g and 306 g. Results demonstrated that the percentage increase in the total weight of crabs were 3.75%, 3.48% and 5.54%. Similarly, percentage increase in CW was 2.99%, 3.79% and 3.955% for group A,B and C respectively. Increase in SGR was 3.38%,4.0% 3.07%; increase in FCE was 0.04, 0.02, 0.01 and increase in FCR was 26.24, 40.41 and 67.46 respectively in three groups. FCR was more for high weighed crab but FCE was low. Thus, the results concluded that despite low FCE and SGR crabs with high weight, increased maximum in weight and food consumption.

Keywords: *Barytelphusa*, growth, Food conversion ratio, Sangla, Nepal

Introduction

Although, from the historical prospective, crabs have been treated with disdain and annoyance and dubbed as disagreeable and bellicose animals. The word Crab denotes anxious to fight. In many languages it has been considered as a synonym with nasty. The Latin word for "Crab" is cancer, the world's most deadly disease. But, with the exception of a few crustaceans which are harmful to mankind as disease carriers or wood borers, the majority of them, particularly micro-crustaceans are of enormous food value and have been contributing to the financial development of mankind. The capture and consumption of natural aquatic food organisms such as fish, shellfishes including, shrimps, prawns, crayfish, lobsters and crabs in India (Agarwal, 1985) and Nepal have been started since the unmemorable time. Besides shrimps, crayfish and lobsters another most advanced and multi-useful decapods is the crab of the Infra-order Brachyura, (Martin and Davis, 2001) [20].

Specific growth and feed conversion efficiency are the most important physiological activities of all the living beings. All the basic functions like growth, reproduction, and development depends on the food consumed by them. In other words, for the general metabolism of the organisms, the body requires energy which is fulfilled by the food consumed (Tiwari, *et al*., 1989) [31], which in turn is used for different physiological activities including growth.

Food conversion ratio (FCR) is a ratio or rate of measuring of the efficiency with which the bodies of organisms convert their feed into the desired output (Malik *et al*., 1996) [19]. In other word feed conversion ratio is used for the description of growth as a meaning of in- taken food, which not only depends mainly on the feeding rate but also on temperature (Bethke *et al*., 2013) [6] as well.

Food conversion efficiency (FCE) is define as the ability of the animal to convert the feed eaten in to the body flesh or weight, while food conversion ratio, is the difference between the actual quantity of feed eaten by the animal and the equivalent weight gained by the living beings over a given period of time that is from stocking to harvest. Feed conversion efficiency is affected by the variations in the offspring produced by catadromous and anadromous animals, (Van Leeuwen *et al*. 2017) [18, 34]. Similarly, interaction of sodium/potassium ratio and level of protein also affects the food conversion efficiency (Zhu *et al*. 2006 and Venkataramian *et al.*1975) [39, 35]. The growth rate and feed conversion efficiency varied with many factors that is diet composition, feed, hydrogen ion concentration, temperature, mineral composition, stocking density (Ariyati *et al*. 2018 and Besson *et al*., 2016) [4, 5] etc. During slow body activity, the majority of the food consumed by organisms is stored in hepatopancrease (Tiwari, *et al*., 1989; Adiyodi, 1969; Passano, 1960) [31, 3]. But high metabolic activities cause re-absorption of the reserve food materials from the reservoir to be utilized at different action sites, (Adiyodi and Adiyodi, 1970; Adiyodi, 1968) [1, 2]. Accessibility of food may regulate growth, fecundity, and ultimately settlement rate and survivorship of both young and adult crabs Christy, (1978) [7]. Lazarus *et al*. (1988) reported the effects of palletized food on feed conversion ratio of experimental field culture of white prawn (*Penaeus indicus*) in polyethylene film coated ponds. Sharma and pant, (1984) [29] studied the energy budget of crustacean (*Simocephalus vetulus)*. Hill, (1979, 1976) [14] described feeding strategy, natural food and foregut clearance- rate of the crab *Scylla serrate* from South African estuary. Unlike fin-fish, the crabs tend to ingest fragmented food rather than swallowing the intact animal (Prasad and Nilakantan, 1988). Reddy (1937; 1938) [27, 26] described the physiology of digestion and cytology of digestion and absorption of the crab *Paratelphusa* (*Oziotelphusa*) *hydrodromus*. Food consumed by the crab is stored in the anterior sac like structure of the cardiac stomach and digestive juices released, preliminary digestion- describing further that the mastication and grinding are the main functions of cardiac stomach which is to be passed back to the mid- gut (Warner, 1977) [35]. The study is use ful for the enhancement in aquaculture production purposes.

Materials and Methods

The experiment was conducted from 17th June, 2007 to 25th August 07 for 70 dayson *Barytelphusa lugubris* collected from Sangla Pwakal Kunchi Village Development Committee (VDC), Kathmandu, Nepal. Sangla is bounded by Jhor, Mahankal V. D. C. on the east; on its southeastern border is Chandeshwari, Pulung to its South and Nuwakot on the northern border. Its western region is demarcated by Kabhresthali. The study area is a terraced bog paddy field. It is situated on the north- western region of the hill where the sun sets early during both summer and winter and the location is comparatively colder. The study was focused to determine specific growth rate, food conversion efficiency and food conversion ratio. The small crabs were collected from the area and acclimatized for seven days till they survived in aquarium. They were categorized into three groups as A, B and C, on the basis of their weight containing eight crabs each. The initial total weight and carapace width of group A, B and C were 63.17g, 79.50g and 92.97g and 33.80, 35.1 and 37.5mmrespectively for eight crabs in each aquarium. Chicken liver thawed in water was supplied to feed the crabs thrice a week and the leftover food was siphoned, weighed and recorded and then, aquaria were cleaned on the same day. The average room temperature throughout the rearing period was 25.7^{o}c and water temperature of all aquaria was 24^{0}c under 24 hour fan. The total amounts of food provided during the experimental periods were 248 g, 248 g and 306 g respectively. The growth of each group was assessed in term of weight gain within the stipulated time period. Mortality was not assessed.

The specific growth rate was calculated based on De Silva and Anderson (1995) [10], where, W_1 was the initial weight, $W_2$was the weight at the end of experiment, and "t" was the time duration of the experiment.

$$\text{Specific Growth Rate (SGR)} = \frac{(W2-W1)*100}{t} \quad (1)$$

Food conversion efficiency (FCE) is reciprocal to food conversion ratio. The higher the feed conversion efficiency the better was the value of the feed. It was calculated as follows:

$$\text{Food conversion efficiency (FCE)} = \frac{\text{Weight gained by the animal in g}}{\text{Weight of the food consumed in g}} \quad (2)$$

Food conversion ratio (FCR) was calculated to compare the ability of feed to support weight gains. The lower was the feed conversion value the better the performance of feed.

$$\text{Food conversion ratio (FCR)} = \frac{\text{Weight of the food consumed in g.}}{\text{Live wt.gained by the animal in g}}. \quad (3)$$

Results

The total final weight and increase in the percentage weight of crabs after rearing in the laboratory were 65.54 g, 82.27 g and 98.12 g, and 3.75%, 3.48% and 5.54% and final carapace widths were 34.81, 36.43 and 38.98mmin three sets as A, B and C respectively. The significant difference was observed in the weights of crabs after feeding them (Kruskal-Wallis chi-square = 0.34009, df = 2, p-value = 0.765>0.05).Similarly, the increase in total weight of crabs of group A, B and C was 2.37g, 2.77g and 5.15g respectively. The average final weight of crabs in each groups were, 8.19g, 10.28g, and 12.27g respectively. Positive correlation (r=0.99) was found between the weight of the crab and the amount of food consumed (t = 16.626, df = 1, p-value = 0.03824).

Table 1: Increase in total weight of the crabs after feeding for 70 days

Experimental Group	Initial total weight in gram (g)	Average initial weight	Final total weight in gram (g)	Average final weight	increase in total weight	% increase in total weight
A	63.17	7.90	65.54	8.19	2.37	3.75%
B	79.5	9.94	82.27	10.28	2.77	3.48%
C	92.97	11.62	98.12	12.27	5.15	5.545

The total increase in the carapace width of crabs of group A,B and C were 8.08mm, 10.64mm and 11.84mm respectively. Similarly, the final average carapace width of individual crab of group A,B and C were 34.81mm, 36.43mm and 34.81mm respectively.

Table 2: Increase in total carapace width of the crabs after rearing for 70 days

Experimental Group	Initial average carapace width (mm)	Initial total carapace width (mm)	Final average carapace width (mm)	Final total carapace width (mm)	Increase in total carapace width (mm)	% increase in total carapace width (mm)
A	33.8	270.4	34.81	278.48	8.08	2.99%
B	35.1	280.8	36.43	291.44	10.64	3.79%
C	37.5	300	38.98	311.84	11.84	3.955%

The percentage of food consumed in group A,B and C were 25.08%, 45.14% and 47.40% respectively (Table 3).

Table 3: Consumed and remaining food given to the crabs of three experimental groups

Experimental Group	Food given in gram (g)	Remaining food in gram (g)	Consumed food in gram (g)	% of Consumed food in gram (g)
A	248	185.81	62.19	25.08%
B	248	136.06	111.94	45.14%
C	306	160.95	145.05	47.40%

The food conversion ratio was maximum (67.46) in group of C and minimum (26.24) in group A and whereas, the food conversion efficiency was maximum (0.04) in group A and minimum (0.01) in group C but Specific growth rate was maximum (4) in group B and minimum (3.07) in group C (Table 4).

Table 4: FCR, FCE and SGR of three groups of crab in 2007

Group	Food Conversion Ratio (FCR)	Food Conversion Efficiency (FCE)	Specific Growth	Specific Growth Rate (SGR)
A	26.24	0.04	0.0338	3.38%
B	40.41	0.02	0.04	4.0%
C	67.46	0.01	0.0370	3.07%

Discussion

Food conversion ratio (FCR) was observed more than the food conversion efficiency (FCE) in all three sets (A, B and C). FCR was more for high weighed set of crabs and decreased with the decreasing weight, but FCE was low in the crabs with more weight, i.e., (Group C) which increased with decreasing weight of the crabs. The FCE in this species seemed to be slow due to low temperature and cool region located on the Southwestern corner of the hill. Lower the temperature slower is the metabolism thus reducing the FCE resulting in slower growth rate, (Miranda-Anaya, 2004 and Wolcott, 1988) [28, 26]. Temperature sets the quickness of metabolic activity by devious molecular dynamics such as diffusivity, solubility, fluidity and biochemical reaction rates, as the internal tissue of the organism is typical at nearly the same temperature as the surrounding water, (Govt. of India, 1992) [13]. The growth of an organism varies in different environment, further in the same environment the growth also varies with season. This is due to the variation in the bed content, water quality and interactions between living and nonliving factors as well (Hartnoll, 1988). The environmental conditions, like food quality or availability may promote different growth rate between the populations within a relative small geographic area (Hines, 1989) [15]. The growth in decapods crustacean is irregular owing to periodic molting (absolute growth) of hard exoskeleton (Reddy and Reddy, 2006) [28] relating post-molt to pre-molt size in crustaceans; size in this context is most frequently defined by a linear measurement of width or length of carapace (Mauchline, 1976) [14]. The specific growth rate (SGR) of *Barytelphusa lugubris* was high (4.0%) for group B crabs followed by group A (3.38%) and group C (3.07%). The variation in the growth rate might be due to presence of soft shell (moulted recently). Group B crab have most soft shell compared to group A and group B. The average increase in weight and SGR was 2.43g and3.47% respectively. The consumption rate was more in the high weight crab and which gradually decreased with decrease in the weight of the crabs in group. High consumption rate resulted high food conversion ratio, but lowing food conversion efficiency and SGR. The highest increase in weight (5.54%) was found in the crabs of Group C followed by crabs of group A (3.75%) and group B (3.48%). Tuene and Nortvedt (1995) [33] found the FCE and specific growth rate of Fish (*Hippoglossushippoglossus*) increased with increasing feed intake substantiate with the present findings. Yuan *et al.* (2017) [38] reared *Eriocheir sinensis* (weight of one crab=0.06g-0.15g)at four different temperatures (18°C, 22°C, 28°C and 30 °C) for 35 days and found relatively maximum 54.5% food conversion efficiency at 22 °C, this result justify the present findings of *B. lugubris* with FCE 40%, although it is slightly lower which might be due to diet supplied, reared temperature, size of the reared species, as well as the growth of the freshwater crab species is relatively lesser as compared to fish. Smaller the size of the reared organism greater will be the molting rate and growth. Yuan *et al.* (2017) [38] also found daily food intake increased ($p>0.05$) with the body weight of crab, concede with the present finding as present studied showed the positive correlation between the body weight and food consumed ($r=0.99$, $P>0.05$). Similarly, Huo *et al.* (2014) [17] found specific growth rate (SGR) of *Portunus trituberculatus* significantly influenced by the dietary protein and lipid levels, however, no significant differences in FCR among all treatments, authenticating present findings as the diet provided was chicken liver which contained both protein and lipid. Specific growth rate not only depends on food supplied but, it is also affected by different shelters provided to them during rearing as, Fatihah *et al.* (2017) conducted an experiment for 57 days on crab *Scylla tranquebarica* creating four treatment groups, treatment 1 (control, without shelter), 2 (black net shelter), 3 (green net shelter), and 4 (sand substrate shelter) and reported that SGR to be 4.10 5.07%, 4.31% and 4.12% respectively. The SGR was more in the crabs with dark net shelter due to cannibalism. But all the treatment groups showed increase in SGR with the food provided which affirm the present findings. The high SGR might be due to the maintenance of all physiochemical parameters, size and species of juvenile crab's reared for experiment and feed supplied. Similarly, Mendez-Martinez *et al.* (2017) [22] found prawns consuming maximum (37.2%) food had maximum (2.15) FCR, concede with present finding as high food consumption rate (47.40%) of *B. lugubris* resulted maximum (67.46%) food conversion ratio. Similarly, Nguyen *et al.* (2014) [24] recorded, the best growth (tissue growth and molt frequency) and the best FCR, for *Scylla serrate*, was with crabs fed on the diet with 40% crude protein concede with the present findings as the chicken liver contains maximum amount of protein. Similarly, Costa-Bomfim *et al*. (2017) [8] categorized the juvenile cobia (*Rachycentron canadum*) in four experimental groups based on amount of feed supplied and recorded SGR (% day1) and FCR to be 5.7, 6.1, 4.7, 5.0 and 1.11, 1.04, 1.49, 1.54 respectively. This result could not be considered as different from the present findings of *B. lugubris* because the time duration for above results was of one day only and that of *B. lugubris* was 70 days. The SGR could increase as compared to present findings, if the experiment period was extended for longer might be due to differences in metabolic activity, reared species and natural feed supplied to the cultured species. Offspring of fresh water Brown trout (*Salmo trutta*) showed higher conversion efficiency from the egg stage to the start of exogenous feeding (hatchlings) than did offspring from anadromous parents (Van Leeuwen *et al*. 2017) [18, 34]. whatever the results when compared but, increase of conversion efficiency in all smaller hatchling, which support the present findings as, 0.04, 0.02 and 0.01 for the group A, B and C. Smaller the size greater will be the conversion efficiency. Similarly, Huisman (1976) [16] showed the gross growth efficiency in *Cyprinus carpio* increased at increasing food levels from the minimum to the optimum food level concede with present findings. Dash *et al*. (2016) [9] conducted 90-days experiment by rearing prawn (*Macrobrachium rosenbergii*) juveniles in water supplemented with three different concentrations of probiotic bacteria viz. T1 (107 colony forming unit), T2 (108 cfu), T3 (109) and the control (C) (un-supplemented water), to evaluate probiotic effect of *Lactobacillus plantarum* and found SGR (%) and FCR to be 2.28, 2.34, 2.39, 2.48; and 4.08, 4.01, 4.06, 3.62 respectively corroborate with present findings as increased in the food amount resulted increase in the specific growth rate of *Barytelphusa lugubris*. There is variation on the feed conversion efficiency of offspring of anadromous and catadramous of freshwater brown trout of the species *Salmo trutta* (Van Leeuwen *et al*. 2017) [18, 34]. Substrate shelters provided also affects the SGR of the rearing species (Fatihah *et al.*2017) [11]. Thus, it could be concluded that food conversion efficiency will be higher in smaller offspring than compare to adult forms. Food conversion ratio is inversely proportion to food conversion efficiency. Whereas, conversion efficiency and specific growth rate depend on various factors such as, size of the species, given food, physicochemical parameters of the rearing ponds, provided substrate shelters, photoperiods and the nature and behavior of rearing species.

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