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ORIGINAL RESEARCH ARTICLE

Effects of fasting period on post-harvest flesh quality of *Clarias gariepinus*

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ABSTRACT

Post-harvest fasting period in aquaculture is carried out to empty the gut of fish, thereby reducing intestinal bacterial load, spread of gut enzymes and potential pathogens, thus preserving flesh quality. Time required for fasting is however unclear, as weight reduction is associated with food deprivation. This present study investigates the effect of fasting period on post-harvest flesh quality of Clarias gariepinus. Fifty C. gariepinus (Mean weight 2.98±0.12kg) were randomly distributed into five plastic tanks (0H, 24H, 48H, 72H and 84H) at 10fish/500L. 0H, 24H, 48H, and 72H were slaughtered at 0, 24, 48, and 72 hours of fasting respectively. However, 84H was not starved but slaughtered at 84 hours. Immediately after slaughtering, 3 fish per treatment were filleted for proximate composition and digestive enzyme activity analysis, while the remaining fish per treatment were processed for organoleptic assessment using five-man trained assessors. Data were subjected to ANOVA at $\alpha_{0.05}$. Fish biomass decreased with increase in fasting period with 72H recording the highest weight loss (190g). Crude protein, ash and lipids content were significantly higher (P<0.05) in dry samples of 0H and 84H, but were higher in 24H, 48H and 72H for wet samples. Protease and lipase activities decreased significantly (P<0.05) with increasing starvation periods while increase in amylase was observed. Protease activity ranged from 15.2U/mg protein (0H), through 12.1U/mg protein (84H) to 7.5 U/mg protein (72H), while Lipase activity ranged from 11.4 U/mg protein (0H) through 9.7 U/mg protein (84H) to 6.8 U/mg protein (72H). Sensory scores revealed that 0H had the best scores for colour, taste, smell, texture and flavor (≥ 8), followed by 84 h. This study revealed a loss in body weight after a fasting period of 48 hours. Also flesh quality was negatively affected with increased periods of fasting. Therefore, for premium quality of flesh, prolonged starvation of C. gariepinus beyond 48h prior slaughter should be avoided.

Keywords: *Clarias gariepinus*, Fasting fish, Digestive enzymes, Fish quality.

INTRODUCTION

Fish and fishery products are a very valuable source of protein and essential micronutrients for balanced nutrition and good health (FAO, 2012). Fish is a rich food consumed largely by riverine populace because of its availability and palatability. Recently, there has been an increase in fish consumption trend, and this is attributed to the growing knowledge of its constituents which contribute immensely to man's healthy life. With a global increase in inland aquaculture production from 29.9 million metric tons in 2007 to 41.9 million metric tons in 2012 (FAO, 2014), there is a growing challenge on the delivery of quality fish meat using various postharvest technology. This is because sustainable development of aquaculture is dependent on the quality of product and flesh quality which is becoming a subject of concern to fishing and aquaculture industry as total production increases. Post-harvest losses of fish which is estimated to more than 50% in developing countries exceed those of any other food commodity (Akande, 1996). This is because fish welfare at harvest is easily compromised by poor choice of handling and slaughter methods, lack of attention to detail and by unnecessary adherence to fish farming traditions.

The harvest process comprises starving the fish to empty gut, crowding the fish, gathering and

moving the fish. Fasting/starving is done for a period of one to three days depending on the water temperature (Wall, 2001). From a welfare point of view, Ashley (2007) and Stevenson (2007) postulated that fasting/starving should be as short as possible in order to avert detrimental effect on flesh quality due to stress. Study on the post slaughter time and fasting period of *Clarias gariepinus* have been reported (Sunnap *et al*., 2011). However, this report has only limited the fasting period to a maximum of 12 hours for *Clarias gariepinus*. However, fishes in aquaculture are normally starved for 24 hours prior to harvesting (Omitoyin, 2007). This study is therefore aimed at assessing the effect of prolonged fasting period on digestive enzyme activity, chemical and organoleptic characteristics of *C. gariepinus* with the specific objective of determining the appropriate fasting period for premium quality *C. gariepinus* meat/flesh.

MATERIALS AND METHODS

Experimental fish and feeding

The study was carried out at Teaching and Research farm of the Department of Aquaculture and Fisheries Management, University of Ibadan. Fifty *Clarias gariepinus* were procured from a reputable fish farm in Ibadan and acclimated to laboratory conditions for 2 weeks in concrete tank ($6m^2$), during which they were fed commercial diets (40% crude protein) twice daily to satiation. Ten fish (Mean average weight 2.98±0.12kg) each were randomly distributed into five plastic troughs (0H, 24H, 48H, 72H and 84H respectively), each with a volume of 500L. 0H, 24H, 48H and 72H were slaughtered at 0, 24, 48 and 72 hours of starvation respectively. However, 84H was not starved but was slaughtered at 84 hours.

Sample preparation and analysis

Fish were stunned and slaughtered using a sharp knife, washed with clean portable water and allowed to drip. Immediately after the fish were slaughter for each treatment, three samples were filleted to determine their proximate composition and digestive enzyme activity while the rest of the samples were processed for organoleptic assessment. The proximate analyses of carcass on wet and dry basis for crude protein, ash, ether extract, crude fibre and moisture were carried out in duplicates using official methods described by AOAC (2005).

For digestive enzyme analyses, the whole gut were homogenized and the homogenates were centrifuged at 1200 rpm for 30 minutes at 4^{o}C (Fagbenro *et al*., 2005). The supernatants were used as crude enzyme extracts without further purification. Amylase and proteases activities were determined according to Olatunde *et al*. (1988) and Balogun and Fisher (1970) respectively. While lipases qualitative determination were carried out as described by Ogunbiyi and Okon (1976).

Organoleptic assessment of smoked fish per treatment was carried out to determine flesh quality. Five-man trained assessors were chosen for sensory (texture, taste, smell, flavor and colour) evaluation using a 9-point hedonic scale (Afolabi, *et al*., 1984).

Statistical analysis

Data representing means were subjected to One way analysis of variance (ANOVA) using SPSS (Statistical Package Computer Software 20.0 version, Chicago Illinois, USA) Differences between individual means were separated using Duncan Multiple Range Test (DMRT) at $P < 0.05$.

RESULTS

The weight of fish before and after starvation revealed a reduction in weight as a result of treatment as shown in Table 1. The weight reduction as a result of treatment varied significantly ($P<0.05$) with the highest reduction in weight recorded in 72H (190g) while the least values of 0g and 10g were recorded in 0H and 84H respectively.

The result of mean proximate composition of *C. gariepinus* (Wet basis) is presented in Table 2. Crude protein (23.00%) was significantly ($P<0.05$) higher in 72H groups, with 0H and 84H having least crude protein values of 12.39 and 12.50% respectively. Similar result was obtained for ether extract, with 72H recording a value of 6.50%, while 0H and 84H recorded 4.81% and 4.30% respectively. Crude fibre contents were statistically similar for all treatments with values averaging 0.1%.

Table 1. Weight of *Clarias gariepinus* before and after starvation for varying periods.

Treatments	Weight before Starvation (Kg)	Weight after Starvation (Kg)	Weight Loss (g)
0H	3.03.±0.57	3.03^{a}±0.05	0g
24H	2,95±0.33	2.87^{d}±0.03	80g
48H	2.98±0.34	2.91^{c}±0.57	70g
72H	2.97±0.57	2.78^{e}±0.43	190g
84H	2.94±0.48	2.93^{b}±0.33	10g

Table 2. Mean proximate composition (%) of *Clarias gariepinus* (Wet basis) during fasting period.

Treatment	Crude protein	Ash	Ether extract	Crude fibre	Moisture content
0H	12.39^{e}±0.01	3.06^{a}±0.49	4.81^{c}±0.01	0.10±0.00	71.37^{b}±0.06
24H	17.90^{b}±0.01	2.50^{c}±0.01	5.40^{b}±0.10	0.11±0.00	67.86^{d}±0.05
48H	16.40^{c}±0.01	2.80^{b}±0.00	5.40^{b}±0.00	0.10±0.00	68.83^{c}±0.05
72H	23.00^{a}±0.00	2.00^{d}±0.01	6.50^{a}±0.01	0.11±0.00	64.23^{e}±0.05
84H	12.50^{d}±0.01	1.30^{e}±0.00	4.30^{d}±0.00	0.10±0.00	74.69^{a}±0.01

Means with the same superscript along the same column are not significantly (P>0.05) different

On dry basis, 84H groups had a significantly (P<0.05) higher crude protein value of 64.80% as shown in Table 3. Fasting resulted in a significant reduction in the crude protein content as values reduced from 52.00% in 24H to 43.76% in 72H. Ash contents were similar and significantly (P<0.05) higher in 0H (11.10%) and 84H (11.03%), while the least value (5.93%)

was recorded in 72H. Ether extract ranged from 16.62% in 48H to 18.17% in 0H. Crude protein, ash, ether extract and crude fibre values were higher in dry samples than in wet irrespective of the treatment.

The results of the digestive enzyme activities in experimental fish are presented in Table 4. The highest protease activities was recorded in 0H (15.20 U/mg protein), followed by 84H (12.10 U/mg protein), while the least value of 7.50 U/mg protein was observed in 72H. Lipase activities followed this same trend, with 0H recording 11.4 U/mg protein, followed by 84H (9.70 U/mg protein) and least value of 6.80 U/mg protein recorded in 72H. Amylase activities ranged from 4.1 U/mg protein in 0H to 6.70 U/mg protein in 72H. Statistically higher values were recorded in 24H (5.8 U/mg protein), 48H (6.40 U/mg protein) and 72H (6.70 U/mg protein).

The result of organoleptic characteristics of *C. gariepinus* is presented in Table 5. The product quality differed significantly (P<0.05) among tested groups. 0H and 84H groups gave the best meat quality in terms of colour, taste, smell, texture and flavor, followed in decreasing order by 24H, 48H and 72H. Colour, taste, smell and flavour in 24H and 48H groups were statistically (P>0.05) similar.

Table 3. Mean proximate composition (%) of *Clarias gariepinus* (Dry basis) during fasting period.

Treatment	Crude protein	Ash	Ether extract	Crude fibre	Dry matter
0H	55.25^{b}±0.46	11.10^{a}±0.10	18.17^{a}±0.07	0.33^{a}±0.05	28.57^{d}±0.06
24H	52.00^{c}±0.70	8.17^{c}±0.28	17.09^{bc}±0.01	0.33^{b}±0.05	32.23^{b}±0.05
48H	49.26^{d}±0.20	9.17^{b}±0.12	16.62^{d}±0.62	0.41^{a}±0.01	31.50^{c}±0.51
72H	43.76^{e}±0.37	5.93^{d}±0.05	16.86^{cd}±0.05	0.30^{b}±0.00	35.83^{a}±0.05
84H	64.80^{a}±0.01	11.03^{a}±0.60	17.26^{b}±0.05	0.40^{a}±0.00	25.02^{e}±0.06

Means with the same superscript along the same column are not significantly (P>0.05) different

Table 4. Digestive enzymes activity of *Clarias gariepinus* during fasting period.

Treatment	Protease Activity (U/mg of protein)	Amylase Activity (U/mg of protein)	Lipase Activity(U/mg of protein)
0H	15.2^{a}±0.25	4.1^{d}±0.00	11.4^{a}±0.15
24H	9.1^{c}±0.35	5.8^{b}±0.15	8.1^{c}±0.20
48H	7.7^{d}±0.15	6.4^{a}±0.05	6.9^{d}±0.15
72H	7.5^{d}±0.10	6.7^{a}±0.50	6.8^{d}±0.05
84H	12.1^{b}±0.25	5.1^{c}±0.25	9.7^{b}±0.10

Means with the same superscript along the same column are not significantly (P>0.05) different

Table 5. Mean sensory score for oven dried *Clarias gariepinus*.

Time (h)	Colour	Taste	Smell	Texture	Flavour
0H	8.4^{a}±0.16	8.2^{a}±0.21	8.1^{a}±0.21	8.0^{a}±0.30	8.1^{a}±0.23
24H	5.8^{c}±0.33	6.0^{b}±0.29	5.7^{b}±0.32	5.9^{b}±0.29	5.9^{b}±0.30
48H	5.4^{c}±0.25	5.2^{b}±0.26	5.3^{b}±0.21	4.9^{c}±0.26	4.9^{b}±0.28
72H	2.9^{d}±0.33	2.8^{c}±0.34	2.9^{c}±0.30	3.3^{d}±0.30	2.9^{c}±0.34
84H	7.6^{b}±0.30	7.7^{a}±0.30	7.8^{a}±0.34	7.9^{a}±0.28	7.8^{a}±0.31

Means with the same superscript along the same column are not significantly (P>0.05) different

DISCUSSION

The weight reduction recorded in this present study as a result of fasting is in agreement with Omojowo *et al.* (2009) who reported a decline in total body weight as one of the manifestations of starvation. Similarly, inverse relationship between fasting period and body weight has been reported in *Salvelinus alpines* and a reduction in the coefficient of conditions reported in fasted trout after 2 days of deprivation (Javier, 2013). Fasting which has been described as early phase of food deprivation, in addition to gut evacuation and reduction in waste production also causes animals to mobilize available metabolites reserves thus accounting for the loss in weight. The effect of food deprivation on body weight reduction has been reported (Sumpter *et al*., 1991; Caruso *et al*., 2011), however the time it takes to start decreasing is unclear. MacMillan and Houlihan (1991)

reported a minimum of 6 days for rainbow trout, while 14 days was reported by Nikki *et al.* (2004) for this same species. However, Figueido-Garutti *et al.* (2002) found significant reductions after just 24 hours in *Brycon cephalis*. In this present study significant reduction in weight was recorded at 72 hours of deprivation.

The mean values obtained for proximate composition varied significantly in wet and oven-dried carcass of *C. gariepinus* for all treatments. These values were found to be within the limits reported by Fawole *et al*. (2010), for *O. niloticus, S. galilaeus, C. gariepinus and H. niloticus.* Crude protein, ash and lipids content were significantly higher in dry sample of fish fed (0H and 84H), while crude protein and lipid were significantly high in wet samples of starved fish (24H, 48H and 72H). The high proteins and lipids content in wet carcass of starved *C. gariepinus* confirms that fasting period of about 72 h delivered better quality product.

Higher protein and lipid contents of dried fish samples in the present study may be attributed to the concentration of nutrients as a result of processing. This assertion is supported by Huda *et al*. (2010) who reported high concentration of protein and fat in processed fish. Power *et al*. (2000) and Guderley *et al*. (2003) showed that starvation produces changes in muscle composition and shrinkage of muscle fiber, therefore leading to increase in concentration of protein and lipid. There was a significant difference in the dry matter content of dry samples, with the highest value recorded in 72H, while it also gave the least moisture content for wet samples. Conversely, the lowest dry matter was recorded in the 84H, which had the highest moisture content. Fasting may have resulted in changes in the chemical structure of the fish thus resulting in varied composition. Reduction in moisture content of fasted fishes has also been reported by Mondal and Mohsin (2014). The digestive enzyme result showed that protease and lipase activities decreased significantly as starvation period increases while amylase increased with increasing starvation period. This is indicative of a rapid utilization of stored glucose to meet the energy demand of the fish at the onset of starvation.

The organoleptic assessment of fish samples showed significant difference in product quality with control groups being superior to the starved groups. Report of the sensory panelists revealed that non-fasted fish had the best scores for colour, taste, smell, texture and flavor. However, the measured parameters decreased significantly with increasing starvation period. This result was supported by the findings of Akande and Ola (1999), who reported that African catfish *Clarias gariepinus* processed immediately after harvest (0 hr. of fasting) displayed a very good physical attributes, with a fresh, fishy odour, delicious flavor and sweet taste together with firm and tender texture. Similar results were reported by Akande and Faturoti (2003) and Robb (2008).

CONCLUSION

The study demonstrated the effect of fasting period on post-harvest flesh quality of *C. gariepinus.* The results of this study suggest that fasting period of not more than 48 hours prior to slaughter is recommended for *C. gariepinus* to prevent loss in weight and maintain premium flesh quality.

CONFLICT OF INTEREST

The authors recognize that there are no financial or other conflicts that may bias this work.

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