Effects of feeding practical diets containing different protein levels to Australian red claw (*Cherax quadricarinatus*)

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Interest in the production of Australian red claw (*Cherax quadricarinatus*) has increased over the past few years and the species is commercially cultured in several countries including China, Mexico and Australia. Currently, production of red claw in the US is small and it is unclear if commercial production of red claw will develop into an industry in the future. The advantages of raising red claw include the following: they consume a prepared diet right after hatching, grow rapidly up to (65-90 g) in a limited growing season (<120 days) in temperate climate ponds and are highly-desired by consumers because of their lobster-like appearance, large size, excellent flavor and good storage quality.

However, raising red claw in the US can be rather costly as a result of a lack of large commercial, domestic hatcheries. There are red claw hatcheries in the US but thy tend to be dedicated to the hobbyist, where red claw are highly-prized in the aquarium industry. Red claw purchased from these suppliers tend to be very expensive ($1-3/individual not including transportation costs), which precludes their purchase by pond producers who need many thousands to stock. Pond producers of red claw, thus, must purchase them from hatcheries in other countries (Australia or Mexico) and costs can range from US$0.50-0.55 per juvenile including transportation costs. Feed costs can represent up to 70 percent of the total operating expenses of an aquaculture enterprise. Thus, recent efforts to determine specific nutrient requirements and evaluate inexpensive practical diets have been devoted to reducing diet costs and, possibly, increasing profits.

Development of a cost-effective and nutritionally-balanced formulated diet is essential, especially for US red claw producers. Protein is generally the most expensive component in a prepared feed for fish or crustaceans. In addition, fishmeal is generally the most desirable animal protein ingredient because of its high protein content and digestibility, excellent source of essential fatty acids and energy and its high palatability. Therefore, in an effort to reduce costs, it would be necessary to either reduce the protein level and/or replace fishmeal with a less expensive protein source.

While information about specific nutritional requirements and practical diet formulations for red claw is increasing, there is no information on the partial or total replacement of fishmeal with other dietary protein levels for red claw grown in ponds. The purpose of the present study was to determine growth, survival, body proximate composition and processing characteristics of red claw fed diets with two different protein levels with or without fishmeal.

Experimental Design

Juvenile red claw (5.75±3.3 g) were obtained from a commercial supplier[2] and stocked into twelve, 0.04-ha ponds at a rate of 1,000 per pond. Groups of 100 live red claw were hand-counted at random until all ponds had been stocked. Three replicate ponds were assigned to one of four practical diets that were formulated to contain two levels of protein (18 percent and 28 percent), with or without menhaden fishmeal (Table 1). Dietary ingredients were processed into 5 mm sinking pellets by a commercial feed mill[3]. Red claw were fed twice daily by distributing pellets over the entire surface area of each pond between 0800 and 0830, and between 1530 and 1600 for 97 days. All red claw were fed the same amount of diet based on age and estimated body weight using a feeding schedule devised by C.D. Webster[4] with survival assumed to be 65 percent. The target harvest weight was 80 g. The amount of diet fed was adjusted every 2 weeks. At the end of the experiment, ponds were completely drained and red claw were manually removed. Red claw were hand-counted, individually weighed and sexed. Twenty males and twenty females from each pond were randomly sampled and chill-killed in an ice bath. Red claw were kept frozen (-15ºC) until analysis. Measurements of claw weight, tail weight, tail muscle weight, and cephalothorax weight were made.

Results

At the conclusion of the feeding trial, the final mean weights of red claw fed Diet 3 (28 percent protein with fishmeal) and Diet 4 (28 percent protein without fishmeal) were significantly higher (58.5 g and 62.4 g) than those of red claw fed Diet 1 (18 percent protein with fishmeal; 51.7 g) and Diet 2 (18 percent protein without fishmeal; 53.0 g). Likewise, red claw fed Diets 3 and 4 had significantly higher weight gain (894 percent and 959 percent) compared to red claw fed Diet 1 (778 percent) and Diet 2 (799 percent) as shown in Figure 1. Specific growth rate (SGR) of red claw

fed Diet 4 was significantly higher (2.43 percent/day) for red claw fed Diets 1 and 2, but not significantly different from that of red claw fed Diet 3 (2.37 percent/day). Feed conversion ratios, survival and total yield did not differ significantly among treatments, averaging 3.55, 65.2 percent, and 724 kg/ha, respectively (Table 2).

Processing traits of male red claw showed that males fed Diet 3 had significantly higher claw weight (17.9 g) than males fed Diet 4 (13.7 g), but did not differ significantly from males fed Diet 1 (16.3 g) and Diet 2 (15.6 g). Male red claw fed Diet 3 also had significantly higher weight of tail (with shell) and tail muscle meat (23.6 g and 16.8 g) compared with male red claw fed Diet 1 (19.6 g and 14.1 g) and Diet 2 (20.6 g and 14.6 g), but not different from male red claw fed Diet 4 (21.9 g and 15.5 g). Male red claw fed Diet 3 also had a significantly higher cephalothorax weight (32.2 g) compared with males fed Diet 1 (27.8 g), but did not differ significantly from males fed the other two diets (Figure 2).

Female red claw fed Diet 3 had significantly higher claw weight (9.7 g) than females fed the other three diets. In weight of tail (with shell), females fed Diet 1 (17.5 g) were significantly lower than those fed Diets 3 and 4 (19.9 and 19.5 g), but not different from female red claw fed Diet 2 (18.4). Female red claw fed Diets 3 and 4 had significantly higher weight of tail muscle meat (13.2 g and 13.1 g) compared to female red claw fed Diets 1 and 2 (11.7 g and 11.8 g). Female red claw fed Diet 3 had significantly higher cephalothorax weight (26.4 g) than females fed Diets 1 and 2, but did not differ significantly from females fed Diet 4 (Figure 3).

Table 1. Ingredient and chemical composition (%) of four practical diets containing two levels of protein with or without fish meal fed to red claw crayfish. Proximate analysis values are means of two replications per diet.

	Diet number			
	1	2	3	4
Menhaden FM[1]	7.3	0.0	11.3	0.0
Soybean meal	0.0	9.5	12.0	35.3
DSG	8.3	18.3	30.0	30.0
Other ingredients	74.4	72.2	47.2	35.2
Chemical analysis				
Moisture	13.7	13.3	13.3	13.9
Protein[3]	17.8	18.3	27.8	32.7
Lipid[3]	9.1	9.2	10.2	10.2
Fiber[3]	5.3	5.2	5.3	3.7
Ash[3]	6.9	5.2	7.4	6.6
NFE[4]	60.9	62.2	49.3	46.8
Available energy[5] (kJ)	16.7	16.7	16.7	17.2

[1]FM= fish meal
[2]DGS = distiller grains with solubles
[3]Dry-matter basis.
[4]NFE= nitrogen-free extract (by difference).
[5]Available energy was calculated as 16.7, 16.7 and 37.7 kJ/g of protein, carbohydrate and lipid, respectively.

Table 2. Means (± S.E.) of specific growth rate (SGR), feed conversion ratio (FCR), percentage survival, and yield of red claw crayfish fed four practical diets containing two levels of protein with our without fish meal. FCR, survival and yield had no significant differences among the diets being fed. Means within a row having different superscripts are significantly different ($P < 0.05$).

	Diets			
	1	2	3	4
SGR (%/day)[1]	2.23±0.08[c]	2.26±0.07[bc]	2.37±0.03[ab]	2.43±0.07[a]
FCR[2]	4.13±0.67	3.48±0.37	3.25±0.27	3.33±0.28
Survival (%)	63.0±8.6	70.1±2.4	66.6±4.6	60.9±2.1
Yield (kg/ha)	645±116	733±65	768±61	748±59

[1]SGR = (%/day)= 100 x [(ln Wt - lnWi)]/day.
[2]FCR= total diet fed (kg)/ total wet weight gain (kg)

Discussion

The results of the present study indicate that red claw grown in ponds can be fed a practical diet in which fishmeal is completely replaced with a combination of plant proteins, such as soybean meal and distillers dried grains with solubles with a protein level of 28 percent. However, when red claw were fed diets containing 18 percent crude protein, even with 7.3 percent FM included, growth was reduced. These data are the first to indicate that the quantity and quality of protein is important for growth of red claw grown in ponds. In a previous study, Thompson *et al.* (2004) reported that growth of pond-cultured red claw was not different when fed diets containing 22 percent, 32 percent or 42 percent protein with a combination of soybean meal and fishmeal.

To test the quality of the protein used in the study, we calculated the essential amino acid index (EAAI) of the four diets by looking at the tail muscle, which has a similar amino acid composition to the whole body. If the protein source is of good quality, then they will have an EAAI value greater than 0.90, while if the protein source is of poor quality it will have an EAAI value lower than 0.70. Calculation of the essential amino acid index on the four

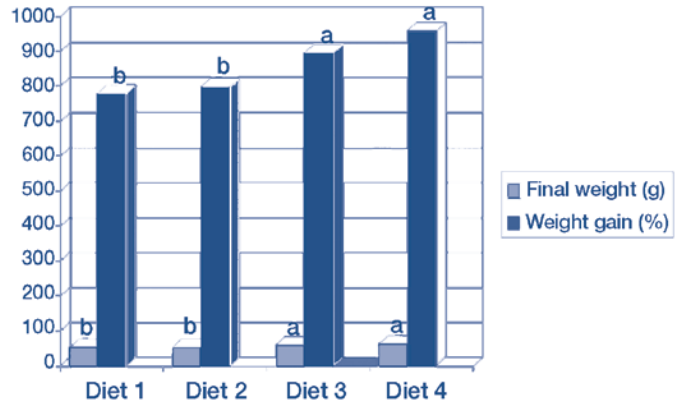

Fig. 1. Final weight (g) and weight gain (%) of red claw fed each of the four treatments. Means with the same letter are not significantly different (P>0.05).

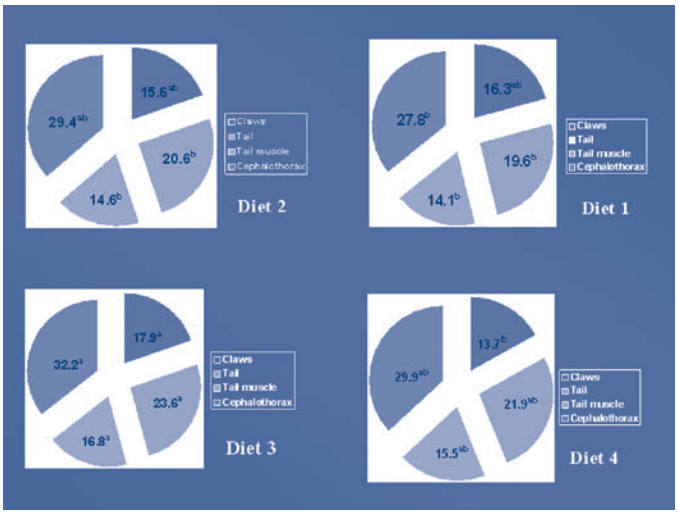

Fig. 2. Processing trait weights (g) of male red claw fed each of the four diets. Means with the same letter are not significantly different (P>0.05).

Fig. 3. Processing trait weights (g) of male red claw fed each of the four diets. Means with the same letter are not significantly different (P>0.05).

diets indicated that Diets 1 Diet 2 (18 percent protein) were deficient in one or more essential amino acids having a EAAI value of 0.72, whereas the 28 percent protein showed to be sufficient in satisfying the essential amino acid requirement of red claw having an EAAI value of 1.15-1.49.

Webster *et al.* (1994) stated that formulation of diets for intensive culture requires an understanding of nutritional requirements and the lack of such information may impede red claw aquaculture in the United States. Thompson *et al.* (2005) stated that in the absence of a commercially available diet formulated specifically for red claw, producers may feed expensive high quality, commercial shrimp diets; a decision that may be a financial and nutritional waste. Another approach would be the use of low-quality diets that do not completely meet the nutrient requirements of the species, but may reduce growth, health and survival.

Processing yield data were evaluated to compare the overall meat yields between male and female crayfish. Data in the present study indicate that males grow larger, have a higher percentage of their body weight comprised of claw (chelae), higher tail (outer shell) weight, and slightly higher tail muscle weight compared to that of females.

In conclusion, the results of the present study indicate that red claw grown in ponds can be fed a diet with 28 percent crude protein with no fishmeal if a combination of plant-protein ingredients is added; however, it appears that 18 percent crude protein with or without fishmeal is not adequate for optimal growth. Reducing protein and fishmeal levels in red claw diets may help reduce operating costs, and, thereby increase producers' profits.

Notes

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[2]Central Queensland Crayfish, Queensland, Australia

[3]Farmers Feed, Lexington, Kentucky

[4]Unpublished data from C. D. Webster, Aquaculture Research Center, Kentucky State University, Frankfort, Kentucky, 40601, USA

References

Thompson, K.R., L.A. Muzinic, L.S. Engler, S. Morton and C.D. Webster. 2004. Effects of feeding practical diets containing various protein levels on growth, survival, body composition, and processing traits of Australian red claw crayfish *Cherax quadricarinatus*, and on pond water quality. Aquaculture Research 35: 659-668.

Thompson, K.R., L.A. Muzinic, L.S. Engler and C.D. Webster. 2005. Evaluation of practical diets containing different protein levels, with or without fish meal, for juvenile Australian red claw crayfish (*Cherax quadricarinatus*). Aquaculture 244: 241-249.

Webster, C.D., L.S.Goodgame-Tiu, J.H. Tidwell and D.B.Rouse. 1994. Evaluation of practical feed formulations with different protein levels for juvenile red claw crayfish, *Cherax quadricarinatus*. Transaction of the Kentucky Academy of Science 55:108-112.