Identifying the nutritional composition of fish waste, bones, scales, and fins

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Abstract. Extraction valuable products from fish waste such as protein, lipid has gained more research attention around the worldwide. In this study, a fish waste was subjected to approximate analysis to determine the nutritional composition includes protein, lipid, and carbohydrates as well as moisture and ash content. The fish waste included scales, fins, and bones isolated from *Cyprinus carpio* fish samples. The fish samples were divided into three samples groups and named G1, G2, and G3. The results showed high protein content in fish waste and the highest value 27.3% found in bones (G3). The highest value of lipid content also was recorded in bones 7%. The higher moisture content was detected in scales parts 73% accompanied with a significant difference (P-value <0.05) in the scales moisture contents among the three fish waste groups. In addition the results revealed that the protein and lipid content increased with increasing weight and size of fish. In general, this study presents a high nutritional value of fish waste, providing another a viable source for sustainable food industry.

Keywords: Fish waste, Nutritional Composition, Protein, Lipid,

1. Introduction
Worldwide interest in the sustainable production of pharmaceutical and nutraceutical products has increased for many reasons in recent decades. The global population growth and global climate change and dramatic rises in food prices have caused worldwide concern about environmental issues and global food security [1-3]. Fish is healthy food and has high nutritional value which makes it extremely important for human chain food. Annually, massive quantities of fish waste are produced during fish processing, and usually fish wastes are discarded [4]. Due to the growth of world population that led to increase in demand and production of fish, it is expected that the volume of fish processing by-products will increase. The use of renewable natural products such as fish wastes in the production of pharmaceutical, and nutraceutical products is considered a first step towards ‘greening’ the life cycle of chemical products in the areas of environmental protection and sustainability [5, 6]. Thus, enhancement the management of fish by-products is urgently required to provide feasible routs for value-added ingredients production. For all these reasons, one of the most current challenges of the food industry is the improvement of the yield and/or the potential of fish processing by-products [7]. By the same token, determining the nutritional content of the fish wastes could be the first step to handle these challenges.

Generally, whole fish contains about 70 to 80% water, 20 to 30% protein and 2 to 12% lipid [8]. The quality and characteristics of fish products are highly various dependent on the processing methods and the potential content of the raw materials [9,10]. Fish processing for various products is accompanied with a large amount of byproduct and bout 45% of fish is discarded. The discarded wastes include fish heads, bones, fins, scales and etc [11]. However, these byproducts have a nutritional composition. From this viewpoint, it is expected that the utilization of these wastes and processing these materials for useful products such will also reduce environmental pollution [12-16]. Generally, nutritional value of aquatic by-products and is scientific documentation is hot research area due to the lack of available information [17].
Thus the proximate analysis is the first step for effective fish waste processing and optimum utilization. It is enable food industry developers to identify the potential of fish processing by-product so be used as nutraceutical or functional ingredients for human consumption and to utilize fish wastes rather discarding these materials. In general, the nutritional composition of fish includes moisture, ash, fat, protein and carbohydrate contents [4]. Therefore, this study aims to identify the nutritional components including the protein, lipid, and carbohydrates content of some byproduct parts of fish processing, these parts are scales, fins, and bones.

2. Materials and methods

2.1 Materials

In the present study, for identifying the nutritional composition of fish waste, these waste comprised of scales and fins, and bones of *Cyprinus carpio* fish. Three groups of this type of fish were collected from Euphrates River by local fishers. Each group included 20 fish samples. These groups were divided based on their weight and named: G1 (300–400.03 g), G2 (310–498 g) and G3 (601–800 g). The average weights and lengths of the three *C.carpio* groups were shown in Table 1. The fish were transported to the ecological research laboratory under chilled conditions and stored at −20°C. The bones, scales, and fins were isolated and collected in petri dishes. Then these materials were dried in oven at 80 °C until reaching a constant weight. The dried materials were separated sieving after drying and grinding into small size for the chemical characterization.

| Groups | Weight (gm) | Length(cm) |
|--------|-------------|------------|
| G1     | 300.2±1.04  | 33.4±0.55  |
| G2     | 416.5±1.23  | 39.8±0.69  |
| G3     | 701.6± 2.05 | 44.6± 0.99 |

2.2 Proximate analysis

The proximate analysis to determine the potential nutritional values of discarded fish parts, these parts included the bones, the scales and the fines. The moisture, protein, lipid, ash, and carbohydrates content of all fish waste groups were measured following the methods that was described in the Association of Official Analytical Chemists (1990) [18]or protein and moisture content determination by the Kjeldahl method (AOA955.04) and the moisture content was assayed by oven drying at 105°C (AOAC 1990-19).

2.3 Statistical analysis

All data were studied with one-way analysis of variance (ANOVA) was performed to determine the differences between two treatments. The significance of differences was defined at (P-value < 0.05) using SPSS Statistical program software (version 7). Data was analyzed using the statistical analysis system, SAS - 2004.

3. Results and Discussion

Fish waste included scales, fines, and bones which normally discarded are subjected to the approximate analysis. The aim of this analysis is to identify the potential of nutritional component including protein, lipid, and carbohydate content, as well as moisture and ash content. In point of view of food industry developer these parts is very important to develop further fish waste processing and recycle these parts as a viable source for food and pharmaceutical industries. The results of the proximate analysis of scales are tabulated and in Table 2.The results illustrated that the higher moisture content of *C. carpio groups was 73.4 %*which was found in G1 of fish waste. It is interesting that to observe that the small size of fish has the higher moisture content which could has natively effect on the potential of nutritional content of this
parts. Meanwhile, ANOVA test showed a significant difference (P-value <0.05) in the scales moisture contents among the three fish waste groups.

The protein contents of the scales were ranged between 22.1 % and 23.9% as shown in Table 2. The results showed that in general more than two third of the scales weight is the moisture content in this part. Moreover, the characterizing of scales showed a low lipid and carbohydrate content which means this part mostly comprises of water and protein. The results revealed that the ash content of the scales was ranged between 3.89, and 5.6%. Consequently, these results revealed that the high protein content in scales parts which encourage recovery and processing this part as a source of protein. Moreover, the comparison among different weight and length groups showed that by increase the weight and the length of fish the protein content was increased accompanied with the decrease of moisture content.

Protein and lipid are the major nutrients in fish and their levels help define the nutritional status of the particular organisms. Meanwhile, the content of protein and lipid of scales were ranged between 22.1-23.99% and 1.9-2.3%, respectively. These results refer to the high content for the protein which is considered the most important constituent for food industry. On the other hand, presence of lipid in this part could trigger the food developer to employ these wastes in food processing. Generally the biological values of protein are greater and it contains all essential amino acid and fish lipid also contains fatty acid and omega-3 fatty acid. The variation in the composition among the three groups for the same species might be related to variance in several factors such as species, geographical, and season variations. Moreover, maturity, food habit and age differences in the same species may also attributed to the significant variation in the total fat [19].

| Groups | Moisture  | Protein  | Lipid  | Ash  | Carbohydrate |
|--------|-----------|----------|--------|------|--------------|
| G1     | 73.4±1.21a | 22.1±0.75a | 1.9±0.24a | 3.89±0.65a | 1.38±0.40a  |
| G2     | 71.2±1.30b | 23.5±0.70b | 2.1±0.09a | 4.98±0.45b | 1.42±0.35b  |
| G3     | 68.5±1.70c | 23.9±0.85c | 2.3±0.40b | 5.6±0.50c | 1.51±0.23b  |

a, b, c refer to mean in the same column for each species followed by different letters. a,b,c are significantly different according to P-value≤0.05 ± standard deviation, while the same letters are not significant different.

The proximate analysis of fins is shown in Table 3. The protein composition of the fins were, less than that were found in the scale, 13.9 ± 0.52, 17.4 ± 0.66, and 19.00±0.70%, respectively. By the same token, the results showed that the fins have low moisture content compared to the scales. The values of the moisture content of fins revealed that presence of 55.8%, 53.2%, and 50.3 % in the G1, G2 and G3 groups. Meanwhile, ANOVA test showed a significant difference with P-value<0.05 for the protein contents in the three tested groups G1, G2, and G3. The lipid content in in the G1, G2, and G3 groups of fins were 3.6%, 4.9%, and 6.11%, respectively, see Table 3. The carbohydrate content in fins is very low and generally less 2.5%. The ash content of the fins was higher than scales and ranged between 8.2%and 10.6%. The results of the statistical analysis illustrated that there is a significant difference among significantly and the P-value was less than 0.05 from each other.

| Groups | Moisture  | Protein  | Lipid  | Ash  | Carbohydrate |
|--------|-----------|----------|--------|------|--------------|
| G1     | 55.8±1.01a | 13.9±0.52a | 3.6±0.16a | 8.2±0.98a | 2.5±0.23a  |
| G2     | 53.2±0.85b | 17.4±0.66b | 4.9±0.42b | 9.1±1.22b | 1.7±0.29b  |
| G3     | 50.3±1.25c | 19.00±0.70c | 6.11±0.48b | 10.6±1.26c | 2.3±0.22a  |
The characterization for nutritional component of fish bones was tabulated in in Table 4. The results showed that the highest level of protein content among fish waste part (scales, fins, and bones) was found in bones, whereas the protein content in G1, G2, and G3 of fish groups were 25.9%, 26.1%, and 27.3% respectively. The observation of bones is rich in protein content consistent with the results that gained by Amitha and his co-worker (2019) [20]. The lipid content of the three fish waste groups, G1, G2 and G3 were 5.9%, 6.7%, and 7.0%, respectively. Both of carbohydrates and ash content were in general less than 2%. About half of bone weight comprises of moisture recorded and showed in Table 4. The percentage of moisture for fish bones in the present study was approximately identical to that one calculated by Hui, 2001 [21] and Pervin et al., 2012 [22]. The percentage of moisture is a better indicator of its relative content of energy, protein and lipids. The lower the percentage of moisture is the higher, the protein and lipids of composition and highest the density of energy for the fish [23].

| Groups | Moisture | Protein | Lipid | Ash | Carbohydrate |
|--------|----------|---------|-------|-----|--------------|
| G1     | 53.6±0.84a | 25.9±0.90a | 5.9±0.15a | 1.48±0.10a | 1.9±0.03a |
| G2     | 49.1±1.09   | 26.1±1.00a | 6.7±0.26b | 1.35±0.18b | 1.7±0.02b |
| G3     | 46.4±0.62   | 27.3±1.20a | 7.00±0.33c | 1.70±0.32c | 1.9±0.05a |

To sum all, the protein and lipid composition increased with increasing weight and size. These results were consistent with Jabeen and Shakoor [24], Javed [25] and Mahboob et al. [26] and Mahboob [27] findings. In the present study, the protein composition showed to increase in the scales, bones and fins with increasing fish weight. This study presented a high nutritive value of fish waste because it contain considerable amount of the protein and lipid content especially in bones. This could be providing another viable source to extract these essential materials for food supplementary products of fish oils (particularly omega-3).

4. Conclusions
In conclusion, the results demonstrated that extracted fish waste are nutritious and can contribute significantly to human health requirements. The results showed that the high protein and lipid content in fish waste, the scales, bones and fins. These filleting wastes can be applied to upgrade fish processing waste into products of commercial utility. These approaches may help in reducing the organic load caused by the fish processing industry. Further, the recovered minerals have good application in various industrial and medical applications. Moreover, it is recommend the use of fish waste powder as protein rich in fish feeding and also mixed with a certain percentage of blackberries, which provide poultry and other animals that depend on the human nutrition.

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