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Time Series Behavioural Effects and Postmortem Changes of *Clarias gariepinus* under Varying Gear Handling Conditions

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Abstract: A study of time series behavioural effects and post mortem changes of *Clarias gariepinus* under varying gear handling conditions was carried out using forty live samples of *Clarias gariepinus* of average body weight 165 gm bought from Aleshinloye market in Ibadan, Oyo State, Nigeria. The samples were grouped into 4 treatments A, B, C and D with 10 pieces in each treatment. Treatment A fish were fixed to Hook and line, fish species in treatment B were fixed to the gill net, treatment C fish were dragged from the pond with a dragnet and fish in treatment D (which served as the control) were washed with clean water and left to die naturally in a clean bowl of water. All treatments were left in the different gears to struggle and die at ambient temperature. They were also left in their various conditions after death for rigor mortis to occur and the time taken for rigor to resolve was noted and at the temperature they occurred. After fish from each treatment were packed in polythene bags with labels and then stored in the freezer at a temperature of-20°C. Organoleptic and chemical assessment test were carried out on samples of each treatment every fortnight for 10 weeks. The death time/rigor time and temperatures at which they occur were as follows:-Treatment A (Hook and line) 158.5 mm death time/181.00 rigor time at 26°C. Treatment B gilled fish) death time 241.50 min/169.00 min rigor time at 28°C. Treatment C (Dragged fish) death time 667.00 min/269.50 min. rigor time at 25°C. Treatment D (control left to die naturally) death time was 827.00 min/289.50 min. rigor time at 26.50°C. Rigor mortis does not last longer in struggling and exhausted fish as it is the case with treatments B and A coupled with their earlier death than in treatments C and D, although rigor mortis started earlier in C. Hence treatment A and B showed earlier signs of spoilage than C and D. Significant differences exist $p<0.05$ between the Total Volatile Base (TVB) and the weeks of storage with the gilled fish (Treatment B) having the highest overall TVB accumulation of 93.00 mg 100 gm^{-1} fish indicating the fastest rate of spoilage, followed by Hook and line (Treatment A) 88.20 mg 100 gm^{-1} fish, ranking third is the Dragged fish (Treatment C) with 84.50 mg^{-1} 100 gm fish, while the least value of 79.20 mg^{-1} 100 gm fish was recorded (in the control) indicating least spoilage. The organoleptic assessment followed a similar pattern. This is further confirmed by the positive correlation coefficients (A-r = 0.99, B-r = 0.99, C-r = 0.60 and D-r = 0.98) in all cases indicating increase rate of spoilage with storage length (weeks). The best gear to use for catching *Clarias gariepinus* (apart from allowing the fish to die naturally) as shown in the study is the DRAGNET, since this exerted far much less stress on the fish.

Key words: Gear handling, death time, rigor time, organoleptic, chemical assessment, spoilage rate

INTRODUCTION

If fish species are left to stay and struggle in fishing gears for a long period of time after capture, spoilage is hastened and consequently there is an increase in the rate of bacteria and autolytic action in the fish. Also the rate of rigor mortis is also affected. Rigor mortis does not last longer in struggling and exhausted fish. Single quick resolution of rigor mortis sets the pace for early spoilage of fish after death, hence fish should be preserved by freezing immediately after landing. Whatever fish gear handling method is used fresh fish pose handling problems to fishermen as they pass through rigor mortis at a fast rate and deteriorate at the prevailing ambient temperature before landing. This is because most artisanal fishermen do not have ice plant or chilling facilities in their boats and in places where they are available they are hardly put to use. (Eyo, 1986).

Good handling of fish ensures that the catch retains its initial freshness, as far as possible. Fish being a highly perishable food and thus its food value deteriorates if not properly handled if the keeping quality and shelf life are to be improved to any reasonable extent (Eyo, 1986).

The stiffening effect accompanying rigor mortis is due basically to a contraction of the transverse muscles. The biochemical and physiological processes in the dying fish muscles are responsible for this phenomenon. Rigor mortis results from a series of complicated chemical changes in the muscle of a fish after death, initially, glycogen is hydrolysed or broken down leading to an accumulation of lactic acid in the muscles and reducing their pH. This in turn stimulates the enzymes that hydrolyse the organic phosphates to break up creative Phosphate and Adenosine Triphosphate (ATP). Early exhaustion of these energy reserves leads to early resolution of rigor mortis, accumulation of spoilage products and accelerated rate of spoilage (Emokpae, 1979).

Rigor mortis is especially important in the preservation of fish, for it retards post mortem autolysis and bacterial decomposition (Frazier and Westhoff, 1978). Therefore any procedure that lengthens rigor mortis lengthens fish quality keeping time. It is longer if the fish have not been handled roughly and bruised during catching and later processing and is longer in certain species of fish than in others.

In order to ensure that fish produced is adequately made available in good quality care must be taken in the selection of gear used to prevent exhaustion, and depletion of energy reserves in order to preserve the quality of the fish and extend its shelf life.

It is therefore the objective of this study

- To promote the best gear handling method that will reduce spoilage to a minimum in *Clarias gariepinus.*
- To determine the different rates at which rigor mortis sets in and resolved under different handling gear conditions for *Clarias gariepinus.*
- To determine the rate of spoilage of *Clarias gariepinus* on cold storage under varying handling gear conditions after resolution of rigor mortis.

MATERIALS AND METHODS

Forty live samples of *Clarias gariepinus* of average weight ranging between 150 gm and 200 gm were bought from Aleshinloye market in Ibadan, Oyo State Nigeria. They were transported to the Departmental fish farm in plastic bucket containing water. They were grouped into 4 treatments in a bid to observing behavioural effects and post mortem changes of *Clarias gariepinus* under varying gear handling conditions. The fishes were subjected to the following gear handling condition until they died and rigor mortis sets in and resolved:-

- Treatment A-The 10 fish samples in this treatment were fixed to hook and line and left to die and rigor mortis resolved.
- Treatment B-The fish samples were gilled to the gill net until death/resolution of rigor mortis.
- Treatment C-Also here the 10 fish samples were dragged continuously after placing in a small dragnet of (10×10 m) in a 20×20×1 m pond until death and resolution of rigor mortis.
- Treatment D-Served as the control fishes in this group were not subjected to any gear handling treatment. They were washed and placed in a 250 litres plastic bowl filled with water. They were left to die naturally and rigor mortis was allowed to set in and resolve.

The time taken for fishes in each treatment to die and for rigor mortis to set in and resolved were recorded and the temperatures also noted. The ambient temperature at the time the fishes were fixed to the gears, temperature at death time and at onset and resolution of rigor mortis were taken.

After the resolution of rigor mortis samples of fish in each treatment were taken to the laboratory for initial proximate analysis, chemical test Total Volatile Base (TVB) and organoleptic assessment of cooked and uncooked samples. The remaining part of each of the 4 treatments were placed on four different polythene bags and kept in the deep freezer at 20°C. The experiment lasted for 10 weeks, while measurements of all parameters (osrganoleptic and chemical) were taken fortnightly however the final proximate analysis of the fish samples in each treatment were taken as the end of the ten week experimental period.

Proximate analysis of samples were carried out for moisture context, ash lipid and crude protein according to A.O.A.C., 1990 methods. Total Volatile Base (TVB) determination was done by the use of the macro-kjeidahl distillation apparatus. The T.V.B. was determined by titrating the distillate with 0.1 NH 504.

A six man panel (made up of students from the department) were briefly trained on sensory assessment. Samples from each treatment was taken from the freezer and left for 2 h to thaw and then assessed for the uncooked fish samples. The measurement for the degree of freshness was obtained with a scoring system with scales acceptable from 8 to 1 (8 denoting extremely acceptable (absolutely fresh) and 1 completely unacceptable (i.e., putrid). The parameters used by the panel members to determine the characteristics of uncooked whole fish were as follows:

- Appearance: This include skin mucus, shape of the eyes, colour of the gills and rigidity of the abdominal wall.
- Texture: degree or loss of elasticity of the flesh
- Odour.

For the cooked fish the parts of fish sample in each treatment was cut and boiled for 25 min and then presented to the panels on plates. The panel members were asked to rinse their mouth before testing the fish so as to avoid any bias in the result. The parameters employed by the panel were as follows:

- Taste
- Odour
- Textxure

Score pattern:

Extremely acceptable/very good	8
Good	7
Satisfactory	6
Just satisfactory	5
Fair	4
Unsatisfactory	3
Poor	2
Extremely unacceptable	1

RESULTS

The fastest death time of 158.50 mins was recorded in treatment B (Hook and line) with a rigor time of 181.00 min Treatment B (Gilled fish) is next with a death time of 241.50 min and with a rigor time of 169.00 min. The third ranking gear is treatment C (Dragged fish) with a death time 667.00 min and a rigor time of 289.50 min, while treatment D (control, with no gear treatment) had a death time of 827.00 min with a rigor time of 289.50 min as shown in Table 1.

As shown in (Table 2 and 3) at the initial stage all the treatment had a high moisture and protein content. Treatment D (control i.e., fish left to die nalturally) had the highest moisture and protein content of 25.20% moisture and 64.50%, while treatment A (fish on hook and line) had the lowest protein and moisture content of 24.46% moisture and 63.46% compared to other treatment.

Also in the final analysis the moisture content of all the treatment was low with treatment B (Gilled) being the lowest (18.61%). Also the protein levels were reduced in all treatments. However higher lipid contents and ash contents were recorded for all treatments at the final stage.

The control (Treatment D) that was left to die naturally (Table 3) had the best keeping quality recording the highest final Ccrude Protein (C.P) of 49.32% and highest lipid of 16.60%. This is closely followed by the dragged fish with C.P. 48.52% and lipid 16.05%. The lower values recorded for treatment A (Hook and line) and B (Gilled) is probably due to the expansion of the fish in their gear before death.

As shown in Table 4 and 5 the mean organoleptic assessment results for both cooked and uncooked followed a sharp decline from good to poor by the end of the 10th week. However very sharp decline (deteriorative changes) were recorded for the cooked/uncooked fish samples as from the 8th-10th week for A (fish caught with hook and line) 2.26-1.63 (cooked)/3.1-1.8 (uncooked) and for B (gilled fish) 2.33-1.70 (cooked)/3.20-1.80 (uncooked).

Table 6 shows there was a rapid increase in the T.V.B. values of all the treatment from the 6th week to the 10th week with treatment A (Hook and line) having the highest value in the 10th week (35.40 mg^{-1} 100 gm fish) while

Table 1: Death time/rigor time of clarias gariepinus under varying gear handling conditions

Treatment	Total length	Weight	Death time	Time rigor mortis starts	Time rigor mortis resolved	Rigor time
A (Hook and line	27.00 cm	167.00 gm	158.50 min	185.00 min	366.00 min	181.00 min
B (Gilling)	27.76 cm	165.00 gm	241.50 min	103.00 min	272.00 min	169.00 min
C (Dragging)	28.50 cm	168.00 gm	667.00 min	223.00 min	492.50 min	269.50 min
D (Control) No gear	26.75 cm	160.00 gm	827.00 min	256.00 min	545.50 min	289.50 min

Table 2:Initial proximate composition of experimental fish

Treatments	Moisture (%)	Crude protein (%)	Crude fibre (%)	Lipid (%)	Ash (%)	N.F.E
A (Hook and line)	24.46	63.49	0.1899	6.60	3.50	1.49
B (Gilled)	24.60	63.76	0.1820	6.56	3.20	1.96
C (Dragged)	24.95	64.03	0.0510	6.50	3.00	1.47
D (Control)	25.20	64.50	0.0620	6.56	2.70	0.98

Table 3:Final proximate composition of experimental fish

Treatments	Moisture (%)	Crude protein (%)	Crude fibre (%)	Lipid (%)	Ash (%)	N.F.E
A (Hook and line)	18.95	47.39	3.865	11.94	14.59	3.27
B (Gilled)	18.61	47.49	3.624	11.43	12.68	3.17
C (Dragged)	20.54	48.52	2.090	16.05	9.87	2.98
D (Control)	21.65	49.32	1.670	16.60	9.06	1.70

Table 4:Organoleptic result uncooked (mean result) of experimental fish

Treatments	0 Day	2nd week	4th week	6th week	8th week	10th week
A (Hook and line)	0.00	7.10	6.70	4.80	3.10	1.80
B (Gilled)	0.00	7.10	6.70	4.90	3.20	1.80
C (Dragged)	0.00	7.20	6.80	5.10	3.70	2.00
D (Control)	0.00	7.30	6.90	5.30	4.00	2.00

Table 5: Organoleptic result cooked (mean result) of experimental fish

Treatments	0 Day	2nd week	4th week	6th week	8th week	10th week
A (Hook and line)	0.00	6.96	6.40	4.70	2.26	1.63
B (Gilled)	0.00	7.03	6.43	4.83	2.33	1.70
C (Dragged)	0.00	7.13	6.53	5.33	2.50	1.86
D (Control)	0.00	7.20	6.60	5.20	3.13	1.86

Table 6: Total volatile base (mg^{-1} 100 gm fish) of gear handled *clarias gariepinus* under cold storage conditions

Treatment	0 Day	2nd week	4th week	6th week	8th week	10th week	Total tvb for 10 weeks
A (Hook and line)	0.00	3.50	8.20	20.50	25.40	35.40	93.00
B (Gilled)	0.00	2.80	7.40	19.20	24.60	34.20	88.20
C (Dragged)	0.00	3.00	6.50	18.60	24.10	32.30	84.50
D (Control)	0.00	2.90	5.00	18.20	23.70	29.40	79.20

treatment D (Control) had the lowest value (29.40 mg^{-1} 100 gm fish). Also the highest cumulative overall TVB value of 93.00 mg^{-1} 100 gm fish was recorded in treatment A, followed by 88.20 gm (treatment B), 84.50 gm in treatment C and the least value of 79.20 gm was recorded in treatment D (control).

DISCUSSION

The mode of handling fresh fish immediately it is caught determines the final quality characteristics of the fish and it also affects the rate of spoilage of the fish, as it is the case for *Clarias gariepinus* in this study. The Total Volatile Base (T.V.B) for treatment A (Hooked fishes), B (Gilled fishes) and C (Dragged fishes) at the end of the 10 week study were 35.40 mg^{-1} 100 gm, 34.20 mg^{-1} 100 gm and 32.30 mg^{-1} 100 gm fish at the final state were all above the acceptability range recommended by Pearson (1982) which states that the T.V.B limit of acceptability of fish (in terms of spoilage) is 20-30 mg^{-1} 100 gm fish, only treatment D (controlled fish) seems to fall under this range with a value of 29.40 mg^{-1} 100 gm fish as shown in Table 6 meaning that only the control fish which was not subjected to any gear could be deemed acceptable within the 10 week experimental period, however, fishes in treatments A, B and C could still be acceptable up to 6 weeks with values 20.50, 19.20 and 18.60 mg^{-1} 100 gm fish respectively.

In this study rigor mortis did not last longer in struggling and exhausted fish. As shown in Table 1 rigor mortis did not last longer in treatment A (Hook and line) (181.00 min.) and Treatment B (Gilled fish) 169.00 min compared with treatment C (Dragged fish) (269.50 min.) and treatment D (Control) (289.50 min.). This also coincided with there earlier deaths in the various gears depending on the level of sophistication of the gears which also shows that fishes in treatment A died earlier followed by B, C and D. It is also noted that fishes in gears having direct contact with a part of the fish such as treatment A and B (having direct contact with the head and gills) died much earlier and went into rigor mortis and also rigor mortis resolved at earlier stages, thus allowing spoilage to set in quickly.

Fish species should therefore not be allowed to stay too long in fishing gears, they should be removed immediately they are caught and then cleaned by rinsing in clean water and should then be stored or preserved immediately by chilling or by freezing immediately after landing.

Also the correlation coefficient (r) of the treatment are almost equal to each other (treatment A-r = 0.99, B-r = 0.99, C has r = 0.60 and D-r = 0.98 out of the correlation coefficient of C is lower to the others), this positive correlation recorded in all cases is an indication that spoilage in *Clarias gariepinus* increases with length of storage as indicated by the increasing TVB value from 0-10 weeks.

Also as shown in Tables 2 and 3 the final proximate analysis of the fish shows that the moisture content of all the treatment was low with treatment B (Gilled fish) being the lowest (18.61%). Also the protein levels were reduced, however higher lipid and ash contents were recorded for all treatments at the final stage.

The Control (Treatment D) that was left to die naturally (Table 3) had the best keeping quality recording the highest final crude protein of 49.32% and highest lipid of 16.60%. This is closely followed by the dragged fish with C.P 48.52% and lipid 16.05%. The lower values recorded for treatment A (Hook and line) and B (Gilled fish) is probably due to the exhaustion of the fish in their gear before death.

CONCLUSION

The best gear to use for catching *Clarias gariepinus* (apart from allowing the fish to die naturally without any form of stress) is the drag net. This gear will reduce stress on the fish and preserve the keeping quality (if not consumed immediately) under cold storage conditions.

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