GROWTH PERFORMANCE OF *MACROBRACHIUM IDAE* JUVENILES FED WITH CARBOHYDRATE RICH DIETS

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ABSTRACT: Eight types of formulated diets contained energy levels of 307, 316, 330, 336 kcals/100g at low protein (23.6 – 26.48%) and 306, 316, 328, 338 kcals / 100g at sub optimum (33.5 – 35.7%) protein levels were prepared and fed to *Macrobrachium idae* juveniles. A separate feed was prepared having 40.34% protein with 357 kcals/100g of dietary energy served as a control diet. Diets contained 26.48% protein and 307 kcal / 100g or 34.6% protein 316 kcals / 100g produced a better growth and FCR. The SGR, PER, PPV decreased when fed with 23.66% protein diets while in 33.8% protein diets all the parameters increased as dietary energy increased. The ANPU reduced as the dietary energy decreased. The balanced P/E ratio in the diets provided to the prawns helped to decrease the intake of dietary protein from 35.7% to 26.48%, by which 30 to 40% of the dietary protein was found to be spared. The utilization of corn meals (32– 37%) provided the protein sparing ability to the prawns. Of various carbohydrate diets given, rice scrap and wheat scrap meals were digested well by *M. idae* (81.3%, 80.3%) followed by corn meal (76.9%) The potato was poorly digested (12.66%) by *M. idae* juveniles indicating the source of carbohydrate diets could be incorporated to fresh water prawn diets to reduce the feed cost in culture system.

KEYWORDS: Carbohydrate rich diets, *Macrobrachium idae,* Protein to energy ratio, Nutrient digestibility.

INTRODUCTION

Information on nutrient utilization of fresh water prawns by using low cost and well balanced dietary source is needed. Currently more attention is focused an investigating the use of various source of nutrients in prawn diets and processing technologies to improve their utilization[1]. In prawn culture system high protein is used as energy source thus making the feed source costlier and a number of studies have pointed out the importance of using less expensive energy from lipids or carbohydrates in order to save protein. The use of alternative protein sources in the culture of crustacean species of commercial importance to reduce feed costs has been reported[2]. Carbohydrates not only supplies instant energy but also have protein sparing effect in prawn diets[3]. Though several reports are available on the utilization of carbohydrates in feed (Ackefors *et al*.,[4]), the capability of digesting and assimilating carbohydrates is not much effectively studied in shell fish. The utilization of carbohydrate is based on the rate of consumption, feeding efficiency and bioavailability of nutrients from the feed[5]. However, evidences indicate that carbohydrates are used partially in fish / prawn feed to substitute dietary protein for energy utilization purposes[6]. The commercially available artificial feeds are highly expensive and are not always affordable to small farmers. The expensive protein sources can be limited by including adequate level of carbohydrate, which in turn enhances the protein sparing effect of a particular diet on growth [7,8,9].

Being an important energy source, carbohydrates plays a significant role in glycogen storage, chitin synthesis, formation of steroids from fatty acids. The capacity to utilize various carbohydrates seems to vary from species to species. Energy production through protein oxidation is a wasteful process both from nutritional and economic point of view. Thus it is found necessary to spare protein for growth by optimizing the level of non-protein energy source. An adequate amount of suitable sources of non-protein energy in a diet is therefore potentially desirable to improve protein utilization[10]. Apart from a few studies (Diaz Herrera *et al*.,[11]) the utilization of carbohydrate in *Macrobrachium* species especially in *M. idae* is lacking. *M. idae* is also considered as one of the important candidate next to *M. rosenbergii* and *M. malcolmsoni* in fresh water culture system in this part of South India and also used along with carps in polyculture system and gives promising growth in recent times. So the present study was made to examine the carbohydrate rich ingredients in the formulated diets of *M. idae* to reduce the protein requirement and to determine the protein:energy ratio there by reducing the production cost without affecting the yield.

MATERIALS AND METHODS

A seven week feeding trail was conducted, fed with eight formulated diets of two protein levels (24 – 26% and 33 – 36%) with four levels of dietary energy (306, 316, 320, 334 k cal / 100g). Diet containing 40.34% protein with 357 k cal / 100g of energy was used as a control to meet the nutritional requirements of prawns. All the selected ingredients were powdered, mixed well and made into a homogenous dough by adding required amount of warm water and pressed through a hand pelletizer to form pellets of 1 mm diameter. The pellets were sun dried for 2-4 days, made to uniform size and stored in a refrigerator until use.

Forty five prawns with an average weight of 3.46g ± 0.29 were recruited from the stock reared at the Centre for Aquafeed and Nutrition (CAFeN) research laboratory, St. Xavier’s College, Palayamkottai. After a period of 10 days acclimatization the prawns were divided into nine groups consisted of five prawns each and introduced into round plastic troughs of 401 capacity. Dechlorinated tap water was supplied to each trough which were connected through a flow through system with a flow rate of 4 ℓ/hr supplemented with aeration. All the diets in triplicates were randomly assigned to each of the experimental prawns. The prawns were fed with experimental diets of 5% of initial body weight, twice a day (9 AM and 4 PM) and the following water quality parameters were maintained viz., water temperature (26 – 28^{o}C), dissolved oxygen (6.2 to 6.9 mg/ ℓ) and pH (7.6 and 7.8). All the experiments were carried out in Light: Dark (12 : 12hr) period. The unfed (if any) and fecal matter were collected by manual siphoning daily before feeding, dried in hot air oven at 56^{o}C and kept for biochemical analysis. Moulting period of prawns were carefully observed and the exuviae were removed, weighed and stored for calculating the growth of prawns. At the end of the experimental period, the test prawns were sacrificed and weighed individually [12].

All the samples were analysed by following standard procedures, viz, Carbohydrate by anthrone method; crude protein by microgheldhal method; crude lipid was extracted by the soxlshet method, crude fibre by acid base wash method and ash by incenerating a known sample at 550^{o}C for 5 hours in a muffle furnace. The grass energy was estimated by using a semi microbomb calorimeter. The apparent digestibility of dry matter, total energy, carbohydrate and protein were determined by wet acid digestion method[13].

Growth performance of prawns were calculated as follows:

$$\text{Specific Growth Rate (SGR)} = \frac{\text{In. Final Weight (g) - In. Initial Weight (g)}}{\text{Experiment al Duration (days)}} \times 100$$

$$\text{Food Conversion Ratio (FCR)} = \frac{\text{Dry Food Consumed (g)}}{\text{Wet Weight Gain (g)}}$$

$$\text{Protein Productive Value (PPV)\%} = \frac{\text{Body Protein Gain (g)}}{\text{Protein Consumed (g)}} \times 100$$

$$\text{Apparent Net Protein Ut ilization (ANPU)} = \frac{\text{Final Carcass Protein - Initial Carcass Protein}}{\text{Dry Protein Intake}} \times 100$$

The ADCS of test diets was calculated as

$$100 - \frac{\text{\% nutrient in faeces}}{\text{\% nutrient in diet}} \times \frac{\text{\% } Cr_2O_3 \text{ in diet}}{Cr_2O_3 \text{ in faeces}} \times 100$$

And apparent digestibility coefficient of test components were calculated as

$$\frac{100}{30}(\text{digestibi lity of test diets}) - \frac{70}{100}(\text{digestibi lity of reference diets})$$

Oneway ANOVA and Dunkan's Multiple Range Tests were applied to find out the difference between treatment of means Coefficient of correlation and linear regression were also employed wherever necessary[14].

RESULT

The present experiment showed an increase in the growth of juvenile prawns at a dietary protein level of 26.48% and 34.63% which had a PE ratio of 86.25 and 113.16 respectively. The energy level needed for the maximum growth fall between 307 to 316 kcal / 100g of feed. Protein levels on either side tend to decrease the growth. The lowest FCR of 1.92 and 2.03 were recorded in the above said respective diets. Though dietary energy increased with dietary protein after 34.63%, the FCR showed elevated values.

Correlation analysis showed that there was a significant relationship between PPV and P/E ratio at 23.6 and 26.48%, protein levels ($r = 0.94$; $P<0.05$). Increasing the dietary energy level from 23 to 26% protein diets resulted in increase of PER and PPV, while increasing the energy level from 33.54 to 35.6% protein diets PER and PPV decreased considerably. However the relationship between PER and PPV and P/E ratio from 33 to 35.6% protein level was not significant ($r = 0.91$; $P < 0.05$ and $r = 20.03$ $P = > 0.05$). ANPU showed a gradual decrease with increase in dietary protein level between 23 and 36%.

ADCs of carbohydrate ranged between 46.86 and 81.3% for cassava and rice scrap (Table 3). Energy and dry matter digestibility's were higher (corn 70.4% and 68.7%) and rice scrap (77.4% and 54.08%) followed by sorgham (52.8% and 23.8%) cassava (47.2% and 52.6%) beetroot (44.8% and 41.4%) and wheat scrap (41.9% and 43.5%). The protein digestibility's were higher in rice scrap (86.4%), wheat scrap (83.5%) and corn (77.3%) than other ingredients. Sweet potato was poorly digested by *M. idae* juveniles with energy 3.3cal/mg and dry matter 2.9% (Table 3). The body composition of the fish fed with carbohydrates rich ingredients is presented in Table 5. At the end of the feeding trials the test prawns of each group had a low moisture and protein and higher lipid content compared to the initial samples. The ash content of test prawn also showed decreased trend. Among the test prawns the carcass protein and lipid contents were higher fed with 26.48% protein diets than those fed with 34.63% protein diets. The carcass lipid showed a gradual decrease as the dietary protein increased. No significant effect of carbohydrate rich ingredients on carcass composition of prawns at both the dietary levels were noticeable.

DISCUSSION

The present study revealed that a proper balance between dietary protein and energy is important for optimum growth. A diet containing 34.63% protein and 316 K cal/100g physiological energy or 26.48% protein and 307 K cal/100g of physiological energy produced better growth and nutrient utilization and other diets. The P/E ratio of both diets (86.25 and 109.58) suggests that within the acceptable protein range this optimum was quite lower. Shifting away on either direction from this optimum values produced negative growth and food conversion in *M. idae* juveniles. As there is little information regarding this type of work in fresh water prawns, similar works could be discussed with fin and other shell fishes.

In the present study with the increase of dietary energy level, growth of prawns fed with 33 – 35.6% protein diet (32.26% corn flour) decreased. But the decreased growth of *M. idae* at low protein (23.6%) and high energy (336 K cal/100g) or suboptimum protein (34.68%) with low energy (306 K cal/100g) could be explained in several ways. The weight of the prawns reduced with increase of digestible energy (336 K cal/100g) fed with low protein diets (23.66%) because the prawns conserve less food which prevented it from obtaining their daily protein requirements[15]. Reduced growth was noticed in *P. monodon* fed with high protein diets containing inadequate non protein energy. The decreased growth may be due to deamination and much of the protein was utilized as energy source.

The optimum range of P/E ratio between 99.23–109.58 was much lower as compared with other species of prawns. Catacuttan[16] reported that *P. monodon* juveniles fed with diet containing 25% bread flour produced higher weight gain with P/E ratio of 222mg/K cal. Koshio *et al.*,[17] reported an optimum P/E ratio of 112mg/Kcal using 11% starch in feed for *M. rosenbergii*. Optimum P/E ratio of 144 mg/Kcal for *P. japanicus* using dextrin as a main source of carbohydrate with 20% starch[18]. For red swamp cray fish *(Procarmbus clarkii)* a P/E ratio of 93.4 mg/K cal with 26% dietary protein and 27% corn grain used as carbohydrate source was reported to produce higher growth. Growth was depressed when corn meal above 45% was incorporated to prawn diets (*P. venameii*)[19]. Piedad – Pscaual *et al.*,[20] reported, that carbohydrate influenced the utilization of *P. monodon* fed diets containing wheat flour (30%) with dietary energy of 310 – 320 Kcal/100g. Gomez-Diaz and Nagakawa[21] also reported a maximum utilization of 40% carbohydrate in *M. rosenbergii* influenced less utilization of protein from diet.

So an estimated physiological energy value of 316 Kcal/100g diet and P/E ratio of 109.58 or 307 mg/Kcal with P/E ratio 86.53 appears to be optimum for *M. idae*. These values were slightly lower in *M. rosenbergi* (407 Kcal.100g and 95 mg/Kcal) while Gomez – Diaz *et al*.,[22]

Table 1 – Percentage composition of ingredients used in formulated feed

Ingredients	1	2	3	4	5	6	7	8	9
Fish Meal (FM)	11	12	12	12	17	19	19	23	35
Groundnut Oil Cake (GOC)	10	10	12	12	15	15	17	17	22
Corn Flour (CF)	55	49	41	37	35	32	29	26	15
Wheat Flour (WF)	9.2	11.5	13.5	12.5	10	10	10	10	13
Husk Dusk (HD)	4.8	7.5	11.5	16.5	13	14	15	14	5
Tapioca Flour (TF)	6	6	6	6	6	6	6	6	6
Vitamin / Mineral Mix	3	3	3	3	3	3	3	3	3
Cr_2O_3	1	1	1	1	1	1	1	1	1

Table 2 – Proximate composition of ingredients used in formulated feed

Ingredients	1	2	3	4	5	6	7	8	9
Carbohydrate (%)	43.88	42.31	42.42	41.08	37.71	36.19	35.34	32.14	22.61
Crude Protein (%)	23.66	24.79	25.93	26.48	33.54	33.87`	34.63	35.66	40.34
Crude Fat (%)	4.33	4.98	4.85	5.02	4.71	4.75	4.86	4.91	6.34
Available Energy (Kcal/100g)	336	330	316	307	338	328	316	306	357
P/E Ratio	70.42	75.12	82.06	86.25	99.23	103.34	109.58	116.53	112.99
E/P Ratio	14.20	13.31	12.19	11.59	10.07	9.68	9.13	8.58	8.85

reported a higher dietary energy 429 Kcal/100g with P/E ratio 110 mg/Kcal. Bautista[23] reported a carbohydrate diet containing P/E ratio of 120 – 174 mg/Kcal with dietary energy of 370 Kcal/100g was optimum for *P. monodon.*

Diets having 30.35% protein with 30% carbohydrate showed optimum growth in *M. rosenbergi* [24]. Jayalakshmi and Natarajan[25]reported a low FCR (2.8) for *M. idae* fed with 30% carbohydrate influenced higher growth. A better growth performance at 37.05% dietary carbohydrate level exhibited in *M. rosenbergii* reported by Felix and Prince Jeyaselan[26]. Boonyaratpalin and New[27] reported that a higher carbohydrate incorporation (35%) could be suitable for formulating cost effective feed for *M. rosenbergii*.

A better performance at 34% dietary carbohydrate level in *M. idae* was obtained in this study corroborates with the reports of Nair and Sherif[28] in *M. rosenbergii*. Apart from sweet potato which was poorly digested by *M. idae*, they have a higher carbohydrate digestibility for other ingredients. This was presumably associated with the physical state of starch present.

Table 3: Growth Performance of *Macrobrachium idae* juveniles fed with carbohydrate rich diets containing varying P/E ratio

Parameters	1	2	3	4	5	6	7	8	9
Initial Weight (g)	3.52 ± 0.03	3.27 ± 0.11	3.62 ± 0.06	3.36 ± 0.13	3.58 ± 0.08	3.61 ± 0.13	3.35 ± 0.11	3.39 ± 0.12	3.49 ± 0.03
Final Weight (g)	4.86 ± 0.04	4.76 ± 0.09	4.93 ± 0.12	5.06 ± 0.09	4.69 ± 0.13	4.42 ± 0.16	5.02 ± 0.05	4.04 ± 0.12	5.08 ± 0.14
Growth (g)	$1.54^{ab} \pm 0.03$	$1.49^{ab} \pm 0.07$	$1.31^{c} \pm 0.08$	$1.70^{a} \pm 0.12$	$1.11^{c} \pm 0.07$	$0.81^{d} \pm 0.09$	$1.67^{a} \pm 0.09$	$0.74^{d} \pm 0.26$	$1.59^{ab} \pm 0.13$
SGR	$0.66^{bc} \pm 0.03$	$0.77^{b} \pm 0.11^{a}$	$0.63^{bc} \pm 0.04^{b}$	0.84 ± 0.12^{a}	$0.55^{c} \pm 0.08$	$0.42^{c} \pm 0.07$	0.83 ± 0.11^{a}	$0.36^{d} \pm 0.06$	$0.77^{b} \pm 0.05$
FCR	2.46 ± 0.06^{bc}	2.36 ± 0.11^{bc}	2.94 ± 0.17^{bc}	1.92 ± 0.11^{c}	3.32 ± 0.17^{b}	4.27 ± 0.21^{a}	2.03 ± 0.13^{c}	5.18 ± 0.26^{a}	$2.09^{c} \pm 0.14$
PER	$0.89^{c} \pm 0.07$	1.32 ± 0.14^{bc}	1.49 ± 0.16^{a}	1.99 ± 0.12^{a}	1.67 ± 0.08^{ab}	1.61 ± 0.14^{ab}	1.83 ± 0.11^{a}	1.07 ± 0.09^{b}	$1.87^{a} \pm 0.06$
PPV (%)	47.62 ± 3.66^{b}	58.17 ± 2.39^{a}	62.41 ± 2.82^{a}	69.13 ± 3.14^{a}	46.59 ± 3.44^{b}	36.69 ± 3.12^{c}	61.77 ± 2.51^{a}	32.88 ± 3.19^{c}	$52.61^{b} \pm 1.24$
ANPU (%)	28.73 ± 1.32^{b}	25.42 ± 2.06^{c}	23.08 ± 1.13^{c}	20.09 ± 1.12^{c}	38.79 ± 1.37^{a}	29.21 ± 3.19^{b}	24.83 ± 1.26^{c}	24.92 ± 2.28^{c}	23.48 ± 1.08^{c}
Survival (%)	92	100	94	100	94	86	92	88	100

Values in the rows having same super scripts are not significantly different ($p < 0.05$).

Table 4 – Apparent digestibility coefficient of feed stuff for *M. idae* (Nutrient content of the test feed % in parenthesis)

Ingredients	Dry Matter (%)	Carbohydrate (%)	Protein (%)	Total Energy (cal/mg)
Corn (CN)	68.7 (39)	76.9 (74.1)	77.3 (992)	70.4
Sweet Potato (SP)	2.9 (2.4)	12.66 (82.7)	54.6 (13.3)	3.3
Cassava (CS)	52.6 (0.4)	46.8 (86.4)	68.9 (1.46)	47.2
Rice Scrap (RS)	54.9 (0.3)	81.3 (78.4)	86.4 (11.29)	77.4
Beet Root (Br)	41.4 (2.1)	76.6 (72.1)	58.5 (4.72)	44.8
Sorgham (Sgh)	23.8 (3.9)	48.6 (63.9)	46.8 (12.72)	52.8
Wheat Scrap (WS)	43.5 (4.2)	80.3 (58.2)	83.5 (20.2)	41.9

Table 5 – Composition of reference diet for digestibility determination and nutrient content of reference diet (RD) and test diets (%)

Reference Diet (RD)		RD Test Diets	Protein (%)	Lipid (%)	Ash (%)	Fibre (%)
Ingredients	**Contents (%)**	**Initial**	**39.36**	**6.24**	**9.34**	**5.27**
Fish Meal	15.6	RD + CN	27.34	4.28	7.81	6.34
Groundnut oil Cake	18.3	RD + SP	22.94	3.19	5.96	3.41
Soybean Flour	20.4	RD + CAS	24.81	3.62	7.69	6.14
Corn	327	RD + RS	21.97	3.27	7.41	3.36
Tapioca Flour	8.0	RD + Br	27.44	2.91	4.87	6.22
Vit/min mix	4.0	RD +Sgh	28.86	4.51	7.63	5.13
Cr_2O_3	1.0	RD + Ws	32.57	4.89	8.87	6.38

Table 6 – Biochemical composition of *M. idae* juveniles fed with formulated diets of varying P/E ratio

Diet No.	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)
Initial	87.39	56.37	18.89	13.67
1	74.18	53.14	26.29	11.14
2	73.36	53.69	28.17	11.89
3	71.44	53.18	30.18	12.16
4	66.17	52.23	28.43	11.83
5	74.25	50.38	26.21	11.07
6	80.07	52.96	24.22	11.38
7	76.83	52.44	27.49	11.65
8	83.11	53.19	23.83	12.08
9	68.12	55.28	21.88	11.73

Apart from corn meal, other meals like rice scrap, wheat scrap and beet root could be used in the diets of prawns as efficient energy yielding ingredients.

In the present study corn meal was used as the major source of energy for *M. idae* juveniles. The dry matter, total energy and carbohydrate digestibility for corn meal were found to be 68.7% 70.4% and 79.6% respectively. The best growth was observed for prawns fed with diet 4 and 7 containing 37 to 29% corn meal. However the growth was depressed when 41 to 55% if corn meal incorporated in the diet. A substantial amount of dietary protein was spared when fed with 24 and 32% protein diets (with 35 to 41% corn meal) as compared to high protein diets. With high carbohydrate could spare 30 to 40% protein above / below their requirement level of 40% dietary protein, implying that the dietary protein could be spared by adjusting proper balance of P/E ratio in the diets. Since carbohydrate rich diets has a protein sparing action in *M. idae* juveniles, inclusion of corn meal from to 32 to 35% reduced the optimal dietary protein level to develop low cost formulated feed for *M. idae* juveniles.

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