Impacts of Exposure Temperature on the Nutritional Characteristics of *Clarias Gariepinus* (African Catfish)

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Abstract
This study aimed to ascertain how African catfish (Clarias gariepinus) were altered nutritionally by temperature and time exposure. Freshly caught mature African catfish (Clarias Gariepinus) were consistently cut and curled before being dried at temperatures of 70, 90, and 110°C until stable weights were achieved. The nutritional properties were established using conventional methods. The experiment results showed that the temperature of exposure affected the nutritional qualities of the biomaterial. Crude protein, fat content, and ash content are the observed quality indicators that typically climb as the drying temperature rises from 70 to 110°C. The crude protein changes from 53,10 to 67.21%, the moisture content decreases from 76.12 to 15.59%, and the lipid content increases from 21.20 to 29.60% as the temperature rises from 70 to 110 degrees Celsius. The positive correlation that all of the mineral contents showed with temperature rises suggests that the concentration of the mineral contents rose as the moisture content dropped. This is in line with the research done by Kilic (2009), who found that increasing the drying temperature enhances fish quality by delaying the biochemical and microbiological degradation of the fish.

Keywords: *Clarias Gariepinus, Nutritional Qualities, Exposure Temperatures, Moisture Content*

Introduction

The African Catfish, or Clarias gariepinus, is a large fish with eel-like characteristics. Its back is typically dark or black with a patch of white in the middle. Records indicate that this catfish is considerably smaller than the largest freshwater species in Southern Africa, the vundu, which lives in the waterways of Zambia. However, according to Fish Base, African catfish are heavier and bigger than that species when they reach their maximum length [1]. Three feet and eleven inches, or one to five meters, is the typical length of an adult Clarias Gariepinus. It may weigh up to 60 kg and reach a maximum length of 1.7 meters (5 feet 7 inches) [2].

Their bodies are small, their skulls are hard and flat, much more modified than those of the Silunus family; their lips are long and 24-terminal, with four pairs of barbels. Moreover, they have enormous frill breathing organs, which are enlarged gill arches. Like many other catfish, the African catfish is a nocturnal fish. Because of its large mouth, it benefits from both live and dead creature materials. It may swallow rather large prey. It is reported to be capable of capturing large ducks, including common moorhens. In between windy seasons, it can also survive for long periods in shallow mud, and it is prepared to crawl on dry ground to avoid drying puddles [3].

A growing number of people are raising African catfish, or Clarias Gariepinus Burchell, in hydroponic systems. All around Indonesia, but especially in Java, Sumatra, Bali, and Kalimantan, it has been highly polished. African catfish were first used in Indonesian hydroponic systems in 1985 when the species was imported from Taiwan. It is constantly expanding display has accelerated the development of hydroponic gardening, a favorite feature among aquarists. The common name for this species was "Dumbo." Sadly, widespread inbreeding brought about by fish farmers' negligent exploitation of brood stock has resulted in genetic degeneration, as shown by the animals' increased distortions, wider size variation, susceptibility to disease contamination, low feed efficiency, and incapacity to finish developmental tasks [2].

The process of drying, as applied to food management, involves lowering a material's moisture content to its more stable, basic state. One important aspect influencing the security, quality, and well-being of biomaterial is its moisture content [4]. When biomaterials are freshly harvested, their water content usually accelerates their rate of degradation. Notwithstanding the possibility that some of their nutritional value was lost during the drying process, prepared or dried horticultural goods remain more stable than fresh ones [5]. Boiling caused moisture to be released, which caused the nut to shrink, as [6] said. When the moisture content drops, the cashew nuts lose water while cooking, which causes the nut to shrink in size.

Moreover, decreasing the moisture content of biomaterials certainly has the effect of hardening the case. When the protective epiporous structure (epicarp) of the agricultural material deteriorates, case-solidifying occurs. This magic often keeps moisture from penetrating to the item's surface layer to dry. Because agricultural material ignores the potential of moisture escaping from the material and into the surrounding air to attain equilibrium moisture content, agricultural material

suffers from casehardening. Consequently, the agricultural goods decompose or waste away quickly.

Both a significant part of our regular diet and a significant source of energy is protein. In addition to serving as the building block for several proteins and other particles, it is essential for the maintenance and repair of tissue, especially muscle. Merely 105 calories may be found in a serving of catfish, which represents 32-39% of the daily needed protein intake. On the other hand, the same number of salmon provides more than half of our daily protein requirements and about 230 calories. Other high-protein foods, such as catfish, might increase sensations of fullness, which can aid in weight loss.

Since there is a lack of knowledge regarding the effects of drying temperatures on the nutritional characteristics of Clarias gariepinus, this research aims to determine the effects of exposure temperature and time on the nutritional properties of the biomaterial. This information may be useful in the development of equipment for the processing, storage, and general handling of this biomaterial.

Materials and method

Sample Collection

Directly from a farm at the I.M.T. Entrepreneurship Centre in Enugu, the matured African catfish (Clarias Gariepinus) were gathered. The nutritional qualities of the samples were assessed under various temperature ranges, ranging from 70 to 110 °C, in the bioprocess laboratory of the Agricultural and Bio-Resources Engineering Department at Enugu State University of Science and Technology (E.S.U.T.). In terms of crude protein, moisture content, fat, ash, lipid, fiber, and carbohydrates, the proximate analysis of bio-materials describes the elemental nutritional composition of the bio-material. [7] approved methods were used to assess the flour samples for moisture content, crude protein, crude fiber, fat, ash, carbohydrates, and minerals at various temperatures [7].

Figure1. African catfish (***Clarias Gariepinus***)

Experimental Materials:

Some of the materials used for the determination of nutritional qualities of ***Clarias Gariepinus***) includes:

(a) 5.28kg of freshly harvested ***Clarias Gariepinus***)

(b). A Mettler Toledo electronic weighing balance, model XP204 having a sensitivity of 0.0001g was used to measure the flour samples' mass at three different temperatures of 70, 90, and 110. The sample was dried at 4-hour intervals for each temperature level.

(c) A Multi-Purpose Oven (Model OKH-HX-1A).

(d) Rapid Visco Analyzer (RVA4 500 NEWPORT SCIENTIFIC AUSTRALIA) was used to obtain the nutritional and mineral contents of the samples at three different temperatures.

Experimental Procedure

The purpose of this experiment was to determine how drying temperature affected the nutritional value of African catfish (Clarias Gariepinus). Following the killing of the recently captured C. Gariepinus, the head was separated and divided into three equal parts, which were thoroughly cleansed with tap water to get rid of any debris. To get a consistent weight, the samples were dried at 70°C, 90°C, and 110°C, respectively. The samples underwent a series of steps including drying, pulverization in a hammer mill, sieving through a 0.50 mm screen, and storage at 4°C until required.

Analysis of the nutritional qualities of the samples

Proximate analysis provides an elemental nutritional composition of biomaterials in terms of crude protein, moisture content, fat, ash, fiber, and carbs. The moisture content, crude protein, crude fiber, fat, ash, and carbs of the flour samples were measured using techniques authorized by [7].

Determination of Moisture Content of the Samples

A food sample's moisture content tells us how much water it has. Many factors, including the meal's kind, age or maturity, variety, and geographic location, affect its moisture content. Moisture content during harvest determines the food material's storage potential [8]. We used the method outlined in [9] to determine the samples' moisture content. Following portioning the samples into 5g portions and placing them in weighted crucibles, an oven was set to 105°C until the weights remained constant. Following their cooling to room temperature in desiccators, the samples were weighed once again. Following this method of determining weight discrepancy, the dry matter is indicated:

$$\textbf{Moisture Content} = \frac{W_1 - W_2}{W_1} \times 100\% \quad (1)$$

Where; W_1 = Wet sample

W_2= Dry sample

Determination of Crude fiber

Part of a nutrient called "crude fiber" is made up of dietary ingredients that are hard to break down. The [9] Method was employed to find the native fiber. In a 1-liter conical flask, add 2 grams of the substance. 100 milliliters of boiling water were then added to a conical flask that held the models. For thirty minutes, the mixture was left to boil after that. After boiling for thirty minutes, the mixture was filtered through a Muslin cloth submerged in a funnel. We thoroughly cleaned the remaining material to remove any traces of alkali. A dry crucible was then filled with the remaining material, and the temperature was raised to 600 degrees. Equation 2 was used to assess the crude fiber.

$$The\ Crude\ fiber = \frac{Weight\ of\ the\ Crucible}{Weight\ of\ the\ sample} \times 100\% \quad (2)$$

Determination of the Ash Content

The mineral or organic remnant of a bio-material is represented by the ash content. It provides a general sense of the overall quantity of minerals in the dietary item. The amount of ash was calculated using [9].

$$\textbf{Ash Content (\%)} = \frac{Weight\ of\ Ash}{Weight\ of\ Sample} \times 100\% \quad (3)$$

Determination of Lipid Content

The proportion of lipid content in the muscles was determined using the soxhlet extraction method [10]. The amount of ground muscle, around 5 g, was measured into the open extraction thimble, weighed, and recorded as W_1. The weight of the sample plus the extraction thimble was noted as W_2. The extractor's contents and the extraction thimble were carefully placed inside. After 110

ml of petroleum ether, which has a boiling point between 40 and 60 °C, was added to the round-bottom flask, it was placed on the heating mantle.

The Soxhlet extraction procedure was utilized to ascertain the percentage of lipid content present in the muscles [10]. A mass of about 5 g of ground-up muscle was weighed, measured, and recorded as W_1 in the open extraction thimble. W_2 is the weight of the sample plus the extraction thimble. The extraction thimble and its contents were gently inserted into the extractor. The round-bottom flask was put on the heating mantle after 110 ml of petroleum ether, which has a boiling point between 40 and 60 °C, was poured into it.

The reflux condenser and extractor were housed in the circular-bottomed flask; the extractor was attached to the water supply's intake tube, and the washbasin served as the outflow. The heating mantle was turned on and regulated such that the solvent in the circular-bottom flask was gently heated up to a boil. Throughout the heating process, water was continuously permitted to flow through the reflux condenser to cool and condense the evaporating solvent. Once the solvent has been added, the mixture gathers in the extractor and uses the extraction thimble to extract the lipid from the sample. It is then drained back into the flask with a flat bottom. For six hours, this technique is performed nonstop. This is the method used to calculate the lipid proportion:

$$\% \text{ lipid content} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \qquad (4)$$

Where W_1 = Weight of empty extraction thimble
W_2 = Weight of extraction thimble plus sample extraction
W_3 = Weight of extraction thimble plus sample residue after extraction.

Determination of Crude Protein

Peptides are the bonds that join amino acids to form proteins. Among them are nitrogen, oxygen, hydrogen, carbon, and other necessary elements. The Kjeldahl technique was used to compute the total nitrogen (crude protein) [9]. A fish sample weighing about 0.5 g was measured on nitrogen-free paper. The model was covered in paper and placed in the bottom of the Kjeldahl digesting flask together with six to eight glass beads, four to five spatulas, and a granular catalyst made of a combination of K2SO4 and CuSO4. The H2SO4 was then added in 20 cc after being well diluted.

The flask was gradually heated on an inclined Gerhardt heating mantle within a fume cupboard until complete digestion was accomplished, which was signified by a color shift from brown to colorless. Calorimetry was used to quantify the total nitrogen after the contents of the flask were transferred to a 100 ml volumetric flask that had been sanitized. A 25 ml aliquot was then utilized for distillation.

Determination of Carbohydrate

As a nitrogen-free extract, carbohydrates are calculated by combining the percentages of ash, moisture content, crude fiber, fat, and crude protein, then deducting the result from 100%. Table 1 displays the values for the nutritional attributes.

Determination of mineral contents

The dry ash extraction technique was used to assess the mineral content of the samples. By the procedure outlined by [8], two grams of the model were burned in a muffle. (As in figuring out g ash). The resultant ash was added to distilled water in a volumetric flask to dilute it to a final volume of 100 milliliters after being dissolved in 100 milliliters of diluted hydrochloric acid (Im HCL). The digest that was produced in this way was applied to other studies. Table 2 lists the values for the samples' mineral composition.

Results

Table1: Results of Nutritional Qualities of *Clarias Gariepinus*)

Temperature ℃	**Moisture Content (%)**	**Crude Protein (%)**	**Lipids Content (%)**	**Ash Content (%)**	**Crude Fibre (%)**	**Carbohydrate (%)**
70	15.65	53.10	21.20	3.62	1.71	3.84
90	15.62	60.59	24.08	3.42	1.83	3.04
110	15.59	67.21	29.60	3.92	1.96	2.78

Table2: Results for other Nutritional Qualities of *Clarias Gariepinus*)

Temperature ℃	**Energy Value (J/Kg)**	**Mass (Kg)**	**Vitamin A (%)**	**Vitamin C** (mg/ml)	**Potassium (%)**	Phosphorus (%)
70	4.14	19.28	0.00053	0.0010	4.5×10^{-4}	2.6×10^{-4}
90	5.33	7.81	0.00061	0.0013	4.7×10^{-4}	3.2×10^{-4}
110	6.24	5.08	0.00073	0.0014	4.8×10^{-4}	4.5×10^{-4}

Discussion of results

The nutritional characteristics of the (Clarias Gariepinus) at various temperatures were displayed in Tables 1 and 2. The experiment's findings demonstrated that exposure temperature affected the nutritional properties of the biomaterial (Tables 1 and 2). Crude protein content, fat content, and

ash content are examples of quality criteria that often rise when evaluated at temperatures between 70 and 110 °C. This is in line with the findings of [8], which demonstrated that lowering moisture levels improves fish quality by postponing fish biochemical and microbiological degradation.

Crude Protein: Dehydrated catfish had a crude protein level that varied from 53.10 to 67.21%. (Table 2). Dried catfish with a minimum protein level of 55% is considered to be of good nutritional grade. Based on the study of [9], high protein retention suggested that the dried catfish had exceptional nutritional quality (see Table 2). The protein levels of the dried catfish were much higher than those of the raw fish, indicating that no protein nitrogen was lost throughout the drying process.

Lipid Content: The lipid content results ranged from 21.20 to 29.60%. (Table 1). With dried catfish and an electric oven, it is within the range of the value (26.22%) obtained [2].

Ash Content: The ash content findings showed a range of 3.62 to 3.92%. Table 1. The range is less than that of the results (4.14 to 5.33%) published by [6], which might be because the moisture level of the dehydrated catfish utilized in this investigation was lower.

Crude Fat: There was a range of 21.06 to 21.34% fat content. Most of the samples with low-fat levels were dried at 110°C, as Table 2 demonstrates. It might indicate that when drying at the lower temperature, there was fatter and moisture evaporating for a longer amount of time. Based on the data of [11], it is comparable to a range of values for lipid content between 21.20 and 29.60%.

Carbohydrate: The percentage of carbohydrates in dehydrated catfish ranged from 3.84 to 2.78%. It showed a propensity to decrease as the temperature increased from 70 to 110 degrees. It is in line with the discovery made by [6] that dried fish products with greater drying temperatures had lower carbohydrate contents.

Crude Fiber: Crude fiber content in dehydrated catfish ranged from 1.71 to 1.96%. As the temperature increased from 70 to 110 degrees, it tended to rise more. It is in line with earlier assessments carried out by other scholars, including [5].

Mineral Contents: The mineral contents, including energy value and vitamins A, C, potassium, and phosphorus, increased in tandem with temperature rises. It also supported the findings of earlier academics' investigations, including [5]

Conclusion

Research on the nutritional value of African bread-based catfish (Clarias Gariepinus) showed that exposure temperatures had a major impact on the nutritional value of the biomaterial in the following ways:

(i). The crude protein ranges between 53,10 and 67.21 as the temperatures increase from 70-110℃

(ii). The moisture Content decreased from 76.12 to 15.59% as the temperatures increased from 70-110℃

(iii). The Lipid Content increased from 21.20 - 29.60% as the temperatures increased from 70-110℃

(iv). The fiber content increased from 1.71 - 1.96%59 as the temperatures increased from 70-110℃
(v). The ash content increased from 3.62- 3.92% as the temperatures increased from 70-110℃
(vi). The Carbohydrate decreased from 3.84 - 2.78% as the temperatures increased from 70-110℃
(vii) The mass of the sample decreased from 192.84 - 50.76g as the temperatures increased from 70-110℃.
(v) All the mineral contents showed a positive correlation with increment in temperatures indicating the concentration of the mineral contents as the moisture reduces

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