Effects of dietary fiber on net protein retention of the prawn *Macrobrachium rosenbergii* (de Man, 1879).

González-Peña[1], M. del C. and Moreira[1], G. S.

[1]Instituto de Biociências, Departamento de Fisiologia, Universidade de São Paulo - Rua do Matão, travessa 14, no. 321,CEP 05508-900 São Paulo, SP - e.mail: carmen@ib.usp.br (MCGP), gmoreira@usp.br (GSM)

Abstract

Body composition and net protein retention were evaluated in adult freshwater prawns *Macrobrachium rosenbergii* (36.96 g ± 3.47) fed iso-nitrogenous (30% crude protein), iso-lipidic (6 % total lipid) and iso-caloric (4.1 kcal g^{-1} gross energy) test diets containing different a-cellulose levels at 0, 5, 10 and 15 % of inclusion. The feeding trial was conducted in 250-L indoor tanks, with three replicates of 13 prawns each. The prawns were fed to apparent satiation twice daily for 7 days a week over 8 weeks. No significant differences ($P \leq 0.05$) were noted on dry matter, lipid, ash and energy body composition of prawn fed different levels of a-cellulose. However crude protein content on carcass composition increased with supplemental a-cellulose on diet. Net protein retention increases as the level of a-cellulose dietary fiber in the diet increased.

Key words: crude fiber, freshwater prawn, protein retention

Introduction

Food constituents that are not digestible by the endogenous mammalian system have been termed dietary fibers. Complex carbohydrates including hemicellulose, cellulose, pectin and gums, and the polyphenol, lignin, comprise the major portion of this group of compounds. The soluble and insoluble fiber each has distinct chemical characteristics and physiological effects. In general soluble dietary fiber reduces lipid digestion whereas insoluble dietary fiber delays transit in the small intestine.

Alpha-cellulose fiber represents a typical filler material and is generally assumed to be of little or no nutritional value (Austreng, 1978) and is often used as a nutrient substitute in experimental diets. However, little is know of the physiological effects of cellulose in prawns. The possibility of providing cellulose and other fiber components to increase nutrient utilization by increasing dietary bulk has not been extensively studied. It has been shown that addition of vegetal matter to the food improve food conversion efficiency and survival rates of brown shrimp *Penaeus aztecus* (c. f. Venkataramih *et al.*, 1975).

Most farmed crustaceans, including the freshwater prawn *Macrobrachium rosenbergii* (de Man, 1879), have high protein requirements. Accordingly the focus of this study was on the effects of dietary fiber on the net protein retention in adult *M. rosenbergii*.

Material and methods

Adult prawns *M. rosenbergii* (36.96 g ± 3.47) were acclimated to laboratory conditions for 2 weeks at the Marine Biology Center of the University of São Paulo laboratories in São Sebastião, SP, Brazil. The feeding trial was conducted in 12 tanks (250 L each) in a closed recirculating water system with a common reservoir of water with a biofilter to remove impurities and reduce ammonia and nitrite levels. Each dietary treatment had three replicates of 13 prawns each. The tanks were individually aerated and the flow rate in each one was maintained at 9.22 L/ min throughout the experimental period of eight weeks. Temperature, dissolved oxygen and pH levels of the water were kept at 30 C, 8 mg/L and 7.5, respectively. Mean values of total NH_3-N, NO_3-N and NO_2-N were <0.1, 0.2 and 0.1 mg/L, respectively.

Four semi-purified diets were formulated with increasing dietary fiber, as α-cellulose, at levels of 0, 5, 10 and 15%. The composition and the results of proximate analyses of the diets are presented in Table 1. The diets were prepared by thoroughly mixing the dry ingredients with oils and then adding warm water until a smooth consistency resulted. This was then passed through a meat mincer with a 3.0-mm diameter die. The resulting pellets were dried in an electric oven at 60° C for 12 h.

Table 1: Formulations and proximate composition of experimental diets (% dry matter)

	Diet 1	Diet 2	Diet 3	Diet 4
Ingredients				
Casein[1]	30.00	30.00	30.00	30.00
Gelatin[1]	7.40	7.40	7.40	7.40
Starch[1]	48.00	43.00	38.00	33.00
α-cellulose[1]	0.00	5.00	10.00	15.00
Oil mix[2]	6.00	6.00	6.00	6.00
BHT[1,3]	0.01	0.01	0.01	0.01
Betaine-HCl[4]	1.59	1.59	1.59	1.59
$CaHPO_4$	5.00	5.00	5.00	5.00
Premix[5]	2.00	2.00	2.00	2.00
Nutrients				
Dry matter	89.74	93.25	93.22	94.29
Crude protein	28.19	29.75	29.50	31.00
Total lipids	5.26	4.93	5.10	4.48
Carbohydrates	48.89	46.88	43.61	41.47
Ash	7.02	7.54	7.24	6.99
Crude fiber	0.38	4.15	7.77	10.35
Gross energy (cal/g)	4155	4154	4210	3973

[1]Sigma Chemical CO, USA
[2]Oil mix contained a 1:1 ratio of anchovy oil (extracted in the laboratory) to Soya oil
[3]Butylated hydroxytoluene
[4]Merk-Schuchardt, Germany
[5]Vitamin-Mineral premix (kg^{-1}): 1,000,000 I.U. vitamin A; 500 mg vitamin B_1; 1,750 mg vitamin B_2; 1,125 mg vitamin B_6; 3,750 mg vitamin B_{12}; 25,000 mg vitamin C; 500,000 mg vitamin D_3; 20,000 I.U. vitamin E; 500 mg vitamin K; 50 mg biotin; 25 mg Co; 2,000 mg Cu, 13,750 mg Fe; 100 mg I; 3,750 mg Mn; 75 mg Se; 5,000 mg niacin; 5,000 mg pantothenic acid; 250 mg phosphoric acid; 20,000 mg Zn.

Animals were individually weighed and tagged with colored silicon rings on the eyestalk. Growth and survival of individuals was monitored over a period of eight weeks. Prawns were fed ad libitum twice a day, 7 days a week at 07:30 and 15:00 h with a maximum duration of each feeding of 3 hours. The food was weighed before feeding and uneaten food was recovered to determine the precise daily intake, on a dry matter basis. The prawns were weighed biweekly and at the end of the trial they were sacrificed. After individual drying at 105°C for 12 h, the carcasses from each experimental group were analyzed. A group of twelve prawns was killed at the start of the trial and their carcass similarly analyzed to determine net protein retention (NPR).

Net protein retention was calculated as:

(NPR) = 100 [increase in carcass protein (g)/protein fed (g)]

Samples of each diet were analyzed for crude protein, crude lipid (ether extract), crude fiber, total ash and moisture according to the AOAC (1975).

The data obtained were analyzed by single classification analysis of variance following tests for homogeneity of variance with the F-max test. When significant differences ($P \leq 0.05$) were detected by analysis of variance, the Student-Newman-Keuls multiple range test was used for pair-wise comparisons among treatment means.

Results

The results demonstrated that there was no significant difference (ANOVA $P<0.05$) in total dietary and total protein consumption during the eight week experiment (table 2).

However there was significant variation in the net protein retention at different levels of α-cellulose. With no cellulose in the diet the mean net protein retention efficiency was 15 % (Fig 1). When 5 % cellulose was included there was a significant increase in net protein retention, approximately doubling the amount of protein returned. With 10 % cellulose the net protein retention increased to 50 %.

Table 2. Biweekly variation in dietary total protein intake in animals fed diets with variable levels of α-cellulose.

Diet	% α-cellulose	Intake in weeks (g)				Total intake	Protein intake
		1	2	3	4		
1	0	2.16	3.16	3.20	3.56	79.47 ± 8.66	22.4
2	5	2.08	2.81	2.92	2.91	74.45 ± 6.76	22.15
3	10	1.83	2.90	2.90	2.15	64.11 ± 8.50	18.91
4	15	2.49	4.29	4.43	2.72	89.52 ± 14.59	27.75

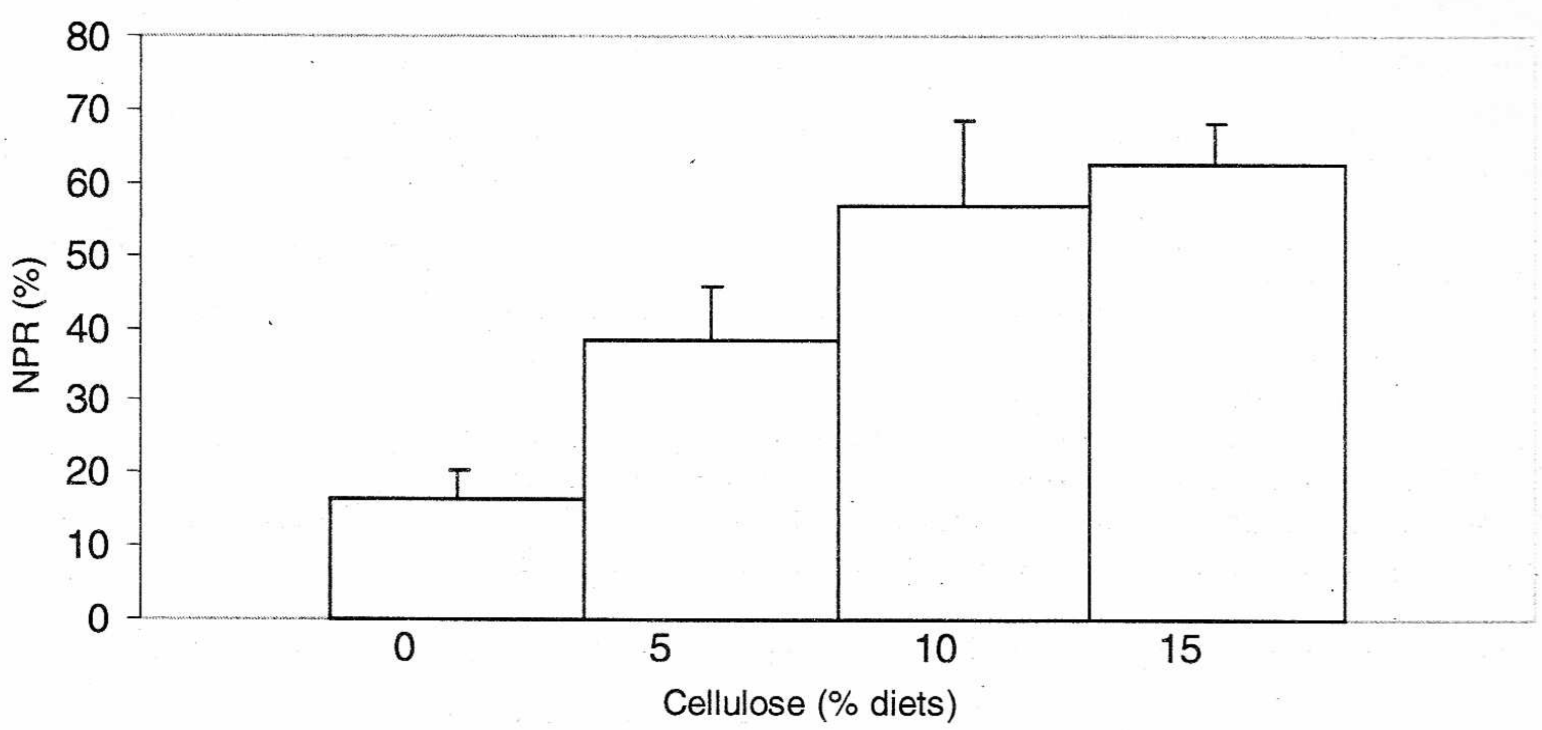

Figure 1: Net protein retention (NPR) of *Macrobrachium rosenbergii* fed diets with different levels of cellulose

Discussion

The results of this experiment clearly demonstrated that the level of α-cellulose included in the diet of adult *M. rosenbergii* influences the efficiency of net protein retention.

Those results support previous observations that dietary fiber can be used to improve protein retention (Nomani *et al.*, 1979; Anderson *et al.*, 1984; Sumagaysay and Chiu-Chern, 1991).

With the diet formulation used in the current study the maximum net protein retention of approximately 50 %, was obtained with 10 % and 15 % of a-cellulose included on the diet.

In future it may be possible to further improve net protein retention. It has been established that the effects of dietary fiber can vary according to the nature of the fiber (eg. lignin content), pH of gut and the length of the digestive tract (Maynard and Loosli, 1980). The low cost of dietary fiber together with the improved retention of protein demonstrated in this study indicate that this will be a productive arena for further research. The results suggest an economical way of increasing *M. rosenbergii* production. Based on the levels of energy and protein of the diet, feeding rate can be manipulated to reach desired energy and protein loads in ponds. Fiber diets can be utilized as an indirect source of energy.

Acknowledgements

The authors are grateful for the financial support of São Paulo State Foundation Research, FAPESP, # 96/07759-5.

References

Anderson, J.; Jackson, A. J.; Matty, A. J. and Capper, B. S. 1984. Effects of dietary carbohydrate and fiber on the tilapia *Oreochromis niloticus* (Linn.). Aquaculture, 37: 303-314.

Association of Official Analytical Chemists (AOAC). 1984. Official Methods of Analysis, 14th edn. AOAC, Arlington, VA.

Austreng, E.; Risa, S.; Edwards, D. J. and Hvidsten, H. 1977. Carbohydrate in rainbow trout diets. II. Influence of carbohydrate levels on chemical composition and feed utilization of fish from different families. Aquaculture, 11: 39-50.

Maynard, A. L.; Loosli, J. K.; Hintz, H. F. and Warner, R. G. 1980. Animal nutrition. McGraw-Hill, Inc., New York. 602 p.

Nomani, M. Z. A.; Fashandi, E. F.; Davis, G. K. and Bradac, C. J. 1979. Influence of dietary fiber on the growth and protein metabolism of the rat. Journal of Food Science, 44: 745-748.

Sumagaysay, N. S. and Chiu-Chern, Y. N. 1991. Effects of fiber in supplemental feeds on milkfish (*Chanos chanos* Forskal) production in brackish water ponds. Asian Fisheries Science, 4: 189-199.

Venkataramiah, A.; Lakshmi, G. J. and Gunther, G. 1975. Effect of protein level and vegetal matter on growth and food conversion efficiency of brown shrimp. Aquaculture, 6: 115-125.

Received em: 15th / 12 / 2000
Approved em: 15th / 12 / 2001