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Effect of Diets on the Biochemical Changes of Fattened Commercially Important Crab *Portuns sanguinolentus* (Herbst)

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Abstract: Among 5 feeds used in the present study, combined feed showed highest percentage of protein (54.28%) and lowest was in clam meat (45.41%). The percentage of carbohydrate was highest in the trash fish (6.03%) and lowest in poultry waste (4.15%). The percentage of lipid was highest in trash fish (4.02%) and lowest in poultry waste (3.0%). Regarding ash content, combined feed showed the maximum of 15.98% and the minimum of 14.32% was in vegetables. The gross energy content was high in combined feed (2.91 kcal/g) and lower in vegetables (2.10 kcal/g)). The water crabs offered with poultry waste showed significantly higher weight gain (25 g). However it was lower when the animals fed with vegetables (5 g). The crabs were hardened significantly in very short duration when they were fed with poultry waste (7 days). But the animals were took long duration when fed with clam meat (17 days). The animals consumed significantly less amount (50 g) of vegetables and they were consumed maximum amount of poultry waste (90 g). Survival was noticed 100% for all feeds were offered with *P. sanguinolentus*. The protein content of the crabs offered with combined feed was maximum (41.08%) and poultry waste fed animals was minimum (37.29%). The carbohydrate content of the *P. sanguinolentus* fed with all feeds did not show significant difference. The lipid content of the experimental crabs was more or less same for all feeds. No significant difference was noticed with reference to ash content of the crabs fed with different feeds. The moisture content of the combined feed, trash fish and vegetables offered animals showed higher values rather than other feeds.

Key words: Fattening, *P. sanguinolentus*, poultry waste, trash fish, vegetables

INTRODUCTION

Among the marine crustaceans found along the Indian coast, crab rank third after shrimp and lobsters for their esteemed seafood delicacy and also the value of fishery they support (Mohammed Saved and Rajeev Raghavan, 2001). In Indian scenario, the consumers mostly prefer bigger crabs viz., *Scylla serrata* and *S. tranquebarica* and they purposely neglect swimming crabs. Even though the swimming crabs viz., *Portunus sanguinolentus* and *P. pelagicus* are available throughout the year in Indian coasts (John Samuel *et al.*, 2004). In recent times the blue swimming crabs are processed and finally sold as a processed food. So demand for these crabs is increasing day-by-day. Usually the soft-shelled or water crabs are discarded from the landing centre. This discarded water crabs will be purchased in less cost and reared until the exoskeleton becomes hard in a short duration thereby inviting the buyers to quote attractive prices. Crab fattening has proved to be a great sources not only in terms of generating extra income but also it increasing awareness among fisher folk about the value of marine resources and the need for conservation and sustainable utilization. To create awareness, economically viable technology is the need of the hour to prevent the loss of useful income generating resource. The fattening of swimming crabs may be economically viable and it will give additional income for the fisherman. Fattening experiments on commercially important swimming crabs are very few in general and the influence of diets on the fattening crabs is in particular. So in the present study was aimed to know the effect of diets on the biochemical changes of fattened crab, *P. sanguinolentus*.

MATERIALS AND METHODS

Selection of water crabs: The water crabs of *P. sanguinolentus* was collected from the Parangipettai (Lat. 11º29′ N; Long. 79º49′ E) landing centre and the size was ranged from 80-130 g. Healthy, live, disease free water crabs were selected and checked for any loss of appendages. The study was conducted during July to August, 2008.

Acclimatization: The water crabs were brought to the laboratory by using bucket and acclimatized to the laboratory conditions (salinity 30-32 ppt; temperature 26-31ºC; pH 7.5-8.2 and dissolved oxygen 5 ppm).

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Table 1: Proximate composition of test diets

S.No	Feed	Protein (%)	Carbohydrate (%)	Lipid (%)	Ash (%)	Moisture (%)	Gross energy (kcal/g)
1	Poultry waste	52.21	4.15	3.00	15.90	61.00	2.60
2	Clam meat	45.41	5.12	3.88	15.18	73.01	2.73
3	Trash fish	47.01	6.03	5.02	15.72	74.83	2.91
4	Vegetables	48.09	5.02	3.01	14.32	75.08	2.10
5	Combined	54.28	5.80	4.02	15.98	74.00	2.78

Table 2: Environmental parameters of *P.sanguinolentus* fed with test diets

S.No.	Feed	Salinity (ppt)	Dissolved oxygen (ppm)	pH	Temperature (ºC)
1	Poultry waste	30-31	4.5-5.00	7.5 to 8.2	27-31
2	Clam meat	26-28	4.5-5.00	7.5 to 8.2	27-31
3	Trash fish	26-28	4.5-5.00	7.5 to 8.2	27-31
4	Vegetables	30-31	4.5-5.00	7.5 to 8.2	27-31
5	Combined	30-31	4.5-5.00	7.5 to 8.2	27-31

Stocking: After acclimatization, the crabs were stocked at a density of 2 crabs/tank (Length -44 cm, width -37 cm and depth -30 cm).

Environmental parameters: The environmental parameters were monitored at every morning around 6 am during entire experimental period. The salinity, dissolved oxygen, pH and temperature were measured by using hand refrectometer, DO meter, pH pen and thermometer.

Feeding: During the experimental period the crabs were fed with poultry waste, clam meat, trash fish, vegetables and combined feed (poultry waste, clam meat, trash fish and vegetables) at 10% of their body weight. The poultry waste was collected from poultry slaughter house and vegetables were actually collected from the nearest market. Clam meat and trash fish were collected from the landing centre. Feeding was done twice in a day in the morning (6 am) and evening (6 pm).

Water exchange: The water was exchanged daily in the morning hours and left over feed and faecal matter was removed while water exchange. Triplicate was maintained for each feed.

Sampling: Sampling was done every two days to assess the healthy condition and weight gain of the experimental crabs.

Harvest: The crabs were harvested once the shell becomes hard (Soundarapandian *et al*., 2004, 2008).

Biochemical analysis of the experimental feeds: The proximate composition of the experimental feeds were determined by using standard methods; viz., protein (Raymont *et al*., 1964), carbohydrate (Dubois *et al*., 1956), lipid (Folch *et al*., 1956), ash (Paine, 1964), gross energy (Bages and Sloane, 1981) and moisture.

Biochemical analysis of the experimental crabs: After termination of the experiment, the proximate composition of the hardened crabs was also determined by adopting the standard methods.

Statistical analysis: To know the statistical significance ($p<0.05$) the data were treated with one way analysis of variance. Individual differences between treatments were determined by Duncans multiple range test by using SPSS/PC^{+} package.

RESULTS

Proximate composition of feeds: The biochemical composition of the feeds is given in Table 1. Among 5 feeds used in the present study, combined feed showed highest percentage of protein (54.28%) and lowest was in clam meat (45.41%). The percentage of carbohydrate was highest in the trash fish (6.03%) and lowest in poultry waste (4.15%). The percentage of lipid was highest in trash fish (4.02%) and lowest in poultry waste (3.0%). Regarding ash content, combined feed showed the maximum of 15.98% and the minimum of 14.32% was in vegetables. The gross energy content was high in combined feed (2.91 kcal/g) and lower in vegetables (2.10 kcal/g)).

Environmental parameters: The salinity did not show much variation (26-31 ppt) and the dissolved oxygen maintained during the entire experimental period for all feeds were 4.5-5.0 ppm. The pH of the present study was always maintained at 7.5 to 8.2 for all feeds. The water temperature of the experimental crabs fed with all feeds was found to be 27-31ºC (Table 2).

Fattening experiment: The water crabs offered with poultry waste showed significantly higher weight gain (25 g). However it was lower when the animals fed with vegetables (5 g). The crabs were hardened significantly in very short duration when they were fed with poultry waste (7 days). But the animals were took long duration when fed with clam meat (17 days). The animals consumed significantly less amount (50 g) of vegetables and they were consumed maximum amount of poultry waste (90 g). Survival was noticed 100% for all feeds were offered with *P. sanguinolentus* (Table 3).

Biochemical composition of the experimental crabs: The protein content of the crabs offered with combined

Table 3: Fattening of *P. sanguinolentus* offered with test diets

Feed	Initial weight (g)	Final weight (g)	Weight gain (g)	Duration (days)	Feed consumed (g)	Survival (%)
Poultry waste	110.00±1.00	135.0±1.03 ^{b}	25.00±2.04 ^{c}	07.0±1.00 ^{a}	90.0±1.25 ^{b}	100
Clam meat	90.00±2.10	110.0±1.33 ^{b}	10.00±2.11^{a}	17.0±1.10 ^{b}	85.0±1.13 ^{b}	100
Trash fish	130.00±2.20	145.00±1.24 ^{c}	15.00±2.22 ^{b}	12.0±0.18 ^{a}	60.0±1.14 ^{a}	100
Vegetables	80.00±2.01	85.00±1.08 ^{a}	05.00±2.10 ^{a}	10..0±1.13 ^{a}	50.0±1.28 ^{a}	100
Combined	80.00±0.23	95.00±1.25 ^{a}	15.00±2.25^{b}	11.0±0.32 ^{a}	60.0±1.18 ^{a}	100

Means with different superscript are statistically different ($p<0.05$; Duncan's multiple range test)

Table 4: Proximate composition of fattened crabs fed with test diets

S.No.	Feed	Protein (%)	Carbohydrate (%)	Lipid (%)	Ash (%)	Moisture (%)
1	Poultry waste	37.29±0.86 ^{a}	1.20±0.72 ^{a}	2.15±0.45 ^{a}	18.90±0.92 ^{a}	72.00±0.48 ^{a}
2	Clam meat	39.02±0.15 ^{a}	1.20±0.12 ^{a}	2.23±0.44 ^{a}	18,63±0.75 ^{a}	73.02±0.15 ^{a}
3	Trash fish	40.24±0.19 ^{b}	0.86±0.62 ^{a}	2.46±0.13 ^{a}	17.32±0.16 ^{a}	74.13±0.23 ^{b}
4	Vegetables	38.24±0.01 ^{a}	0.92±0.12 ^{a}	2.12±0.12 ^{a}	18.36±0.12 ^{a}	74.13±0.21 ^{b}
5	Combined	41.08±0.86 ^{b}	1.22±0.84 ^{a}	2.38±0.86 ^{a}	19.98±0.65 ^{a}	74.00±0.65 ^{b}

Means with different superscript are statistically different ($p<0.05$; Duncan's multiple range test)

feed was maximum (41.08%) and poultry waste fed animals was minimum (37.29%). The carbohydrate content of the *P. sanguinolentus* fed with all feeds did not show significant difference. The lipid content of the experimental crabs was more or less same for all feeds. No significant difference was noticed with reference to ash content of the crabs fed with different feeds. The moisture content of the combined feed, trash fish and vegetables offered animals showed higher values rather than other feeds (Table 4).

DISCUSSION

In the present study demonstrated that diets had accelerated the hardening process of the soft shell crab of *P. sanguinolentus*. In most of the growth studies, the internmoult period and tissue growth was mainly dependent on the nutrional quality of feeds (Koshio *et al.*, 1990). In the present study, 4 types of individual and 1 combined feeds (poultry waste, clam meat, trash fish and vegetables) were given to the experimental crabs for comparison. The average weight gain of the *P. sanguinolentus* noticed in the present study was not directly related to the level of protein in the diet. It is known from the previous studies that the optimum requirement of dietary protein for crustaceans was in a range of 20 to 60% (Guillaume, 1997). The dietary protein content in the present study was ranging between 44.41 to 54.28%. But the animals fed with poultry feed showed the highest weight gain (25 g), while the lowest weigh gain (5 g) was observed in animals fed with vegetables. The experimental animals also took shorter duration (7 days) for hardening when offered with poultry waste than other feeds. In contrast to the present investigation, weight gain of *P. pelagicus* was maximum when mixed feed (oyster, clam meat and trash fish) was offered than individual feeds. The animals also took shorter duration for hardening when exposed to combined feed rather than individual feeds (Soundarapandian and Dominic Arul Raja, 2008).

Kanazawa *et al.* (1970) reported that the fresh diets of short neck clam (*Tapes philippinarum*) gave superior growth compared to the compounded diets for *P. japonicus*. Similar results were obtained by Forster and Beard (1973) for *P. serratus*. Frequent moulting was observed during feeding experiment with fresh clam meat (Ali, 1982). The fleshes of molluscs and crustaceans have been found to be the most acceptable and producing the best growth for *M. rosenbergii* (Bages and Sloane, 1981) and *M. malcolmsonii* (Soundarapandian, 2008). Marine sources included fish meal, *Acetes* sp. and squid was used as a feed because it is known to be highly digestible for some crustaceans (Catacutan, 2002).

In the present investigation, all feeds were given to the crabs at the rate of 10% of the body weight. According to Rattanchete and Dangwatankul (1992), a higher rate of feeding is practiced in Thailand where trash fish and horse muscle are given at the rate of 7-10% of the body weight, once or twice a day. De Silva (1992), used offal, clam meet and fish for feeding the mud crabs and found that first preference was for clam meat and then for offal. Similar result was observed in the present study also. Among 5 feeds (poultry waste, clam meat, trash fish, vegetables and combined feed) were used the experimental crab only select clam meat, trash fish and poultry waste and they were avoided vegetables. Trash fish was given at higher feeding rates of 10-15% of body weight of experimental crabs (Cholik and Hanafi, 1992). The feeding rate 10% of body weight followed during the present experiment appears to be reasonable considering the prevailing environmental conditions of the water. The poultry waste, clam meat and trash fish were offered in fresh condition were found to pollute the water as evident from the colour change and foul odour. This problem was partly solved by thorough washing of the live feeds before feeding.

The carbohydrate content of combined feed was found to be 5.80% and poultry waste was 4.15%. Lipid content of both the diets of the present study was also followed similar trend as carbohydrates. As a result of various experiments in crustaceans, dietary lipid of 2-10% was found to be optimum (Biddle *et al*., 1977; Sheen and Abramo, 1991; Soundarapandian, 2008). In the present study also all feeds used had more or less same optimum range of lipid (3.00-5.02%).Guillaume (1997) noted that crustaceans are not able to tolerate more than 10% of lipid in their diet and its inefficient utilization causes reduced growth. The ash, moisture content and gross energy of the present investigation was agreement with the findings of Soundarapandian (2008).

In the present study the environmental parameters such as salinity, DO, pH and temperature were found in the ranges of 26-31 ppt, 4.5-5.00 ppm, 7.5 to 8.2 and 27-31ºC respectively for all feeds which is actually ideal for crab culture. In general salinity and temperature variations are considered the most important factors influencing the growth and survival of crabs. It is likely that oxygen and pH have many additional impacts on the immune system of invertebrate. Low oxygen and pH suppress the activity of crustacean phenoloxidase activity (Christopher *et al.,* 2006). Mwaluma (2003) reported that pH 7.7-8.4, temperature 27-29.4ºC and salinity 29.1-39.3 was ideal for mud crab fattening. Soundarapandian and Dominic Arul Raja (2008) already recorded 30 ppt salinity was ideal for the fattening of *P. pelagicus.* Other parameters also similar to the present investigation (temperature 26-31ºC, pH 7.5-8.2, dissolved oxygen 5 ppm).

Feed consumption is always related with weight gain. In the present study *P. sangunolentus* consumed more amounts of poultry waste and less amount of vegetables. So the weight gain was correspondingly higher in poultry waste fed animals (25 g) rather than vegetables (5 g). But most of the earlier studies indicated that combined feed influence higher weight gain than that of individual feeds. Senthilkumar (1996) used three types of live feeds *viz*., clam meat, fish meat and beef meat for the water crabs of *S. serrata*. He used those feeds individually and combined together. Growth, survival and production rate was maximum when the water crabs were fed with combined feeds rather than offered individually. Similar result was obtained by Soundarapandian and Dominic Arul Raja (2008) when *P. pelagicus* offered with combined feeds (oyster, clam and trash fish) rather than individual feeds. Williams (1978) also suggested that the mixed diets support superior growth. No significant change was observed in the total weight of *S. serrata* fed with trash fish, slaughter house waste and clam meat during fattening (Anil and Suseelan, 2001).

In the present study, good survival was (100%) obtained when all feeds were offered with experimental crabs. According to Catacutan (2002), a survival of more than 80% is usually considered as good for crustacean culture. The lower stocking density in mud crabs leads to higher survival (Guillaume, 1997). An increase in survival rate with lower stocking density may have been due to reduced cannibalism among the stock (Poovachiranon, 1992; Jayaman, 1992; Trino *et al.*, 1999). In the present investigation, two animals were stocked in each tank. So the survival was maximum for all feeds. Biochemical studies are very important from the nutritional point of view. The biochemical constituents in animals are known to vary with season, size of the animal, stage of maturity, temperature and availability of food. In the present study, protein content was higher in combined diets consumed crabs (41.08%) followed by trash fish (40.24%) than those other feeds used in the present study. Values of protein in the present study are agreement with other studies (Sheen and Abramo, 1991; Murugesan *et al.*, 2008). Balasubramanian and Suseelan (2001) assessed the protein values in *C. smithii* was 59.8 to 71% in dry matter basis. The protein value in *P. vigil* was 15.75 to 20.16% (Radhakrishnan and Natarajan, 1979) and in *C. affinins* was 17.8% (Vasconcelos and Braz, 2001). In *S. serrata*, the protein content of the body meat and claw meat was 20.11 and 18.54% respectively (Prasad and Neelakantan, 1989). Anonymous (1997) reported that the protein value in blue crab was 17.17%. George and Gopakumar (1987) observed the protein content in *S. serrata* with egg (19.16%), without egg (20.92%), body meat (16.8%) and claw meat (16.28%). The protein content of *P. pelagicus* and *P. sanguinolentus* was 0.47 to 15.91% and 12.81 to 13.6% respectively (Radhakrishnan, 1979). Thirunavukkarasu (2005) recorded the protein values in *S. tranquebarica* from different parts viz., body meat (65.48 to 72.24%), claw meat (69.5 to 80.29%) and leg meat (69.47 to 74.7).

Carbohydrates constitute only a minor percentage of total biochemical composition. Carbohydrates in fishery products contain no dietary fiber but only glucides, the majority of which consist of glycogen (polysacchride). They also contain traces of glucose, fructose, sucrose and other mono and disaccharides (Okuzumi and Fujii, 2000). In the present study, carbohydrate contents of the crabs fed with all feeds were not significantly different. The previous studies were suggested that the carbohydrate in the muscle varied from 0.3 to 0.63% in *P. vigil* (Radhakrishnan and Natarajan, 1979), 2.4 to 3.4% in *C. smithii* (Balasubramanian and Suseelan, 2001), 0.17% in body meat, 0.24% in claw meat of *S. serrata* (Prasad and Neelakantan, 1989), 0.16 to 0.55% in *P. pelagicus* and 0.44 to 0.73% in *P. sanguinolentus* (Radhakrishnan, 1979). In *S. tranquebarica*, the carbohydrate values of body meat, claw meat and the leg meat was 0.59 to 2.23%, 0.68 to 2.87% and 0.76 to 2.76% respectively (Thirunavukkarasu, 2005). The results of Alva and Pascual (1987) and Diaz and Nakagawa (1990) indicated that different types of dietary carbohydrates can influence the proximate composition of prawn. But the study of Soundarapandian and Ananthan (2008) indicated that dietary carbohydrate has no effect on body carbohydrate of *M. malcolmsonii* as in the present study.

Lipids are highly efficient as a source of energy, and it shows more than twice the energy of carbohydrates and proteins (Okuzumi and Fujii, 2000). As in carbohydrate, the lipid contents of the crabs fed with different feeds were not significantly different. In *P. vigil* the lipid values assessed from 5.13 to 9.73% by Radhakrishnan and Natarajan (1979). Balasubramanian and Suseelan (2001) recorded the lipid values from 6.2 to 7.6% in *C. smithii.* In *C. affinis,* the lipid values were 0.7% (Vasconcelos and Braz, 2001) and in blue crab it was 1.5% (Anonymous, 1997). Prasad and Neelakantan (1989) noticed that the lipid content in *S. serrata* from body meat was 1.65% and claw meat was 2.01%. George and Gopakumar (1987) assessed the lipid values in *S. serrata* with egg (0.43%), without egg (0.7%), body meat (1.07%) and claw meat (1.0%). In *P. pelagicus*, the lipid value was 3.3 to 5.6% and *P. sanguinolentus,* it was 3.8 to 5.5% (Radhakrishnan, 1979). The lipid content of the body meat (1.6 to 0.9%), claw meat (1.83 to 2.06%) and leg meat (1.58 to 2.08%) was estimated by Thirunavukkarasu (2005). In crustaceans, lipids are not only the principal organic reserve and source of metabolic energy, but also indispensable in maintaining cellular integrity. Lipids as a general rule act as major food reserve along with protein and are subject to periodic fluctuations influenced by environmental variables like temperature (Nagabhushanam and Farooqui, 1982).

The body lipid content of the *P. sanguinolentus* of the present study was not influenced by diets. Soundarapandian and Ananthan (2008) observed similar type of changes in *M. malcolmsonii*. In *P. monodon*, carcass fat decreased while faecal fat increased with increasing dietary carbohydrate (Catacutan, 2002). This indicates that higher levels of carbohydrates depressed lipid deposition as noted by Alva and Pascal (1987) in *P. monodon* juveniles fed with 30% trehalose or 20% sucrose. The wide fluctuations in lipid composition have been reported to occur both in hepatopancreas and gonads of prawns during gonadal development (Pillai and Nair, 1973). But this does not affect the lipid composition of muscle to any great extent.

The body ash content of the crabs of *P.sanguinolentus* was higher than feeds. So the body ash content of the crabs in the present study was definitely affected by diets. But this was not significantly different between the feeds. Similar result has been reported in the juveniles of *M. malcolmsonii* (Soundarapandian and Ananthan, 2008).

The body moisture content of the present investigation was ranging between 72.00-74.00%. The moisture content ranged from 73.5 to 81.8% in body meat, 73.5 to 80.16% in claw meat and 73.23 to 79.6% in leg meat of *S. tranquebarica* (Thirunavukkarasu, 2005). Radhakrishnan and Natarajan (1979) observed comparatively lower moisture values of 69.54 to 74.46% in *P. vigil*. Where as in *C. affinins*, the moisture value was noticed as 80.16 by Vascocelos and Braz (2001). In *S. serrata*, Prasad and Neelakandan (1989) observed moisture of 77.7% in the body meat and 78.76% in the claw meat of blue swimming crab. But at the same time Radhakrishnan (1979) reported a moisture level of 69.52 to 80.51% and 67.44 to 82.04% in *P. pelagicus* and *P. sanguinolentus* respectively. George and Gopakumar (1987) assessed the moisture value in *S. serrata* with egg, without egg, body meat and claw meat as 78.02, 77.2, 80.19 and 82.94%, respectively.

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