Journal of Coastal Development ISSN: 1410-5217
Volume 5, Number 1, October 2001 : 13-19 Accredited: 69/Dikti/Kep/2000

DIETARY PRACTICAL INGREDIENTS WITH EMPHASIS ON PROTEIN SOURCES FOR PENAEID SHRIMP

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Received August 10, 2001; accepted August 30, 2001

ABSTRACT

Studies on the utilization of dietary practical ingredients, in particular protein sources, by penaeid shrimp juveniles were reviewed in this paper. It has been proved by a number of researchers in shrimp nutrition that diets containing a mixture of two or more protein sources are better utilized by shrimp than those containing single protein sources. In general, evaluation of the nutritive value of a feed ingredient for growth is based on both the quantity and the quality of the protein in the ingredient. The amino acid composition and the relative proportions of other dietary nutrients are mostly relevant to the efficiency of protein assimilation by penaeids. Based on the essential amino acid index (EAAI) used to screen some potential protein sources for penaeid shrimp, there were found that fish meal, shrimp meal, squid meal and soybean meal were good dietary potential protein sources with EAAIs between 0.87-0.98.

Key words: Penaeid shrimp, protein, dietary

INTRODUCTION

Experimental diets for penaeid shrimp are numerous. They include purified, semi-purified and practical diets and may be designed for larvae, postlarvae or juveniles (Akiyama, 1991). Purified diets refer to diets, which include a source of purified protein such as casein, gelatin and albumin alone or in combination. Practical diets are usually based on less refined protein sources, which are available for use in commercial diets. Commercial diets are diets processed in a factory and sold to farmers. In the previous section, some nutritional requirement studies of penaeids have been discussed. This section focuses on studies of the utilization of practical dietary ingredients, in particularly protein sources, by penaeid shrimp juveniles.

The Quality of Dietary Protein

The growth of shrimp is affected not only by the quantity of the dietary protein but also by the quality of the protein (Smith *et al.*, 1985). Diets containing a mixture of two or more protein sources are better utilized by shrimp than those containing a single protein source (Colvin, 1976; Alava and Lim, 1983; Rajyalakshmi *et al.*, 1986; Shiau *et al.*, 1991; Sudaryono *et al.*, 1995; Millamena and Trino, 1997). Sedgwick (1979) found that the optimal utilization of protein by *P. merguiensis* was closely related to the energetic value of the diet and that carbohydrate and lipid can also increase growth efficiency at sub-optimal levels of protein. The efficiency of protein assimilation by penaeids is also likely to be affected by the relative proportions of

ISSN: 1410-5217
Accredited: 69/Dikti/Kep/2000

lipids and carbohydrates in the formulation as well as by the amino acid composition of whatever protein source is employed (Hanson and Goodwin, 1977).

The best protein sources for decapod crustaceans are those amino acid (AA) profile most closely mimic the decapod's protein AA profile (Deshimaru and Shigueno, 1972; Wilson and Poe, 1985; Aquacop and Cuzon, 1989; Kanazawa, 1990; Lim and Persyn, 1989; Sarac *et al.*, 1993). Since proteins constitute the largest chemical group within the decapod body, the nutritive value of a protein ingredient will be determined to a large extent by its amino acid composition, and in particular by the availability and profile of the essential amino acids (EAA) present. Deshimaru and Shigueno (1972) in their study on the artificial diets for *Penaeus japonicus* found that an inferior feed efficiency occurred when the diets were deficient in the essential amino acids, arginine, histidine, and lysine. Akiyama *et al.* (1992) stated that in making practical diet formulations for shrimp, one consideration is to provide enough of the dietary lysine, methionine, threonine and arginine, which are the most critical essential amino acids. In another trial, Deshimaru *et al.* (1985) reported that *P. monodon* fed diets with high percentages of all essential amino acids and high ratios of methionine and arginine to total essential amino acids, showed better growth, feed efficiency and survival. Lan and Pan (1993) added that the protein digestibility of diet increased when the amount of basic essential amino acids (arginine and lysine) and aromatic amino acid (phenylalanine) in the total essential amino acid composition of the diet increased. Akiyama *et al.* (1992) suggested that to maintain an optimum growth of shrimp, the dietary lysine: arginine ratio should be at 1:1.0 to 1:1.1. This is needed to avoid depressed growth due to a dietary lysine-arginine antagonism relationship.

Studies on Potential Protein Sources

Many workers incorporate squid meal as a dietary protein for shrimp. Squid meal is believed to be a good protein source in the diet and gives a significantly better growth for *P. indicus* (Bose, 1988), *P. japonicus* (Deshimaru and Shigueno, 1972), *P. monodon* (Lim *et al.*, 1979; Rajyalakshmi *et al.*, 1986; Cruz-Ricque *et al.*, 1987; Cruz-Suarez *et al.*, 1992), *P. setiferus* and *P. stylirostris* (Fenucci *et al.*, 1980) than other protein sources (concentrated soluble fish protein, fish meal, mysid meal, shrimp meal, soybean meal). Lim *et al.* (1979), using *P. monodon* post-larvae, also reported that squid meal and shrimp meal appeared to be good protein sources. Combinations of various dietary protein sources for *P. monodon* have also been tested. Pascual (1989) found a combination of 35% defatted soybean meal and 16% peruvian fish meal (40% protein) to give the best yield. Rajyalakshmi *et al.* (1986) reported that best performance was given by feeds with a combination of soybean and squid meals. Penaflorida (1989) screened some potential protein sources for *P. monodon* feeds using the essential amino acid index (EAAI) calculated by comparing the ratio of EAAs in individual feedstuffs with that of whole *P. monodon* juvenile. The results showed that fishmeals, white and peruvian fishmeals, shrimp meal, squid meal, and soybean meal (EAAI of 0.92–0.95, 0.96, 0.94, 0.98, 0.96, and 0.87, respectively) were found to be good potential protein sources.

In growth experiments with various penaeid species, shrimp meal or shrimp waste meal also proved to be a good protein source (Chen *et al.*, 1986; Liang *et al.*, 1986; Godfred *et al.*, 1991; Hartnoll and Salama, 1992; Holland and Borski, 1993; Fox *et al.*, 1994). However, physical properties of shrimp meal with its high fibre content have resulted in a limitation of its use in shrimp diet. Increasing the dietary shrimp meal inclusion levels had a negative effect on nutrient digestibility (Ali, 1992) and water stability (Akiyama *et al.*, 1992; Fox *et al.*, 1994) but a positive effect on palatability (Hartnoll and Salama, 1992; Fox *et al.*, 1994). Akiyama *et al.* (1992) suggested that dietary shrimp meal inclusion levels should not exceed 15%; normally shrimp meal is incorporated in shrimp diets with a range of 5–15%. Superiority of the mollusk meals, scallop meal as a protein source for the growth of juvenile *P. monodon* (Sudaryono *et al.*, 1995) and mussel extract (Murai *et al.*, 1985) have been reported. Hutabarat *et al.* (1995) found that the addition of a local material of kingworms (*Eisenia foetida*) in diets increased the growth of *P. monodon*.

Plant vs Animal Protein Sources

The use of soybean meal as a partial or complete alternative protein source for fish meal, shrimp meal, squid meal or a combination of two or more marine animal protein ingredients for various species of penaeid shrimp has been evaluated in several studies (Forster and Beard, 1973; Sick and Andrews, 1973; Colvin and Brand, 1977; Fenucci *et al.*, 1980; Lawrence *et al.*, 1986; Akiyama, 1989; Akiyama and FSGP, 1989; Lim and Dominy, 1990). Many of the reported results are contradictory. This may reflect differences in species and size of shrimp, diet composition, quality of the test ingredients, feeding management and culture conditions. Generally, however, high inclusion levels of dietary soybean meal or complete substitution of animal proteins resulted in poor growth and feed efficiency. Increasing the inclusion levels of dietary soybean meal over 42% was Reported to have an adverse effect on pellet water stability and palatability (Lim and Dominy, 1990). Akiyama (1991) reviewed the utilization of soybean meal by marine shrimp and concluded that soybean meal was a highly digestible source of protein. Brunson *et al.* (1997) found that plant protein supplements (soybean meal and cottonseed meal) were digested as efficiently as, or better than, proteins of animal origin (squid liver powder, menhaden fishmeal, shrimp meal and crab meal) by *P. setiferus*. Eusebio (1991) reported that *P. monodon* seemed to utilize the dehulled leguminous seeds (cowpea and rice bean) as protein sources more efficiently than the whole seeds.

GENERAL CONCLUSIONS

Although EAAI of the ingredients is a useful tool for predicting protein quality it does not mean that the individual amino acids present are biologically available and can be completely utilized by shrimp. To determine the biological availability of the amino acids, *in vitro* and/or *in vivo* digestibility measurements of ingredients are required (Akiyama *et al.*, 1989; Eid and Matty, 1989; Lan and Pan, 1993; Reigh *et al.*, 1990). The most common method used by researchers for estimating the nutrient digestibility of individual feedstuffs has been to evaluate a standard reference diet in which the test ingredient is incorporated at a single fixed level of 30% (Cho *et al.*, 1985; Akiyama *et al.*, 1989; Reigh *et al.*, 1990; Brunson *et al.*, 1997). Variations of nutrient digestibility value have been reported to attribute to differences in dietary protein source, ingredient dietary inclusion level, ingredient particle size, feed preparation method, and feeding regime (Forster and Gabbot, 1971; Akiyama and Dominy, 1991; Palaniswamy and Ali, 1991).

ACKNOWLEDGEMENTS

Thanks to Prof. L.H. Evans and Dr. E. Tsvetnenko from Aquatic Science Research Unit, Curtin University of Technology, Australia for their valuable review and suggestions of this manuscript.

Special thanks to anonymous reviewers for their revision on this manuscript.

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