Utilization of Palm Kernel Cake (PKC) in Aquaculture

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INTRODUCTION

China's feed industry has developed rapidly during the last few years with the demand increasing every year. The demand for fishmeal, the main source of animal protein, is increasing and the supply will not be able to meet the demand in the future. The search for new feed sources becomes important in view of the diminishing resources and concerns over environment protection. Feed manufacturers are also looking at ways to reduce the cost of feed production. Vegetable proteins that are economical and readily available will be used for replacing fishmeal. These include soyabean and corn meals.

Palm kernel cake (PKC) may be considered as an energy feedstuff because of its high oil content. Currently, the world production of fishmeal, which is the main source of protein and makes up 30%-50% in most commercial feed formulations, is unable to meet the demand. Thus, PKC can be used for replacing partially soyabean meal, corn flour, bran or fishmeal in feed (Ng, 2004).

Nitrogen and phosphorus are the two pollutants in the aquatic environment. Fishmeal contains 40%-72.0% protein and 1.67%-4.21% phosphorus while soyabean meal contains 44.8%-50.0% crude protein and only 0.6%-0.7% phosphorus. PKC has 15%-18% crude protein and about 0.41% phosphorus (Ng and Chong, 2002; Wan Zahari and Alimon, 2004). The partial replacement of fishmeal and soyabean meal with vegetable protein will thus not only reduce the amount of phosphorus released into the ecosystem but also lower the cost of feeds.

There is also concern over the food safety of genetically modified (GM) products in aquafeed. GM soyabean and corn were developed to enhance their resistance to weeds and diseases, and the European market remains skeptical about the safety of GM foods, such as salmons produced by using partial gene-modified elements. The question remains: will GM soyabean and GM corn influence human health and product quality, and will the modified DNA be transferred into the products? Soyabean meal, fishmeal, corn flour, rapeseed meal and cottonseed meal are all important ingredients in feeds, but they may be derived from GM materials. On the other hand, PKC is GM-free.

In China, the demand for fishmeal and soyabean meal exceeds the supply. In 2005, China produced 360 000 t of fishmeal and 25.6 million tonnes of soyabean meal, while it imported 1.6 million tonnes of fishmeal and 203 000 t of soyabean meal. In 2007, fishmeal production decreased to 290 000 t while soyabean meal production increased to 28.5 million tonnes. Fishmeal and soyabean meal imports in 2007 decreased to 984 000 and 105 000 t, respectively (Oil World, 2008).

In China, the prices of fishmeal, soyabean meal, corn flour, rapeseed meal, cottonseed meal and PKC in November 2008 were RMB 6300, 3100, 1400, 2000, 1700 and 1200 t^{-1}, respectively.

The main objective of introducing PKC into fish feed formulations is to reduce the cost of the feed without affecting the growth and quality of the fish, and also reduce water pollution by phosphorus at the same time.

MATERIALS AND METHODS

A laboratory feeding experiment on *Tilapia nilotica* was carried out at Ocean University of China, Qingdao, Shandong Province. Tilapia fry were purchased from a supplier. The average weight of the

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fry was about 2.5 g each (*Figures 1, 2, 3* and *4*). PKC was imported from Malaysia, while commercial feed meal and veterinary drugs for the tilapia were purchased from the market.

Four dietary treatments were tested:

A: feed meal with no PKC (control);

B: feed meal containing 2% PKC;

C: feed meal containing 6% PKC; and

D: feed meal containing 10% PKC.

Composition of feed meal was fish meal 15%, soyabean meal 30%, bran 25%, flour 15%, corn 10% additive 5%.

The experimental conditions were as follows:

- fifty fingerlings were stocked per aquarium, and the experiments were done in duplicates;
- the dissolved oxygen content in the water was >6 mg litre^{-1};
- one-fifth of the water in each aquarium was changed 30 min after each feeding;
- the water temperature was >20°C;
- pH was 7.0-7.5; and
- NH_3-N was ≤0.1 mg litre^{-1}.

The fry was fed to satiation twice daily at 08:00 and 16:00 until no residual feed was left in the aquarium. The feed used was 2 mm sink pellets, and the amount used per day was about 5% of the body weight of the fry during the whole period. The feeding trial was conducted over 12 weeks. The fish was batch-weighed once every two weeks.

At the end of the feeding period, three batches of 240 fish samples each were collected.

Figure 1. Tilapia fry (2nd week).

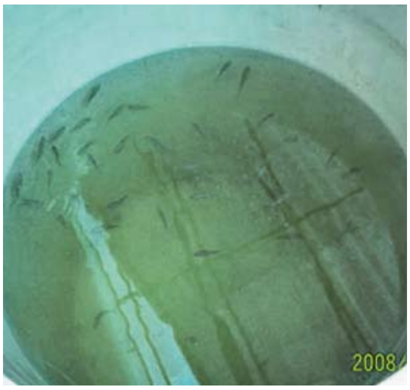

Figure 2. Tilapia fry in aquarium (2nd week).

Figure 3. Tilapia fry (10th week).

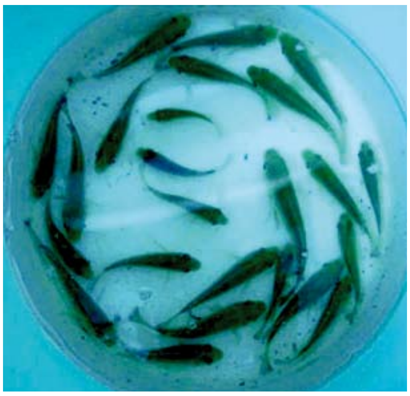

Figure 4. Tilapia fry in aquarium (10th week).

Batches, each comprising 10 fish samples from each aquarium, were collected and weighed. Of these, five were dissected (*Figures 5* and *6*). Stomachs, livers, intestines and bodies were collected and kept frozen at -70°C. They were analysed for their enzyme activity, which included amylase, lipase, protease, and cellulase. The remaining five were kept frozen at -70°C, and the bodies were analysed for the protein, fat, dry matter and ash contents.

Five fish samples were collected from each aquarium and the blood of 40 fish samples phlebotomized (*Figures 7* and *8*). The blood samples were sent to the affiliated hospital of Qingdao University for the analyses of protein, urea nitrogen, blood sugar, total bilirubin, *etc.*

The toxicity of PKC was also evaluated in another experiment on tilapia. In this experiment, 30 fish were selected from the surplus fish in the aquariums, and were divided into three groups of 10 each. They were fed with feeds containing 0%, 50% and 100% PKC, respectively. The toxicity of PKC was evaluated on the basis of the death rate recorded for each group. The experiment was carried out for three weeks.

RESULTS AND DISCUSSION

The results showed that the rate of weight gain (*Table 1*) of the fish fed on feed containing 2% PKC was higher than that of the control, while those fed with feeds containing 6% and 10% PKC showed lower growth rate compared to the control.

Results of the analysis of the blood serum of tilapia (*Table 2* and *Figure 9*) showed that the contents of total protein and urea nitrogen were reduced and that the blood

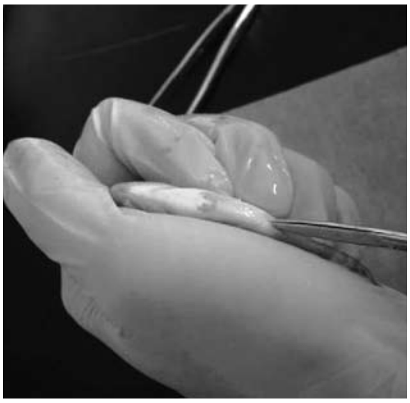

Figure 5. Dissected fish.

Figure 7. Tilapia fish blood samples.

Figure 6. Tilapia fish viscera.

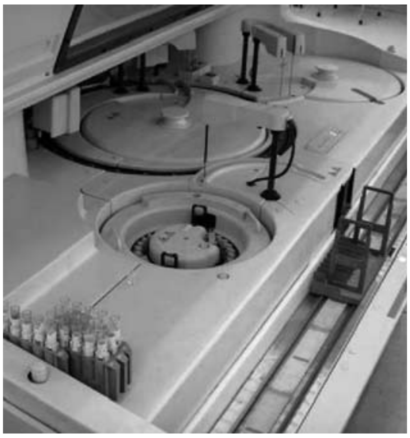

Figure 8. Analysis of blood.

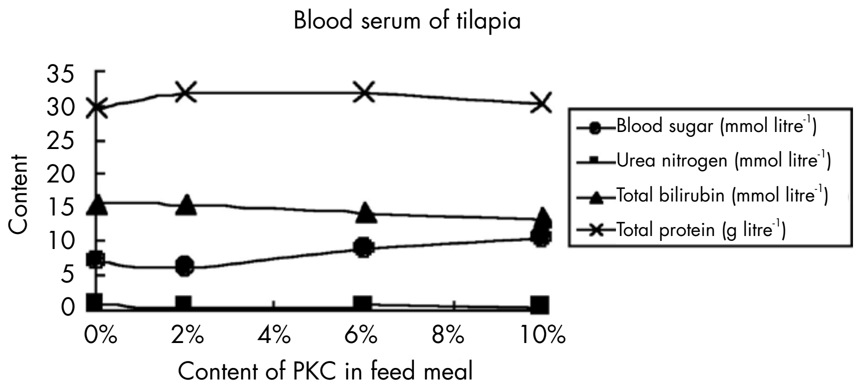

Figure 9. Analysis of blood serum of tilapia.

sugar content rose from Groups A to D. The low protein content in PKC resulted in a reduction in total protein and nitrogen in urea from Groups A to D, while the high fibre content gave rise to an increase in the blood sugar content.

In medical terms, total bilirubin is indicative of the function of the liver. If the total bilirubin content is high, the function of liver is abnormal. The blood serum analysis showed that the total bilirubin was reduced from Groups A to D following the increasing ratio of PKC in the feed.

The results of the experiment on the toxicity of PKC showed that no fish died in the three-week study period, and that all were active. This indicates that PKC is non-toxic to

TABLE 1. AVERAGE WEIGHT OF TILAPIA FISH DURING THE FEEDING EXPERIMENT*

Group	Content of PKC in feeding pellets (%)	Average weight (g)					Growth rate (%/8 weeks)
		1st (after 2 weeks)	2nd (after 4 weeks)	3rd (after 6 weeks)	4th (after 8 weeks)	5th (after 10 weeks)	
A1	0%	2.54	2.99	3.53	4.43	6.72	164.6
A2	0%	2.49	3.02	3.63	4.74	7.31	193.6
B1	2%	2.70	3.27	3.95	5.23	7.60	181.5
B2	2%	2.66	3.23	3.92	5.49	7.91	197.0
C1	6%	2.61	3.27	3.73	4.55	6.60	152.9
C2	6%	2.72	3.23	3.52	4.67	6.59	142.3
D1	10%	2.60	2.89	3.39	4.28	6.34	143.9
D2	10%	2.89	3.28	3.84	4.58	6.21	114.9

Note: *The project is still on-going, the statistical analysis will be carried out after the completion of the project.

TABLE 2. ANALYSIS OF BLOOD SERUM OF TILAPIA*

Group	Total protein (g litre^{-1})	Total bilirubin (mmol litre^{-1})	Urea nitrogen (mmol litre^{-1})	Blood sugar (mmol litre^{-1})
A	29.93	15.75	0.83	7.26
B	32.04	15.58	0.61	6.36
C	31.99	14.51	0.53	9.07
D	30.49	13.61	0.37	10.70

Note: *The project is still on-going, the statistical analysis will be carried out after the completion of the project.

the tilapia fish and thus, considered suitable as a feed for tilapia.

CONCLUSION

Results from this research show that feeds with 2% PKC are non-toxic and suitable for feeding tilapia fish although the inclusion of PKC can change the contents of some components in the blood of the fish, including blood sugar, total protein, nitrogen of urea and total bilirubin. PKC can partially replace soyabean meal or fish meal for feeding tilapia, and has a good potential as an ingredient in fish feeds in China.

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