

DEVELOPMENT OF FISHMEAL PRODUCTION FROM CATFISH PROCESSING WASTE

Charun Likitrattanaporn

Department of Agro-Industry Technology, Faculty of Agricultural Technology, Rajamangala University of
Technology, Thanyaburi (RMUTT), Thailand

ABSTRACT: Thailand is ranked among the top nations in the world for marine culture and freshwater aquaculture. Artificially propagation of the hybrid catfish *Clarias gariepinus* x *C. macrocephalus* started commercially in 1984 and has expanded throughout the country. Catfish processing as dried fish, pickled fish and fish sausage is an important farming industry providing income and boosting the local economy. Most of the processing waste is used as organic fertilizer. However there is a more valued use in the by-product as fishmeal. A simple fishmeal application process was developed from catfish processing waste (CPW). Both steaming and boiling cooking method were examined before pressing and drying processes. The composition of the fishmeal regarding protein, fat, ash and moisture content was evaluated. The results showed that both cooking processes, boiling and streaming, produced a feed with similar overall qualities. However boiling required less energy than streaming. All fishmeal samples had protein content of lower than 36%, and a fat content of about 15%. This preliminary investigation indicated that CPW was a suitable by-product for use as fishmeal.

Keywords: Catfish, Fishmeal processing, Catfish processing waste

1. INTRODUCTION

Catfish farming in Thailand has increased dramatically after the widespread cultivation of hybrid fish reaching 137,000 tons in 2012. [1] Most of the catfish are sold in domestic markets. The artificially propagated hybrid catfish (*Clarias gariepinus* x *Clarias macrocephalus*) is easier and quicker to raise than *Clarias macrocephalus* and initially, commanded better prices than the more widely cultured *C. batrachus*. However, soaring production and slow market growth have reduced profit margins. Fish farmers have adapted by reducing feed costs and increasing unit sizes.

Since the 1960s marine trash fish have been used as feed for catfish culture, although floating pellet feeds were always available. [2] Trash fish has been a popular feeds for catfish culture since 1993 [3]. Later chicken processing wastes, principally heads, intestines, and leg bones became popular catfish feed.

Catfish feed is the major cost for Thai fish farmers who often use either chicken manure or pig manure as the alternative feed in order to reduce the cost. Customers are disgusted to consume the catfish. This affects the catfish market share of freshwater fish production. Moreover, the bird flu epidemic in 2003 had a negative effect on integrated catfish farming. Protein from fishmeal is commonly used as a major ingredient in the composition and nutrient content in catfish feeds.[4] Catfish feed and feeding practices must be economical to maximize profits for the local farmers.

The catfish market value is increased by

processing it as dried fish, pickled fish, and fish sausage. These can double the price of the commodity. Catfish processing waste comprising fish heads, guts and skin is used as organic fertilizer this does not earn any direct income for the fish farmers. Over 50% of the total catfish weight is lost as waste product. In the marine processing industry this waste is transformed to fishmeal and fish oil. Farmers earn money from the by-product as an alternative protein source for cattle and poultry.

Fishmeal processing follows six steps: cooking, pressing, separating, evaporation, drying and grinding. When the fish is heated the protein present in its coagulate and ruptures the fat deposits. The cooked fish is then pressed to remove the large amounts of liquid from the raw materials. The liquid is collected and fish oil is separated from the water. The water also known as stick water is then evaporated to produce the thick syrup containing 30-40% solids. Finally, the pressed fish cake is dried to obtain a stable meal. This meal is then ground to the desired particle size. [4]

Self-sufficient economy for catfish production farming can be applied to develop feeds and feed practice value through processing and marketing. This can be done by developing catfish processing waste to produce fishmeal.

2. MATERIALS AND METHOD

2.1 Catfish Processing Waste (CPW)

The CPW used in this study was collected from

the community enterprise namely “Bueng-Kham-Proi Catfish Processing Centre”, Thanyaburi, PathumThani Province, Thailand. Normally a small size of 200-300 gram of catfish was selected as shown in Fig 1 and the final product dried catfish as shown in Fig 2. The community produces 300 kg of draw catfish twice a week which yields around 40% of CPW, mostly as fish heads and guts shown in Fig 3. The CPW was collected and cooled before being transported to the laboratory for the experiment.



Fig. 1 The selected catfish 200-300g each



Fig. 2 The dried catfish



Fig. 3 The catfish processing waste (CPW)

2.2 Fishmeal Processing Design

Fishmeal processing was done in six steps: cooking, pressing, separating, evaporating, drying, and grinding. The three outputs from these processes are fishmeal, fish oil, and protein syrup. [5]

Fig. 4 shows the individual steps in the industrial fishmeal processing method which is commonly used for marine by-products, especially in the processing of tuna waste that contains valuable fish oil and protein extracts. Freshwater fish contain different fish oils which are used for

other purposes. In this study waste processing focused on fishmeal to add value, and develop catfish feed. A fishmeal production process for sustainable agriculture requires a simple process design with cheap, available equipment and with low energy requirements.

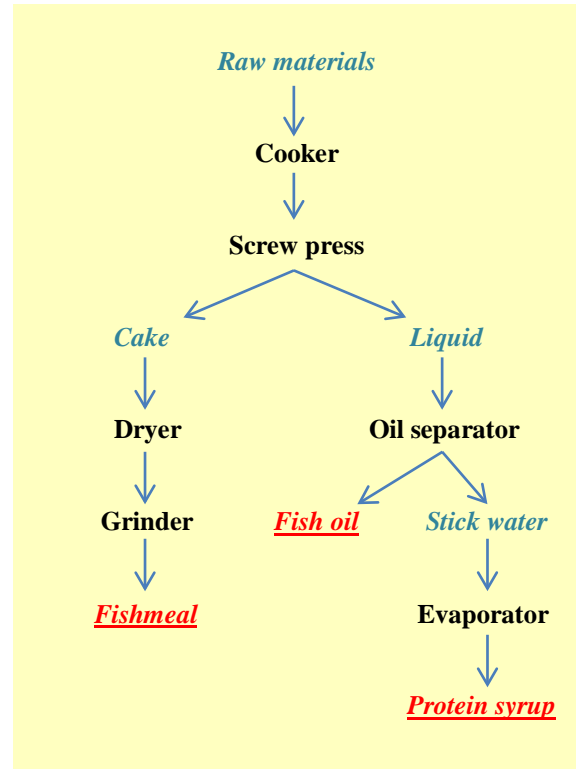


Fig.4 The fishmeal processing flow diagram (Zhoushan Xinzhou Fishmeal Equipment Factory)

The CPW was processed by using various methods to produce fishmeal. The processed fishmeal had 30% fat content mixed with hard skull material. The catfish head is the largest part of the fish, and the CPW was chopped and squeezed before drying.

Fishmeal production consisted of five processes which began with cooking. Water and oil were then squeezed from the cooked waste. The cake was milled into small pellets which are 6mm. cylindrical shape dried, and then ground.

2.2.1 Cooking process

The cooking process was the first step to stop enzymes and microorganisms in the waste and to prevent deterioration and spoilage. Both boiling and steaming methods were used in this study. Production of fishmeal from the aquatic processing waste must consider pathogen transfer which causes disease and contamination [6]. The cooking process for CPW required heating to 100°C for 30 minutes. Equal weights of CPW and water were boiled for 30 minutes with occasional stirring. The

CPW was then leached and cooled before milling. For the steaming process, CPW was placed in a basket and steamed at atmosphere pressure for 1 hour, before cooling to room temperature and milling.

2.2.2 Squashing process

A simple manual squashing process was used (Fig. 5). Cooked CPW was added to the perforated column. The handle was then turned clockwise to move the compression plate downwards to compress the CPW and release the water and oil through the holes in the perforated column.



Fig. 5 The manual compressing equipment

2.2.3 Milling process

The milling equipment used for cutting the CPW into small particles as shown in Fig. 6. Squashed CPW was fed continuously into the feed tube and pushed through the holes in the plate. The CPW was then cut into small pieces as a wet cake and then dried.



Fig. 6 The milling equipment

2.2.4 Drying process

Drying was performed using two methods. Sun drying was applied in order to save power and also a tray dryer was operated at 60°C. The small pellets were dried under sun shine for 5 days. The moisture content of fishmeal was occasionally determined by infrared moisture balance during drying and the desired moisture content should be below 10%.

2.3 Experimental Design

The experimental design of this research is shown in Fig. 7.

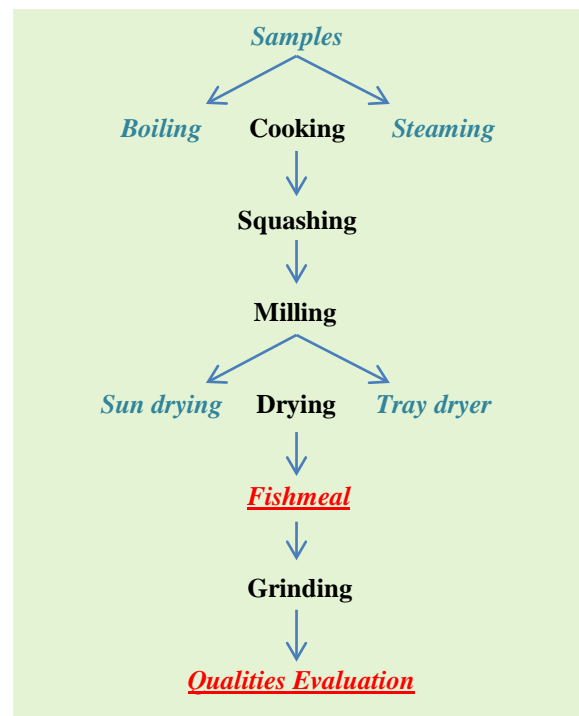


Fig.7 The Experimental design diagram

CPW samples were cooked by two different methods; boiling and steaming. After cooking the samples were cooled to room temperature and then milled using meat grinding equipment. The samples were sun dried or dried in trays until the moisture content (MC) was below 10%. The dried fishmeal was then ground before content evaluation of protein, fat, ash, moisture, and calcium. Three replications were performed and the average values were compared and analyzed.

3. RESULTS

3.1 Fishmeal Processing Design

Fishmeal production for farmers and community entrepreneurs followed a simple process requiring boiling process or steaming

process. The CPW was cooked to sterilize it before milling and drying. CPW contains large quantities of oil and water. This must be removed before milling and drying. The cooking process did not use specialized equipment. Cooking time required was 30 min for the boiling method, and 1 hour for steaming. Both the boiling and steaming methods involved hot materials so careful handling was necessary.

The cooked CPW was squashed using manual compressing equipment to remove the water and oil. The boiled CPW looked more rotten than the steamed CPW possibly due to stirring during cooking (Figs. 7 and 8).

Compressed CPW, which may be called a half dried CPW has nearly 30% of moisture removal including fish oil. However, the manual compressing equipment needs man power which is hard to control force steadily. Oil content will affect its quality and power consumption of the drying process.

Drying of CPW under control drying temperature at 60°C can be sure that heat will not affect to protein content and other vitamins. So both sun drying and tray drying at low temperature will be the same in term of quality but only the drying time and power consumption will be different. Tray drying took 72 hours to dry the CPW to 10%MC compared to the sun drying which took 5 days for about 15%MC.

The fishmeal processing from CPW could be developed in simple process which consists of 5 continuous processes; first cooking, then squashing and follow with milling and finally drying. The coarse fishmeal gains from this process and must be ground again before being used as a feed.



Fig. 8 Dried CPW fishmeal after the boiling process

3.2 Qualities evaluation

The dried fishmeal was ground before qualities evaluation such as protein content, fat content, ash, moisture content and calcium content were taken. The results of the fishmeal qualities evaluation from different fishmeal processes are shown in Table 1.



Fig. 9 Dried CPW fishmeal after the steaming process

Table 1. Fishmeal quality evaluation

Content (%)	Boiling	Steaming
Protein content %	35.68±1.71 ^a	35.91±1.22 ^a
Fat %	15.14±2.24 ^a	14.69±2.53 ^a
Ash %	38.15±0.87 ^a	37.90±1.08 ^a
%MC	8.09±1.52 ^b	6.19±1.33 ^a
Calcium %	12.78±2.63 ^a	15.25±2.17 ^b

Remark: The same letter shows no significant difference

The fishmeal qualities from boiling and steaming show a non-significant difference for the three major qualities; protein content, fat content and ash. The protein content gains about 36% which slightly below the commercial fishmeal class III (at above 40%) in both samples. While fat content is quite high, compared to the commercial fishmeal in which the screw compressor or screw expeller is used. The manual cylinder compressor may not be met the same level of compression which is a mechanical force. The commercial screw expeller could separate over 50% of the stick water. The moisture removal commonly causes low fat content be below 3%. To improve this matter the screw compressor should be used instead of the manual cylinder compressor. The percentage of ash is shown as very high at above 37% in both samples. This may be from soil and clay in the gut. Normally, Catfish live and eat on the river bed. A good fishmeal should control the low level ash as much as possible, so the CPW in this process should separate head and gut in order to decrease the ash.

For the moisture content in this experiment, the CPW fishmeal shows slightly low percentage of moisture content of below 10% which is too low for commercial purpose. This occurs only if the tray dryer is used. For sun drying the CPW fishmeal will dry to 15% in 5 days and shorter if solar dryer is applied.

The calcium content from this experiment shows a slightly high level at 12.78 and 15.25% for boiling and steaming respectively. Normally calcium is needed for all formula feeds at about 1-3%. In this case the exceed calcium may cause some problems to animals. If it is used it can be

applied for specific formula feed which need high calcium.

Overall qualities of CPW fishmeal both from the boiling process and steaming process are not significantly difference. The CPW fishmeal can be used as the Catfish feeds by mixing other materials based on catfish feeds formula requirement.

3.3 Adoption on Feeds Processing

From this experiment the CPW fishmeal shows nutrition value at a certain level which can be used as the nutrient composition for catfish feeds. Normally the catfish feeds need protein content above 50% and low calcium content under 15%. Therefore, other protein sources should be added with the CPW fishmeal so as to control the limitation of calcium content.

There are some difficulties on the drying process and limitation of using the meat grinder for milling process. Adoption of catfish feeds processing should be applied by mixing the cooked CPW and other compositions such as rice bran, fine corn etc. Then the ingredients will be mixed feeds. They will be milled by the meat grinder or pellet maker, and then be dried as catfish feeds.

4. CONCLUSION

The fishmeal processing is designed for sustainable agriculture and can be simply adopted in 5 steps. First, the CPW is cooked by boiling or steaming, then the cooked CPW is pressed or squashed so water and oil comes out. After that the CPW cake is milled into small pellets and then dried. The dried CPW pellets are ground into fine particle which is fishmeal. However, the CPW fishmeal quality may not meet the standard of fishmeal class III, but it can be adopted to be as feeds for any other animals especially for high Calcium formula feeds.

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Corresponding Author: Charun Likitrattanaporn
