The potential use of palm kernel meal in aquaculture feeds

Wing-Keong Ng, PhD

Fish Nutrition Laboratory, School of Biological Sciences, Universiti Sains Malaysia, Penang 11800, Malaysia.

Aquaculture is currently the fastest growing animal production sector in the world. The rapid expansion of the aquaculture industry is most pronounced in Asia, which contributes about 90% of the total global aquaculture production (by weight). This increase in aquaculture production must be supported by a corresponding increase in the production of formulated diets for the cultured aquatic animals. For most aquaculture systems, the cost of feed constitutes 30 to 60% of the operational costs of the farm, with protein being the most expensive dietary component. Even though fishmeal continues to be used as a major source of dietary protein in commercial aquafeeds, its escalating cost has stimulated much research into the use of alternative plant protein sources. Among the plant proteins tested, soybean meal has enjoyed the most commercial success. Nevertheless, soybeans are not grown in tropical countries and soybean meal has to be imported.

In recent years, the cost of imported feed ingredients used in commercial aquafeeds in many developing countries in Asia has continued to rise due to increased global demand and because of foreign currency exchange fluctuations. The rising costs of imported ingredients such as fish meal, soybean meal, corn flour and wheat flour greatly cuts into the profit margins of local fish farmers to such an extent that many local aquaculture enterprises are no longer profitable. This is especially true for the culture of lower-value fish species such as catfish, tilapia and carps. There is currently great interest within the animal feed industry to reduce costs by using locally available feed ingredients.

Palm kernel meal

Palm kernel meal (PKM) is a by-product of palm kernel oil extraction from the nut of the palm tree, Elaeis guineensis. The global production of PKM is ever increasing due to the tremendous growth of the oil palm industry in many parts of Asia and Africa. In Malaysia alone, about 3 million tons of palm kernels were harvested in 2001 producing about 1.4 million tons of palm kernel oil together with 1.6 million tons of PKM as its by-product. Currently, most of the PKM produced in Malaysia is exported at a low price to Europe for use as cattle feed concentrates in dairy cows to increase milk fat. PKM is an established feed ingredient for ruminants, supplying valuable dietary sources of protein, energy and fiber. PKM has also been successfully tested in poultry and swine feeds at low levels of incorporation. The low cost and availability of PKM in many tropical countries where aquaculture is practiced have recently generated much interest in its potential use in fish diets.

Challenges in the use of PKM in fish diets

As with most plant-based and oilseed meal ingredients, several factors can limit the incorporation of PKM into fish diets. These include (1) relatively low protein content, (2) possible amino acid deficiencies, and (3) presence of antinutritional factors. The Fish Nutrition Laboratory at Universiti Sains Malaysia has initiated a series of experiments to attempt to enhance the nutritive value of PKM by dealing with each of these three major challenges so that higher levels of PKM can be incorporated into fish feeds.

Increasing protein content of PKM

One way to increase the protein content of PKM is by the process of solid state fermentation with fungus. We have screened about one hundred isolates of microorganisms obtained from soil samples for the optimal formation of fungal biomass and protein content when cultured using PKM as the substrate. A fungus, which was later identified to be *Trichoderma koningii*, was selected as a potential

Center: Palm kernels before oil extraction which gives palm kernel meal as a by-product. Photo courtesy of S.L. Lim.

Figure 1 and 2 (above/below). Palm oil fruit bunches are harvested from oil palm trees, Elaeis guineensis. *Photo courtesy of MPOB.*

microorganism. This process almost doubled the protein content of raw PKM, from about 17% to 32% crude protein. Since *T. koningii* is a cellulolytic fungus, the reducing sugar content of the fermented PKM was also higher compared to raw PKM. However, when the fermented biomass was incorporated into tilapia diets, a marked reduction in fish growth was observed. We believe that despite the higher protein and digestibility of the fermented PKM, mycotoxins might have been released during the fermentation process. Further studies are being planned to use mycotoxin adsorbers to alleviate these problems in the use of fermented PKM.

Another way to increase the protein content of PKM is to extract the protein using chemical and physical processes. Isolating proteins from PKM will essentially eliminate the problems of low nutrient digestibilities. Despite the high costs of such processes, we are currently conducting some initial studies to see if the protein isolate is of high enough nutritive value for high value marine fish.

Amino acid supplementation

Some studies have reported that amino acid supplementation can improve the growth of fish fed plant-based diets. PKM is low in sulfur amino acids and probably lysine, which are essential amino acids necessary for optimal fish growth. A feeding trial conducted with hybrid catfish showed that up to 20% raw PKM could be incorporated into

catfish diets without any negative effects on growth performance. However, at 40% PKM, growth was significantly depressed and this was not alleviated with the addition of 1.2% dietary L-methionine. One possible reason could be that methionine may not be the first limiting essential amino acid in the PKM-based diets. Further studies involving the use of other essential amino acid and combinations thereof are currently being planned.

Utilization of feed enzymes

The low digestibility of PKM is commonly attributed to the high levels of non-starch polysaccharides (NSP) found in the cell wall materials. These anti-nutritional factors impair the digestibility and utilization of nutrients present in PKM either by direct encapsulation of the nutrients or by increasing the viscosity of the intestinal content thereby reducing the rate of hydrolysis and absorption of nutrients in the diet. The use of proteolytic, fibrolytic or carbohydrate-degrading enzymes to PKM-based diets have great potential in releasing unavailable nutrients and energy.

Studies have shown that tilapia fed PKM pretreated with commercial feed enzymes consistently show better growth and feed utilization efficiency compared to fish fed similar levels of raw

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PKM. Up to 30% enzyme-treated PKM could be incorporated into red tilapia diets without significantly depressing growth (Ng et al., unpublished data). However, direct inclusion of exogenous enzymes in diets for tilapia have so far not been successful. Research is currently being carried out in our laboratory to further optimize the use of feed enzymes in PKM-based diets, varying parameters such as the type, levels and application method (direct, pretreatment, post-extrusion coating).

Conclusion

Initial studies on the use of PKM in tilapia and catfish diets have generated encouraging results with fish growing well on dietary levels as high as 20%. Studies with grass carp were even more encouraging in terms of higher levels of raw PKM being used in their diets (Ng and Teoh, unpublished data). It is anticipated that with further research on enhancing the nutritive value of PKM, this low cost locally available oilseed meal can be used as a viable partial substitute for many of the imported feed ingredients resulting in savings in feed costs for the local fish farmers.

Culture of sandfish

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Without these facilities many animals were kept in tanks at high density (where they grew only slowly), long past the time when they were ready for transfer.

The area of bare tanks for first nursery needs to be about 15-30 times the area of the hatchery. The area for nursery in tanks with sand and ponds has to be 10-20 times bigger again, depending on the size of juveniles required. A basic hatchery and fairly simple culturing methods should be able to produce enough seed for at least pilot-scale commercial aquaculture and/or restocking trials as long as there is sufficient tank and pond space for the nursery stages.

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