VARIATION OF PROXIMATE COMPOSITION, AMINO ACID AND FATTY ACID PROFILES OF PARTS OF CULTURED *Heterobranchus bidorsalis* (Geoffroy Saint-Hilaire, 1809)

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ABSTRACT

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Cultured African catfish (*Heterobranchus bidorsalis*) divided into head, middle and tail sections were analyzed for gross chemical composition, lipid (fatty acid) profile and amino acid profile. The gross chemical composition analyzed included crude protein, crude fat, ash, crude fibre and moisture content. The lipid profile analyzed included behenic acid, linoleic acid, linolenic acid, oleic acid, palmitic acid and stearic acid while the amino acid profile analyzed included alanine, arginine, histidine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine and valine. The study was aimed at investigating if there are variations in the nutrient concentration in the different parts of the fish (head, middle and tail). The experiment was designed as a complete randomized design. Data were analyzed using Genstat (2005) and statistically tested using ANOVA. Means were separated using Duncan Multiple Range (DMR) All tests were carried out at 5% level of probability. The result from the study showed that there is significant variation in the proximate composition of the head, middle and tail section. *H. bidorsalis* is high in protein and low in oil. The middle and tail portions were found to be richer in crude protein with values of 33.17% and 8.44% for middle and tail respectively. The crude fat was also higher at the middle and tail portions with values of 9.97% and 1.03% respectively. The head section had the highest ash content of 17.58%, followed by the tail portion (15.67%) and the least was in the mid section (3.3 %). Results of the statistically analysis of the lipid and amino acid profiles showed that there was no significant difference among the different parameters analysed between the various parts (head, middle and tail). However, there were significant differences in the different parameters analysed both for lipid and amino acid profiles respectively. The quantities of fatty acid types decreased significantly with values of 24.32, 19.35, 15.91, and 2.71g/100g for palmitic, linoleic, stearic, linolenic and behenic acids respectively. The highest quantity of amino acid detected was Lysine with a value of 19.92 g/100g as a major limiting amino acid. Whole fish consumption was recommended for human consumption to give full nutritional benefit.

Keywords: *H. bidorsalis*, Proximate composition, Fatty acid, Amino acids profiles

INTRODUCTION

Fish is a highly proteinous food consumed by a larger percentage of populace because of its availability and palatability (Foran et al., 2005). About one billion people world-wide rely on fish as their primary source of animal protein (FAO, 2000). Sadiku and Oladimeji (1991), Fagbenro et al. (2005), Anthoni and Akwume (1991), and Slan (1973) reported fish as excellent source of human diet. Also, when compared to other protein sources like goat and chicken meat, it is safer, healthier and also known to be an excellent source of essential and non essential amino acid and digestible protein (Astawan, 2004). The flesh of oil-rich fish, such as herring, mackerel and catfish are important sources of the long chain n-3 polysaturated fatty acids (PUFA) including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), due to the large amounts of these fatty acids in marine algae upon which the fish feed (Stone, 1996). Fish as an excellent source of polysaturated fatty acids reduces the risk of cardio vascular disease and other associated human health problems such as diabetics, cancer, obesity among others and it is therefore highly recommended for human consumption (Alasalvar et al., 2002). Furthermore, fin fishes and sea foods are rich in anti-oxidants like selenium and coenzymes Q-10 that help to fight disease and promote health and longevity. Mizushima et al. 1997 reported the production of red blood cells, antibodies and maintenance of central nervous systems mainly from vitamins such as vitamin B6 and B12 present in fish. Also Iodine and Calcium are vital for good health and are present in sufficient quantity in fish. Nutritional deficiencies may take the form of inadequacies of total caloric intake, protein intake, or certain essential nutrients such as the vitamins and, more rarely, specific amino acids (components of proteins) and fatty acids.  

However, the chemical composition of fish is highly susceptible to various factors such as the species of fish, parts of fish, source, time of year and the type of feed available to the fish (Aigbe, 2007; Fagbenro et al., 2000). Therefore benefit from fish consumption may vary with the part of fish consumed. The processor, the nutritionist, the cook and the consumer all have a direct interest in the quality and composition of fish. Knowledge of the chemical composition of fish is of paramount importance to evaluate fish nutritive value. The processor needs to know the nature of the raw material before he can apply correctly the techniques of chilling, freezing, smoking or canning. The nutritionist and cook must know the contribution of fish to the diet and health. The consumer is interested not only in whether a particular fish tastes good, which is a matter of opinion, but also in whether it is
nutritious. Knowledge of proximate composition and especially moisture and oil content are important to determine the quality of such products as fish protein concentrate, fishmeal, or other products where drying or oil extraction eliminates moisture and oil in the manufacturing process. Clarid catfishes constitute the main food fish of economic value in Africa. There are two important genera in this family namely Clarias and Heterobranchus. The genus Heterobranchus is endemic to Africa and contains four species (Teugels et al., 1990), three of which are from West Africa (Holden and Reed, 1972). The African giant catfish, Heterobranchus bidorsalis, is the second most important clarid catfish highly preferred by consumers and used for aquaculture in Nigeria (Vanden Bossche and Bernacsek, 1990; Fagbenro et al., 1993). Catfish consumers in Nigeria exhibit different preferences for the various parts of the fish they consume. For some it is the head region, for others, the mid-section and caudal region. Evaluation of differences in nutritional benefits of these sections of H. bidorsalis is essential to guide the consumers. Therefore this study is carried out to evaluate the quality of various parts of H. bidorsalis through proximate composition and fatty and amino acids profile analyses.

MATERIALS AND METHODS

Three table size Heterobranchus bidorsalis were purchased from the Department of Fisheries, Faculty of Agriculture fish farm of the University of Benin. The fishes were cultured in a concrete tank under semi-intensive culture system. It was fed artificial feed of 35% crude protein content. The specimens were transported live to the laboratory. In the laboratory, the specimens were washed to eliminate slime from the skin. Afterwards, morphometric measurements were taken by means of a meter rule and an analogue weighing balance. The specimens were afterwards killed and cut into three sections viz; head, mid section and tail section. The abdominal (mid) section was then degutted and all three parts were washed off slime and blood. The three different sections from each fish were then weighed differently. Each fish represented a replicate making a total of three replicates for each section and a total of nine samples. The nine samples were weighed, labelled and transferred to an oven set at 105°C until a constant weight was recorded. Proximate composition was determined using AOAC, 1994 method. The parameters measured were crude protein, crude fat, moisture, crude fibre and ash.

The fatty acids and amino acids were also determined by AOAC, 1994 method. The fatty acids determined were behenic, linoleic, linolenic, oleic, palmitic and stearic acids. Amino acid parameters determined include alanine, arginine, histidin, leucine, lysine, methionine, phenylalanine, proline, serine, threonine and valine. The experiment was designed as a complete randomized design. Data were statistically analysed using Genstat (2005) and statistically tested using Analysis of Variance (ANOVA). Means were separated using Duncan Multiple Range (DMR) Test. All tests were carried out at 5% level of probability.

RESULTS AND DISCUSSION

Proximate composition

The results of the proximate composition of different parts of H. bidorsalis are shown in Table 1. There were significant differences (P < 0.05) among the different proximate composition parameters for the various sections of the fish (i.e. head, middle and tail). There was a significant difference in the protein content of the fish parts (P < 0.05). Crude protein was significantly higher in the middle section (33.17%) due probably to the dominance of fish flesh in this section, followed by the tail (28.44%) and least was found in the head (21.44%) due probably to the relatively low amount of flesh and high amount of bone casing in the head. This agrees with the findings of Stansby and Olcott (1963) who reported higher levels of protein at the middle and tail and least level at the head in pink salmon. The quality of fish protein is high and it is easily digestible and fish diets consumption reduces levels of cholesterol in the blood thereby reducing the risk of heart disease (Bocek, 1991). Consumption of the mid section gives more of protein than the other sections of the fish.

The result (Table 1) also showed that the mean crude fat content was significantly different at the various parts of the fish (P<0.05). Crude fat was found to be highest in the middle (9.97%), followed by the tail (1.03%) and the least was at the head (0.79%). This may be due to the fact that fats are deposited at the fish flesh and organs more than the tail and head region. This agrees with the observations of Stansby and Olcott, 1963; Murray and Burt, 1982 who noted that oil content decreases from mid section of the fish to the tail and head region. Catfish consumers who desire low fat intake diet will benefit more from consumption of the fish head while those that require the fat will benefit more from consumption of the mid section of the fish. Ash content of the fish was found to be significantly highest at the head region (21.44%) because of the higher bone concentration, followed by the tail (15.67%) and least in the middle section (3.37%). Fish provides a well balanced supply of minerals in a readily available form (Tidwell et al., 2001). Thus fish head is a good source of minerals.
Table 1: Mean values for proximate composition of tank reared African catfish (Heterobranchus bidorsalis) divided into three sections (g/100g).

<table>
<thead>
<tr>
<th>Fish part</th>
<th>Crude protein</th>
<th>Crude fat</th>
<th>Ash</th>
<th>Crude fibre</th>
<th>M.C.</th>
<th>N.F.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>21.44c</td>
<td>0.79c</td>
<td>17.58a</td>
<td>0.53b</td>
<td>31.84c</td>
<td>27.82a</td>
</tr>
<tr>
<td>Middle</td>
<td>33.17a</td>
<td>9.97a</td>
<td>3.37c</td>
<td>0.25c</td>
<td>33.26a</td>
<td>19.98b</td>
</tr>
<tr>
<td>Tail</td>
<td>28.44b</td>
<td>1.03b</td>
<td>15.67b</td>
<td>0.94a</td>
<td>32.26b</td>
<td>15.67c</td>
</tr>
<tr>
<td>mean</td>
<td>27.68</td>
<td>3.93</td>
<td>12.21</td>
<td>1.72</td>
<td>32.45</td>
<td>21.16</td>
</tr>
</tbody>
</table>

Note: Means with different alphabetic remarks are significantly different.

Lipid profile of different parts of Heterobranchus bidorsalis

Results of the lipid profile of the different parts of the fish (Table 2) showed that there was no significant difference (P > 0.05) between the fatty acid concentration in the head (16.63%), middle (16.74%) and tail (16.909%). This means that whether a consumer relish catfish head, middle or tail, he consumes the same quantity of the determined fatty acids in the long run. However there was significant variation of the quantity of fatty acid types (P<0.05). The composition of fatty acids significantly decreased from palmitic acid (26.77g/100g), to linoleic acid (24.32g/100g), and the lowest which were not significantly different were, oleic acid (19.33g/100g), stearic acid (15.91g/100g), linolenic (11.48g/100g) and behenic (2.75g/100g) as shown in Figure 1. Fish oils are characterized by their high content of poly unsaturated fatty acids (PUFA). PUFA such as eicosapentanoic acid (EPA), decosahexanoic acid (DHA), oleic acid, linoleic acid and linolenic acid which have been found to be essential in human diets are known for their function in smoothening the flow of blood, preventing cerebral and myocardial infarction and their effects on the development of the brain nerve system (Dada, 2003; Fox and Cameron, 1989). All the parts of the specimen are rich in linolenic acid which is the raw material for the synthesis of long chain omega-3 fatty acids such as eicosapentanoic acids and docosahexaenoic acids. Omega-3 fatty acids are referred to essential fatty acids because of the inability of the body to synthesize them hence they must be made available in the diet. They have a number of health benefits as they play an important role in reducing inflammation throughout the body, decrease the clumping of blood platelets and help reduce heart diseases (Wikipedia, 2002). Behenic acid which was found to be least abundant on the other hand is cholesterol raising fatty acid in humans despite its low bioavailability (Carter and Denke, 2001), thus making it safe in catfish consumption. Lenoleic acid which was second in abundance is an unsaturated omega-6 fatty acid. It is an essential fatty acid. Aside from being very useful to humans, it has many industrial and research uses. It is used in making quick drying oils which are useful in oil plants and varnishes. Lenoleic acid has become increasingly popular in the beauty products industry because of its beneficial properties to the skin. Burk et al., (1930) noted that linoleic acid has anti-inflammatory, acne reductive and moisture retentive properties when applied topically to the skin. Oleic acid is classified as a monounsaturated omega-9 fatty acid that posses several uses in human diets, as an emulsifying agent in soap manufacture amongst others. Palmitic acid is the most common saturated fatty acid and the most abundant in fish. According to the World Health Organization, there is convincing evidence that consumption of palmitic acid increases risk of developing cardiovascular diseases. Staeic acid is one of the most common saturated fatty acids found in nature following palmitic acid. In general, applications of stearic acid exploit its bifunctional character, with a polar head group that can be attached to metal cations and a nonpolar chain that confers solubility in organic solvents. The combination leads to uses as a surfactant and softening agent. Stearic acid has application in soap, cosmetic, detergent, lubricant and softening agent manufacture, (Burk et al., 1930). This acid can be derived from the fish. Figure 1 shows the distribution of various types of fatty acids at the various sections of the fish.

Table 2: Mean values for fatty acid composition of tank reared African catfish (Heterobranchus bidorsalis) divided into three sections (g/100g).

<table>
<thead>
<tr>
<th>Fish part</th>
<th>Behenic acid</th>
<th>Linoleic acid</th>
<th>Linolenic acid</th>
<th>Oleic acid</th>
<th>Palmitic acid</th>
<th>Stearic acid</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>0.697</td>
<td>23.560</td>
<td>10.347</td>
<td>21.270</td>
<td>28.520</td>
<td>15.410</td>
<td>16.634a</td>
</tr>
<tr>
<td>Mean</td>
<td>2.750c</td>
<td>24.320b</td>
<td>11.480c</td>
<td>19.330c</td>
<td>26.770a</td>
<td>15.910c</td>
<td>16.760</td>
</tr>
</tbody>
</table>

Note: Means with different alphabetic remarks are significantly different.
Amino acid profile of *heterobranchus bidorsalis*

The results of the amino acid profile of the different parts of the fish (Table 3) showed that there was also no significant difference in the amino acid concentration in the head, middle and tail of the species. This means that whether a consumer relish catfish head, middle or tail, he consumes the same quantity of amino acids in the long run. However, there was significant difference in the amount of different types of amino acids (P < 0.05). Figure 2 shows the distribution of amino acid types in various parts of the fish species. As shown in figure 2, the amino acid with the highest average value was lysine (19.027%) which was followed closely by alanine (14.042%). Histidine had a mean value of (9.229%) while valine made up 8.864% of the fish species. The quantity of arginine was 7.978%. Methionine made up 7.74% of the fish and this was followed closely by threonine (7.229%). Phenylalanine, proline and serine had near equal values of 6.949%, 6.774% and 6.758% respectively. Leucine had the least value of 5.596%.

Table 3: Mean values for amino acid composition of tank reared African catfish (*Heterobranchus bidorsalis*) divided into three sections (g/100g).

<table>
<thead>
<tr>
<th>Fish part</th>
<th>Alanine</th>
<th>Arginine</th>
<th>Histidine</th>
<th>Leucine</th>
<th>Lysine</th>
<th>Methionine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>13.667</td>
<td>8.103</td>
<td>9.177</td>
<td>5.700</td>
<td>19.350</td>
<td>8.003</td>
</tr>
<tr>
<td>Middle</td>
<td>11.930</td>
<td>8.067</td>
<td>9.260</td>
<td>5.443</td>
<td>18.543</td>
<td>7.457</td>
</tr>
<tr>
<td>Mean</td>
<td>14.042b</td>
<td>7.978e</td>
<td>9.229c</td>
<td>5.596i</td>
<td>19.027a</td>
<td>7.740f</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fish part</th>
<th>Phenylalanine</th>
<th>Proline</th>
<th>Serine</th>
<th>Threonine</th>
<th>Valine</th>
<th>mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Middle</td>
<td>6.860</td>
<td>8.103</td>
<td>8.057</td>
<td>7.183</td>
<td>9.097</td>
<td>9.091</td>
</tr>
<tr>
<td>Tail</td>
<td>6.933</td>
<td>6.053</td>
<td>5.430</td>
<td>7.250</td>
<td>8.200</td>
<td>9.091</td>
</tr>
<tr>
<td>Mean</td>
<td>6.949h</td>
<td>6.774h</td>
<td>6.758h</td>
<td>7.229g</td>
<td>8.864d</td>
<td>9.108</td>
</tr>
</tbody>
</table>

Note: Means with different alphabetic remarks are significantly different

Figure 2 showed that fish consumer take in more lysine. As noted by NRC 1983, lysine is one of the limiting sulphur base amino acid in plant protein sources. Thus consumption of any part of fish offers a very good source of the acid among other amino acids. Lysine and Methionine are limiting amino acids because they are the first essential amino acids to show deficiency symptoms. Lysine enables the synthesis of carnitine, which converts fatty acids into energy and also plays an important role in the production of hormones, antibodies and enzymes. Having a deficiency in lysine can lead to niacin deficiency and cause a health condition called pellagra (Fagbenro et al., 2005). Methionine on the other hand aids in the production of sulphur, which is necessary for normal metabolism and it is also essential for the synthesis of haemoglobin and glutathione that fights against free radicals.
CONCLUSION

The African catfish (*Heterobranchus bidorsalis*) can be classified as a “high protein and low oil fish. There is significant variation in the nutritional qualities of this tank-reared African catfish among its parts (head, middle and tail). The middle and tail parts are richer in crude protein and crude fat content while the head contained more minerals. The lipid profile of the three named parts showed that they are rich in Omega-3 fatty acids which prove invaluable to the human well being. There was no significant difference in the fatty acid concentration between the different fish parts (head, middle and tail) but there was however significant differences among the different fatty acid types. Although the head contained the least amount of crude protein, analysis showed that it contained a higher concentration of most of the analyzed amino acids. However, like the case with the lipid profile, there was no significant difference in the amino acid concentration between the different fish parts (head, middle and tail) but there was however significant differences among the different amino acid types. This means that the three fish parts contain the same total concentration of amino acids. Hence no matter the part consumed, the consumer attains the same concentration of the total sum of amino acids present. This all important food may be consumed whole to benefit maximally from the protein, fats, minerals and vitamins.

REFERENCES


