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Effect of Different Weight Classes of Processed *Clarias gariepinus* on Yields of Fish Fillet and Fishmeal Production

Salisu A. A. A.[1], Faturoti E. O.[2]

[1]Fisheries Component, Ogun State Agricultural Development Programme, Abeokuta, Nigeria

[2]Department of Aquaculture and Fisheries Management, University of Ibadan, Ibadan, Nigeria

Abstract: ***Four weight classes of African Catfish, Clarias gariepinus (Burchell 1822), - below 500g, 500g – 999g, 1.000 kg – 1.499 kg and 1.500 kg – 1.999 kg - were processed into fish fillets and the by-product into fishmeal. The fillet yields ranged between 31.85% - 39.50% with the biggest fish group producing the highest fillet yield but lowest amount of solid waste (58.25%). There was a direct relationship between fish weight and fillet yield as well as solid "waste" yield. The fishmeal produced from the solid "waste" also revealed a direct relationship between the fish weight and the amount of fishmeal produced. The biggest fish group (1.500 kg – 1.999 kg), despite having the lowest amount of raw material, produced the highest amount of fishmeal with the best conversion ratio 4.48:1 (raw fish: dried fishmeal). Proximate analysis revealed crude protein range of 55.87 ± 0.16 to 57.40± 0.95 with the biggest fish group having the highest crude protein. There were significant differences among the fish fillet, solid waste and drip loss yields of the fish weight classes. Likewise, there was a significant difference between the crude protein and ash contents of the smallest fish group and those of the biggest fish group.***

Keywords: Different weight classes. *Clarias gariepinus*. Fillet yields. Waste yields. Fishmeal

1. Introduction

Clarias gariepinus (Burchell, 1822), (African catfish), is the most widely cultured fish species in Nigeria (Fagbenro and Arowosegbe, 1991) and indeed Africa (Garibaldi, 1996; cited by Fagbenro et al, 2013) probably because it is tasty, hardy, tolerates poor water quality conditions (Idodo-Umeh, 2003) and readily accept different kinds of feed ingredients included in its diet (Faturoti, 2000). It also has high consumer preference ranking, fast growth rate to marketable size within a short time, early maturity and ability to breed easily in captivity. *Clarias gariepinus* table size is usually consumed by man whole as fresh fish. However value could be added to the fish by processing it into fish fillets, this provides more choices to the consumers, gives more profit to the farmer and reduces possibility of fish glut.

Fish fillets (fish flesh excluding bones, viscera and the head), which may be skinless or with the skin on, are getting popular in Nigeria (Adeyemi et al, 2012) probably because they are convenient for housewife to cook and easier to eat. The by-products of fish fillet production, that is, the head, viscera, the backbone and the trimmings, could serve as raw material for the production of fishmeal.

Fishmeal constitutes a substantial part of formulated feed for diverse fish species and livestock globally (FAO, 1998) and this universal use is as a result of its excellent amino acid profile, palatability and high nutritive value (Alceste and Jory, 2000). Fishmeal is the most expensive ingredient in aquaculture diets probably because of high demand and dwindling landing of captured fish hence production of fishmeal from locally available raw material is germane to aquaculture development.

Adeyemo (2013), Adeyemi et al (2012) and Eyo (2001) reported fillet yields of *Clarias gariepinus* among other fish species. However, works on fillet yields of *Clarias gariepinus* of different weight classes are scarce. Also, there is little or no information on yields and chemical composition of fishmeal produced from the waste generated through processing of *Clarias gariepinus* of different weight classes into fish fillets.

This research work was then aimed at:

- Determining the effect of different weight classes on the yields of skinless fillets obtainable from processed *Clarias gariepinus*.
- Determining the effect of different fish weight classes on the yields and chemical composition of fishmeal produced from the waste generated from processing *Clarias gariepinus* into fillets.
- Recommending the best weight class of *Clarias gariepinus* that could be processed into fish fillet for the highest amount of fillet yields.

2. Materials and Method

The different sizes of *Clarias gariepinus* were obtained live from Aquabeet fish farm, Sango-ota, Ogun state, Nigeria and transported to Fish Technology Department Laboratory, Nigerian Institute for Oceanography and Marine Research (NIOMR), Lagos, Nigeria.

Fish Preparation and Processing

Four groups of *Clarias gariepinus* of different weight classes used in this work were:

Clarias Group A - *Clarias gariepinus* of below 500g each
Clarias Group B - *Clarias gariepinus* of between 500g – 999g each
Clarias Group C - *Clarias gariepinus* of between 1.000 kg – 1.499 kg each
Clarias Group D - *Clarias gariepinus* of between 1.500 kg – 1.999 kg each

Prior to filleting, the weight of each fish was measured using sensitive weighing balance (OHAUS model PA 4101, capacity 4100g) to ensure it fell within the group and the total weight of 40kg was obtained for each replicate of each group.

Fish Fillet Production: Each replicate was processed into fish fillets and the by-product into fishmeal in the laboratory of Department of Fish Technology, NIOMR. The fish were stunned using 5% (w/w) table salt (NaCl) (Adeyemi et al, 2012) and then washed manually with water containing 3.4% (w/v) common alum (hydrated potassium aluminium sulphate: $KAl(SO_4)_2 \cdot 12H_2O$). (Adeyemi et al, 2012) to remove slime for easy handling during filleting. Manual fish filleting technique as described by Rival (2011) was adopted using stainless steel filleting knives to produce skinless, single fish fillets. Weights of skinless fillets and by-products were taken and recorded.

The percentages of product and by-products were calculated as:

$$\%\text{Fillet yield} = \frac{TWFF}{TWF} \times 100$$

$$\%\text{Solid “waste” yield} = \frac{TWSW}{TWF} \times 100$$

$$\%\text{Drip loss yield} = \frac{TWF - (TWFF + TWSW)}{TWF} \times 100$$

where:
TWFF = total weight of fish fillet
TWF = total weight of fish
TWSW = total weight of solid waste

Production of Fishmeal: The by-product (solid “waste”) obtained from the production of fillets from each of the replicate was used to produce *Clarias* fishmeal using NIOMR’s fishmeal plant (Denmark, type FR 100) as described by Akande et al. (2014).

Conversion ratio of raw fish to fishmeal was calculated as:

$$\frac{\text{Weight of raw fish used (kg)}}{\text{Weight of fishmeal produced (kg)}}$$

Conversion percentage was calculated as:

$$\frac{\text{Weight of fishmeal produced (kg)}}{\text{Weight of raw fish used (kg)}} \times 100$$

Proximate Analysis: Each of the fishmeal produced was analyzed for proximate composition using the standard methods of A.O.A.C., (2000). Each analysis was carried out in triplicates.

Statistical Analysis: All data obtained in this research work were expressed in means ± SD and subjected to one way analysis of variance (ANOVA) at 5% level of significance using SPSS for windows (version 16.0). Least Significant Difference test was then used to determine the differences among the means. Yields obtained were also expressed as percentages.

3. Results

Clarias Group D (fish of 1.500 kg – 1.999 kg) yielded the highest amount of fish fillet (15.80±0.01 kg), the lowest amount of solid fish “waste” (23.30±0.01kg) and the lowest amount of drip-loss (0.9±0.02kg), while *Clarias* Group A (fish below 500g) yielded the lowest amount of fish fillet (12.74±0.02kg) but the highest amount of solid fish “waste” (25.40±0.03kg) and the highest amount of drip loss (1.80±0.05kg) as shown in Table 1. Conversion percentage of raw fish to fish fillet was highest in *Clarias* Group D (39.50%) and lowest in *Clarias* Group A (31.85%). Percentage of solid waste generated was highest in *Clarias* Group A (63.50%) and lowest in *Clarias* Group D (58.25%) while drip loss percentage was also highest in *Clarias* Group A (4.65%) and lowest in *Clarias* Group D (2.25%) as shown in Table 2.

Table 1: Yields of processed *Clarias gariepinus* of different weight classes

Products	*Clarias* Group A	*Clarias* Group B	*Clarias* Group C	*Clarias* Group D
Total fish weight (kg)	40.00 ± 0.00^{a}	40.00 ± 0.00^{a}	40.00 ± 0.00^{a}	40.00 ± 0.00^{a}
Weight of fillets (kg)	12.74 ± 0.02^{a}	13.20 ± 0.02^{b}	14.38 ± 0.01^{c}	15.80 ± 0.01^{d}
Weight of Solid Waste (kg)	25.40 ± 0.03^{a}	25.12 ± 0.04^{b}	24.58 ± 0.02^{c}	23.30 ± 0.01^{d}
Drip Loss (kg)	1.86 ± 0.05^{a}	1.68 ± 0.06^{b}	1.04 ± 0.03^{c}	0.90 ± 0.02^{d}

The above values are means of triplicate data ±SD.
Mean values in each row with different superscripts are significantly different ($P < 0.05$).

Table 2: Yield percentages of processed *Clarias gariepinus* of different weight classes

Products	*Clarias* Group A	*Clarias* Group B	*Clarias* Group C	*Clarias* Group D
Fish Fillets (%)	31.85 ± 0.04^{a}	33.00 ± 0.04^{b}	35.95 ± 0.03^{c}	39.50 ± 0.03^{d}
Solid Waste (%)	63.50 ± 0.09^{a}	62.80 ± 0.09^{b}	61.45 ± 0.05^{c}	58.25 ± 0.03^{d}
Drip Loss (%)	4.65 ± 0.13^{a}	4.20 ± 0.15^{b}	2.60 ± 0.08^{c}	2.25 ± 0.05^{d}

The above values are means of triplicate data ±SD.
Mean values in each row with different superscripts are significantly different ($P<0.05$).

Fishmeal Yields

Clarias Group D (fish of 1.50kg – 1.99kg), despite having the lowest amount of raw material (23.30±0.01kg), yielded the highest amount of fishmeal (5.20±0.00kg) with conversion ratio of raw fish to fishmeal being 4.48:1 (22.32%) while *Clarias* Group A (fish below 500 g) with 25.40±0.03kg of raw material yielded the lowest amount of fishmeal (4.80±0.01kg) with conversion ration of raw fish to fishmeal being 5.29:1 (18.90%) as shown in Table 3.

Table 3: Results Obtained after Production of Fishmeal from the Solid Waste

Products	*Clarias* Group A	*Clarias* Group B	*Clarias* Group C	*Clarias* Group D
Weight of Raw Fish (kg)	25.40 ± 0.03^{a}	25.12 ± 0.03^{b}	24.58 ± 0.02^{c}	23.30 ± 0.01^{d}
Weight of Fishmeal Produced (kg)	4.80 ± 0.01^{a}	4.85 ± 0.01^{b}	5.00 ± 0.01^{c}	5.20 ± 0.00^{d}
Conversion Ratio (raw fish: fishmeal)	$5.29:1^{a}$	$5.18:1^{b}$	$4.92:1^{c}$	$4.48:1^{d}$
Percentage (%)	18.90^{a}	19.31^{b}	20.34^{c}	22.32^{d}

The above values are means of triplicate data ±SD.

Mean values in each row with different superscripts are significantly different ($P<0.05$).

Analysed Composition of *Clarias* Fishmeal: *Clarias* Group D fishmeal had the highest crude protein content of 57.40 ± 0.95 and it is significantly higher ($P < 0.05$) than *Clarias* Group A Fishmeal with crude protein of 55.87 ± 0.16. However, crude protein content of *Clarias* Group A fishmeal was not significantly different from that of *Clarias* Groups B and C fishmeal while crude protein contents of *Clarias* Groups B and C fishmeal were also not significantly different from that of *Clarias* Group D fishmeal. In terms of Ash content, *Clarias* Group A fishmeal was not significantly better from *Clarias* Group B fishmeal but both were significantly different from *Clarias* Groups C and D fishmeal which were also significantly different from each other. (Table 4).

Table 4: Analyzed Composition of *Clarias* Fishmeal

Parameter	CA FM	CB FM	CC FM	CD FM
Crude Protein	55.87 ± 0.16^{a}	56.70 ± 0.26^{ab}	56.90 ± 0.26^{ab}	57.40 ± 0.95^{b}
Ether Extract	8.00 ± 0.00^{a}	$8.05\pm.50^{a}$	8.15 ± 0.50^{a}	8.50 ± 0.50^{a}
Ash	25.10 ± 0.40^{a}	25.00 ± 0.10^{a}	22.23 ± 0.18^{b}	20.00 ± 1.13^{c}
Dry Matter	89.55 ± 0.74^{a}	89.10 ± 1.11^{a}	89.86 ± 0.47^{a}	89.82 ± 0.46^{a}
Moisture Content	10.45 ± 0.74^{a}	10.90 ± 1.11^{a}	10.14 ± 0.47^{a}	10.18 ± 0.46^{a}

The above values are means of triplicate data ±SD.
Mean values in each row with different superscripts are significantly different ($P < 0.05$).

Key:
CA FM = *Clarias* Group A fishmeal
CB FM = *Clarias* Group B fishmeal
CC FM = *Clarias* Group C fishmeal
CD FM = *Clarias* Group D fishmeal

4. Discussion

This study revealed a direct relationship between fish weight and fillet yield as well as "waste" yield. The bigger the fish, the more the fillet yield and the less the "waste" yields. This conforms to the findings of Souza et al,(2005) on *Oreochromis niloticus* and Santos et al,(2000) on *Hoplias malabaricus*. A range of 31.85% to 39.50% obtained in this study is comparable to 36.80% - 44.40% obtained by Bugeon et al., (2010) in rainbow trout and agrees with Oellermann and Hecht (2001) that reported 38.90% for *Clarias gariepinus*. The result of 33.00% for *Clarias* Group B (500 g – 999 g) and 35.95% for *Clarias* Group C (1.00 kg – 1.499 kg) also agree with 34% reported by Adeyemi et al., (2012) for *Clarias gariepinus* of body weight ranged between 0.9 kg and 1.2 kg. However, results of this study differ from that reported by Adeyemo, (2013), who reported
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52.50% for *Clarias gariepinus*. Higher fillet yields had also been reported for some other fish species such as 47.43% - 49.79% for Pirarucu – *Arapaima gigas* (Forgaca et al., 2011), 56.20% - 65.40% for skin-on rainbow trout fillet (Bugeon et al., 2010) and 43.80% for *Clarias gariepinus* 5 *Heterobranchus longifilis* hybrid (Oellermann and Hecht, 2001).

Conversion ratio (raw fish: fishmeal) range of 5.29:1 to 4.48:1 obtained for the production of fishmeal from by-product of processed *Clarias gariepinus* in this study agree with 5:1 ratio reported by Akande et al. (2012) as well as with the standard yield obtainable from industrial fishmeal plants (FAO, 1986). Although, the range of 55.87% – 57 .40% crude proteins obtained from analyzed *Clarias* fishmeals produced from by-product of processed *Clarias* *gariepinus* was lower than the range of 59.2% - 61.9% crude protein reported by Dale, (2001) for catfish meal, the range of 20.00% - 25.10% ash content reported in this work for was similar to the range of 22.8% - 24.1% ash content reported by Dale, (2001) for catfishmeal.

5. Conclusion

Weight of *Clarias gariepinus* was found to have direct relationship with its fillet yield. A fish processor is hereby advised to process *Clarias gariepinus* of weight class 1.5kg – 1.99kg to get the highest amount of fillet yield. The waste generated from processing *Clarias gariepinus* of weight class1.5 kg – 1.99kg is also recommended for fishmeal production since it gave the highest amount of fishmeal yield, crude protein content and lowest ash content of the fishmeal produced thereby making it most desirable for compounding diets for growing fish and other livestock.

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