

A SURVEY OF UTILIZING BY-PRODUCTS FROM TRA CATFISH PROCESSING INDUSTRY IN VIETNAM

KHẢO SÁT VIỆC TẬN DỤNG PHỤ PHẨM CÔNG NGHIỆP CHẾ BIẾN CÁ TRA Ở VIỆT NAM

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ABSTRACT

*This article aims to provide some information from a survey carried out by the Research Center for Aquafeed Nutrition and Fishery Post-Harvest Technology (APOTEC) on the current status of post-harvest practices for by-product utilization from Tra catfish (*Pangasius hypophthalmus*) processing industry in Vietnam. A large number of seafood factories in the Mekong Delta were investigated to collect necessary information and evaluate the efficiency of using the Tra catfish by-products on both economical and environmental aspects. Apart from information collected from interviews, chemical analysis on composition of the Tra catfish by-products was also conducted for more understanding about this potential resource of seafood industry. Our investigation has identified three main problems relating to economical, technical and environmental aspects that the processors have to cope with when utilizing by-products from Tra catfish processing. For the purpose of increasing the efficiency of by-products utilization and minimizing the environmental impacts, some recommendations have been proposed including change in perception, improvement in the way of pre-treatment and collection, more investment in R&D activities and collaboration between research organizations and processors in solutions of the problems.*

Keywords: *Tra catfish; by-product; waste; processing; utilization.*

TÓM TẮT

*Bài báo nhằm cung cấp thông tin từ một nghiên cứu của Trung tâm nghiên cứu Công nghệ Thức ăn và sau thu hoạch Thủy sản (APOTEC) liên quan khảo sát hiện trạng tận dụng phụ phẩm công nghiệp chế biến cá Tra (*Pangasius hypophthalmus*) tại Việt nam. Việc khảo sát được thực hiện tại nhiều nhà máy chế biến cá Tra ở đồng bằng Sông Cửu Long nhằm thu thập các thông tin cần thiết và đánh giá hiệu quả việc tận dụng phụ phẩm cá Tra trên quan điểm cả về kinh tế lẫn môi trường. Cùng với thông tin từ phỏng vấn các đối tượng liên quan, các mẫu phụ liệu cá Tra cũng đã được phân tích thành phần nhằm tìm hiểu kỹ hơn tiềm năng nguồn phụ phế liệu của nghề chế biến cá Tra. Khảo sát của chúng tôi cho thấy có ba vấn đề lớn liên quan tới các khía cạnh kinh tế, kỹ thuật và môi trường mà các nhà chế biến gặp phải khi tận dụng phụ phẩm từ chế biến cá Tra. Từ đó nhóm nghiên cứu đã đề xuất một số giải pháp nhằm nâng cao hiệu quả việc tận dụng phụ phẩm cùng với giảm thiểu tác động lên môi trường. Các giải pháp bao gồm thay đổi nhận thức, cải thiện phương pháp sơ chế và thu gom, đầu tư hơn nữa vào nghiên cứu phát triển và hợp tác chặt chẽ giữa các cơ quan nghiên cứu*

và các cơ sở sản xuất trong việc giải quyết các vấn đề liên quan tới xử lý phụ phế liệu chế biến cá Tra.

Từ khóa: Cá Tra; phụ; phế liệu; chế biến; tận dụng.

1. INTRODUCTION

Catfish aquaculture in Vietnam is a traditional livelihood of farmers in the Mekong Delta - Vietnam. However it has been significantly contributing into the development of Vietnam since 1990's when artificial breeding of the major species of *Pangasius* (*P. bocourti* and *P. hypophthalmus*), namely basa and tra, was achieved and successfully applied in the region. Since then the area for Tra catfish farming has been remarkably expanding from nearly 500 hectares to around 6,000 hectares, mainly in the Mekong Delta. According to VASEP (Vietnam Association of Seafood Exporters and Producers), the production of Tra catfish in Vietnam is estimated around 1.2 to 1.3 million tons annually in recent years. Most of the catfish (80%) are processed in the form of fillet for export and the value of which is more than 2 billion USD per year for the country.

However, the fillets occupy only 30 – 34 % in the proportion of the whole catfish. With the production of more than one million tons, Tra catfish processing industry in Mekong Delta annually creates hundreds of thousand tons of by-products and wastes. The residues comprises many parts of the fish including heads, scales, fins, guts, entrails, flesh residues, fat, liver and blood ..., which need to be handled in good manners for both economical purpose and environmental protection [1, 2].

Research Center for Aquafeed Nutrition and Fishery Post-Harvest Technology - RIA2 has a mandate to study and apply post-harvest and processing technology in fisheries. In 2016, the Center has been carrying out an investigation on the matters involving

utilization of by-products and wastes in Tra catfish processing industry.

The main objectives of the study are to:

- Evaluate the quantities and values of by products from Tra catfish processors in the Mekong Delta.
- Identify the problems in the treatment of the by-products and wastes in Tra catfish processing industry.
- Propose relevant solutions to enhance the added values and efficient utilization of by-products and reduce the environmental pollution in the region.

2. LITERATURE REVIEW

According to K. Jayathilakan et al. (2012) [3], efficient utilization of by-products has direct impact on the economy and environmental pollution of the country. Non-utilization or under utilization of by-products not only lead to loss of potential revenues but also lead to the added and increasing cost of disposal of these products. Non-utilization of fish by-products may results in major aesthetic and catastrophic health problems. The utilization and disposal of fish wastes is difficult, due to its inadequate biological stability, potentially pathogenic nature, high water content, potential for rapid auto oxidation and high level of enzymatic activity.

On the other hand, fish by-products and wastes are very rich source of nutrients such as minerals, proteins and fat that can be utilised to produce a large number of useful products. In many cases, fish processing wastes have been considered as a potential source for recycling or conversion into useful

products. Fish by-products and wastes can be utilized in various fields including fish meal, protein concentrate for livestock and aquatic animal, functional & nutraceutical foods, fish oil, chitosan & collagen, biodiesel/biogas, and natural pigments.

Among those converted from Tra by-products & wastes, the biggest portion and most important is fish meal for animal feed. A study conducted by Tuan T.T. (2010) [4] on evaluation of Tra catfish residue meals as protein sources for pigs reported that broken meat (BM) and bone & head by-products (BH) from Tra catfish can be well digested by pigs which are the most popular animal being farmed in Vietnam. However, there is a negative relationship between crude fat content in the by-product and its digestibility. This can be explained that microbes use lipids to synthesize membranes and release high amounts of fecal endogenous material, and therefore digestibility is reduced. Thus, it is recommended that fat should be separated from by-products before being treated for Tra catfish BH meal (Thuy N.T. et al., 2010) [5].

In a survey conducted by Thuy N.T. et al. (2007) [6] at 3 catfish processors in Mekong Delta, Tra catfish by-products were mainly converted into fish meal (wet or dry), only 5% used for human consumption. In practice, there are generally three kinds of Tra catfish fish meal produced from different parts: Bone and head meal (HM), catfish meat meal (broken meat BM) and the meal from waste water (WM) production. Some data from this research shows the chemical composition of the three categories of catfish by-product meal in the Table 4. As shown the Table, it is obvious that the quality of fish meal depends on fractions of the by-products. BM has highest protein content, while the lowest belongs to WM which is mainly used by local farmers directly for growing pigs.

Another potential for re-utilization of the fish by-products is functional food. Functional foods are considered as the special foods which are intended to be consumed as part of the normal diet and provide specific health benefit which is beyond its normal nutritive values (Bah Piyon Tan, 2008) [1]. The functional foods include those derived from the by-products such as peptides, mineral, collagen, amino-acids... Apart from using in food, they are widely applied in cosmetics and medicine industry. The global functional foods sectors are tremendously growing all over the world, now become a multi-billion dollar industry with its value expected around \$167 billion USD in 2010. The United States currently possesses the largest and most rapidly expanding functional food and nutraceutical market in the world (World Nutraceutical, 2006). The fastest growing category in the US at present is sport nutrition, which consist mainly sport drink containing vitamin, minerals, protein amino acids, electrolytes or nucleic acids.

K. Jayathilakan et al. (2012) [3] applied enzymatic treatment to produce protein hydrolysate from fish waste. This product could be used as a cryoprotectant to suppress the denaturation of proteins in surimi during frozen storage. Using similar method, Ghaly, A. E. et al. (2013) [2] reported that collagen or keratin in fish waste may be converted to useful products, providing new physiologically functional food materials or raw materials for production of protein hydrolysates and peptides which can be used as food ingredients. Ghaly, A. E. et al. (2013) [2] conducted a research on using auto-hydrolysis of waste fish viscera to produce peptone hydrolysates which is used as a key component in micro - biological media to support growth of acetic acid bacteria in bacteriocin production.

Thuy N.T. et al (2010) [5] studied on fermentation characteristics of catfish by-products (ensiled with rice bran (RB) or sugarcane molasses (SM) in different ratios) and the digestibility of the silages in growing pigs. The results suggested that catfish by-product can be successfully ensiled with 20-40% of sugarcane molasses and 30-40% of rice bran (fresh and dry weights, respectively). The total tract apparent digestibility of crude protein and ether extract in ensiled catfish by-product was comparable to that of fish meal.

Minh N. P. (2014) [7] investigated the hydrolysis of *Pangasius hypophthalmus* by-product for fish oil production and its stability during preservation. The results indicated that lipid content in Tra catfish by-product was determined as 7.34% and lipid recovery was 67.83%. The fish oil extracted from hydrolyzed by-products contains 99.58% lipid; 0.35% moisture and 1 meq/kg peroxide index. Tra catfish oil contains essential fatty acids, especially DHA and EPA content in total fat of whole body of Tra catfish was characterised in (0.68-0.79%) and (2.15-2.64%), respectively (Nguyen and Anh, 2013) [8]. Temperature and vitamin ratio (especially vitamin E) significantly affect to the fish oil stability against hydrolyzation and oxidation during preservation. Those effects should be considered as disadvantages of the by-product when processed and preserved because it need low temperature (less than 4 °C) and vitamin added [9-10].

Recently, Thao N.T.H. et al. (2016) [10] studied for isolation and purifying peptide from Tra catfish by-products. Data from this project shows that Tra catfish by-products can be used to produce high quality calcium binding peptide. It is considered as an excellent functional product for solution of calcium deficiency in human body.

Although a large number of studies have been conducted on Tra catfish in general and its by-products in particular, for the purpose of practical application there are many problems need to be solved, such as economical feasibility, further provision stability and environmental effects of Tra catfish by-products treatment. This survey aims to provide some more data to support a solution for the problems, [9-10].

3. MATERIALS AND METHODS

For objective 1: Evaluating the quantities and values of by-products from Tra catfish processors in the Mekong Delta.

A survey was conducted from April to June 2016 for general information of the ratio between different fractions of Tra catfish by-products and the popular practices of reutilizing by-products and wastes from five typical seafood processors in the region (Agifish, Vinh Hoan, Nam Viet, Afiex, Hung Vuong). The collected information includes different kinds and qualities of the by-products were processed and the practical technologies were applied for catfish by-product processing;

At the same time, by-product samples were collected for analysis to determine their valuable components and the capability of conversion into commercial value-added products using assay procedures. Samples of by-products from each processors were analyzed for DM, CP (using Kjeldahl method with N conversion of 6.25), ether extract (EE), nitrogen free extract (NFE), ash, calcium and phosphorus by standard of AOAC methods (AOAC 1990). Method of Spackman et al (1958) was used for amino acid analysis, fatty acid content was determined using gas chromatography (ISO/CD 5509:94).

For objective 2: Identifying the problems arising in utilization of the by-products and treatment of wastes from Tra fish processing.

To identify the problems, a survey was carried out using the method of direct in-place interview. Senior officials at the five companies were interviewed using a semi-structured questionnaire, to determine the main problems and potentials for catfish by-product production. Basing on the information from the interviews and the data from analysis of the samples, the major problems were figured out to indicate what the processors were coping with during utilizing Tra by-products.

For objective 3: Proposing the solutions to improve the technology for efficiency of the by-products and wastes utilization and reduction of the environmental pollution in the region.

The solutions were proposed basing on the data from the chemical analysis, the information from interviews combined with various literature references. The solutions should be practical, feasible and suitable for the local communities.

4 RESULTS AND DISCUSSIONS

4.1 Tra catfish by-product and its composition

The whole body of Tra catfish collected from processors were anatomised and weighed to get information of fractional composition. The results are shown in Table 1.

The results have an agreement with the data from other references in fillet percentage that occupies a third of the total fish body weight. However, there is a lack of published data for comparison of other sections. Therefore, the data in Table 1 & 2 is useful for further research to develop new products from parts of the fish.

Similarly, data in Table 2 shows that head is the biggest section (32%), and smallest ones belong to skin, fins, broken meet, bladder, stomach and liver, each occupies only around 2% - 3% of the total weight of the by-products.

Chemical analysis results in Table 5 indicated that among by-products, head and fins have similar composition that richest in protein and calcium, while belly fat is highest only in lipid but lowest in the other nutrients. Therefore, it is favorable to separate belly fat (including free fat) from the byproducts before processing into fish meal or other protein products. It can be clearly seen in the Table 3, the by-products without belly fat content 14% protein compared to the content 10% in the one included belly fat.

Except belly fat, all other parts contain high content of ash, which means they are a rich source of essential minerals, particular Calcium and Phosphorus. Although occupying small portion of the residues, fins and skin contain quite high content of protein, mainly in form of collagen that is the important material to produce functional foods and cosmetics.

Table 1. Anatomical composition of Tra catfish

Body parts	Percentage (mean %)	SDV ±
Fillet (%)	35.4	1.51
Skin (%)	1.6	0.17
Head (%)	20.8	0.71
Bone, fins, tail (%)	17.9	0.58
Broken meat (%)	1.7	0.37
Belly fat (%)	8.1	0.55
Free fat (%)	3.1	0.08
Liver (%)	1.8	0.19
Stomach (%)	1.8	0.56
Bladder (%)	1.4	0.09
Gut (%)	6.1	1.17

After Tra catfish filleted, the remain is referred as a mixed by-product. In practice, it is quite difficult to separate every organs apart completely. For fish meal production, only belly and free fat need to be removed in order to avoid rancidness from oxidation and improve product quality. It can be seen in Table 3, even though belly fat removed, lipid content is still as high as 20% in the by-product of Tra catfish. To prevent the negative problems occurring during fish meal processing and preservation, it's necessary to decrease lipid content in the by-products as low as possible.

Table 2. Fractional composition of by-products from Tra catfish

By-product parts	Percentage (mean %)	STD ±
Skin	2.4	0.36
Head	32.4	1.55
Bone	21.4	0.86
Fins	2.1	0.27
Tails	4.4	0.47
Broken meat	2.6	0.69
Belly fat	12.6	0.82
Free fat	4.9	1.82
Liver	2.8	0.30
Stomach (%)	2.7	0.89

Table 3. Chemical composition (%) of mixed by-products from Tra catfish.

Parameter	Types of by-products	
	belly fat	No belly fat
Moisture (%)	49.7 ±1.19	58.6 ±0.97
Protein (%)	10.3 ±0.80	14.3 ±0.15
Lipid (%)	31.7 ±1.48	20.3 ±1.74
Ash (%)	7.4 ±0.37	6.4 ±0.50
TVB-N (mg/100g)	11.0 ±0.56	11.4 ±0.82
pH	6.9 ±0.08	7.0 ±0.07

4.2 Problem arising in treatment of the by-products and wastes

Basing on the information collected from interview activities, on-site investigation and data of analysis, there are some problems were recognized when the by-products are utilized. Those can be classified into 3 groups, namely economical, technical and environmental problems.

4.2.1 Economic problems

Almost of by-products from Tra catfish processing industry are nowadays used to produce fish meal. Basing on the mixed by-products, this fish meal is generally considered lower in quality compared to those produced from marine fish. In consequence, price of the fish meal have to compete with other protein sources (marine fish meal, extracted soy meal).

In the past, according to Thuy N.T. (2007) [6] the fish meal from Tra by-products could not compete with the other protein sources. Thus, processors tend to utilize the by-products in the form of wet fish meal (semi-processed), that is difficult for preservation and may lead to environmental problems.

However, this situation has recently changed, since price of imported protein sources for animal has been relentlessly increasing, Tra by-product meal currently turn to be an important source of dried fish meal, especially in pigs growing. However, the revenue from this business seems not to be sustainable, and much smaller than the economic potential benefit from value added products.

4.2.2 Technical problems

For value added production, it's necessary to separate the individual parts of the by-products that need much higher cost of

labour or need high technology for the separation and equipment for further processing. Today, almost processors are gradually aware the potential source of by-products from Tra fish processing industry. However, processors are still reluctant to invest in this area due to the risks from the fluctuation in raw materials on both quality and quantity aspects, and the instability of the market for the final products.

4.2.3 Environmental problems

Even though utilization of the fish by-products is a good solution for environment protection, the utilizing process itself may cause some other pollution, such as creation of bad odour and dust, over-use of chemicals in processing.

4.3 Proposals to enhance efficiency of by-products utilization

4.3.1 Change in general perception

Obviously, by-products from Tra catfish processing industry are the high potential resources for the national economy. Therefore, there should be a good policy from the government to incentivize and promote processors to invest more in reutilization of the by-products or recycling of wastes, such as a tax reduction policy for advanced technology application and value added products made in this area.

4.3.2 Better practices in pre-treatment and collection of the by-products

From the survey over many fish processing factories, it could be seen a lack of proper manner in the treatment of the by-products. Fish residues were often left for a long time at normal temperature before cold preserved. The raw materials were rarely to be separated into individual parts that lead to cross contamination (Trung L.Đ. 2006) [9]. If

a good practice is applied, the quality of the by-products must be higher and more suitable for further high added value production. In addition, there should be well organized system for collection of the by-products from many small processors.

4.3.3 Investment in R&D activities for utilization of the by-products:

As mention above, for added value production, it requires application of high technology that need to invest more capital and human resources for R&D activities. Another way seems to be more simple that is import high-tech equipment from developed countries. However there are some risks in this way, such as different conditions between Vietnam and the export countries, lack of human resource qualified enough for proper operation and maintenance the import equipment. In any way, investment in human resources and R&D is the smart and sustainable strategy for the industry.

4.3.4 More collaboration between research organizations and processors

The importance of this collaboration has been known for long time. In practice, however, there is a large gap still available between the scientific community and the business. A large number of research papers in this domain have been published but not many of them are practically applied because of various reasons. To bridge the gap, therefore, some appropriate measures to connect scientists and processors should be proposed, e.g. incentive policy for the R&D investment in the processing industry.

5 CONCLUSION

From the results of this survey and other published references, by-products from Tra catfish processing industry are great source of nutrients that could be converted into various

types of value – added products, such as foods, medicines or cosmetics. However, in Vietnam almost all by-products are being used to produce fish meal for livestock feed. It is necessary to invest in further research and development to increase the proportion of the value-added products in this area.

Some proposals as solutions to enhance efficiency in utilization of the by-products including changing social perception on by-products so that a helpful policy and regulations can be applied to incentivize R&D

activities and value-added production from the by-products. Using better practices in pre-treatment and collection, closer link between research organisations and processors are also good suggestions to deal with the problems.

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Table 4. *Chemical composition (% in DM) of Group 1, 2, 3.*

Item	Group 1 (HM)			Group 2 (BM)			Group 3 (WM)		
	1	2	3	1	2	3	1	2	3
Dry matter	78.7	82.9	91.4	94.9	93.1	90.3	87.7	80.7	87.8
Ash	17.3	25.3	33.8	3.5	9.7	12.2	20.0	15.4	23.5
Crude protein	37.8	37.7	37.1	57.3	61.7	45.8	13.5	26.0	27.1
Ether extract	15.7	15.8	12.8	31.7	18.7	30.3	6.3	9.1	10.8
Crude fibre	0.17	1.10	1.34	1.9	0.9	1.3	10.7	4.0	4.8
Calcium	8.31	7.75	13.2	7.5	6.8	5.2	7.9	4.8	7.8
Phosphorus	2.10	2.40	3.10	0.7	0.9	0.8	0.5	2.1	2.2
Nitrogen-free extract	28.9	20.1	14.9	5.7	9.1	10.3	49.5	45.5	33.8
Drying method*	M	S	S	M	M	M	S	S	S

By machine (M) or sunlight (S) (head and bone meal HM), Group 2 (broken meat BM) and Group 3 (waste water & waste matter meal WM) by-product meals from different factories (1-3)

Table 5. *Chemical composition (% DM) of by-products from Tra catfish*

By-product Parts	Protein	Lipid	Ash	Calcium	Phosphorus
Head	29.88 ±3.04	47.39 ±1.53	17.73 ± 4.86	3.96 ±0.33	2.83 ±0.70
Belly fat	16.92 ±4.27	82.30 ±7.60	0.49 ± 0.03	0.50 ±0.01	0.19 ±0.04
Bone	25.02 ±1.13	42.91 ±4.80	19.88 ± 3.29	3.47 ±0.14	2.51 ±0.38
Fins	36.80 ±0.47	39.44 ±0.44	16.00 ± 3.73	5.58 ±1.19	2.63 ±0.52
Tails	23.05 ±5.12	53.83 ±3.34	16.17 ± 0.94	3.59 ±0.17	2.26 ±0.06

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