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Effect of Different Storage Temperatures on Chemical Composition and Sensory Attributes of the Flesh of *Cyprinus carpio* and *Clarias gariepinus*

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ABSTRACT

The organoleptic evaluation and proximate analysis of *Cyprinus carpio* and *Clarias gariepinus* were determined in fresh fish and when refrigerated at two different temperatures (-21ºC and 4ºC) for a period of six weeks. A panel of twelve trained judges evaluated the colour, texture, softness and flavour of fish meat after two minutes of steam cooking. Average score revealed a general decline in organoleptic properties such as colour, texture, freshness, and taste of *Cyprinus carpio* and *Clarias gariepinus* stored at two temperatures compared to the fresh fish. Proximate analysis revealed, decrease in crude protein and lipid contents, and increase in ash content of muscles of *Cyprinus carpio* and *Clarias gariepinus* stored at freezing temperatures. Moisture content decreased in the fish muscle samples of both the fish species stored at -21ºC but increased in the samples stored at 4°C. pH of fish was found to increase in the samples stored at 4°C and -21°C. There were significant differences ($P<0.05$) in the organoleptic and proximate composition of the stored and fresh *Cyprinus carpio* and *Clarias gariepinus*. The quality of fish muscle stored at 4°C deteriorated faster than that of the one stored at -21ºC. Thus, storage temperature and duration have adverse effects on the nutritional quality of fish meat.

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***Cyprinus carpio, Clarias gariepinus,* organoleptic evaluation; chemical analysis, proximate composition of fish flesh.**

INTRODUCTION

Presently people are more sensitive to healthy eating than in the past (Oriakpono *et al*., 2011). People prefer white meat like fish over to red meat due to its high nutritional contents (Mahboob *et al.*, 1996). Aquaculture practices are considered today as one of the most promising sources of animal protein. During the recent past, the potential and prolific nature of fish culture has been directed towards its large-scale adoption and promotion in developing countries. A reason for the steady increase in aquaculture production and maintenance is the lack of research and technical input and the expansion of areas under culture (Mahboob, 2014). Fish and shellfish contain about 19% protein similar in amino acid composition to that found in muscle meats. The protein content varies up to 20%, depending upon the species and the season of the year. Fish contains considerably lower fat content than beef (Ndome *et al*., 2010a).

Nutritional quality and organoleptic acceptability in terms of color, texture, smell, flavour and appearance may be affected by the environmental degradation and quality of nutrition and feed provided during culture, especially in semi-intensive and intensive culture systems compared to wild fish (Thomas, 1973; Grigorakis *et al*., 2003). Meyers (1975) reported the attributes of off-flavour of freshwater fish reared under nutritional treatments and different water quality parameters with special reference to consumer acceptance rather than conventional individual characteristics such as flavour, taste and appearance. The spoilage of fresh fish can be attributed to series of metabolic processes that deteriorate fish quality and render it undesirable and unacceptable for human consumption due to changes in sensory and biochemical characteristics (Ndome *et al.,* 2010b). The noxious smells of spoiled fish are suspected to be produced by microbes to repulse large animals, thus reserving the food resource for them while increasing spoilage and reducing organoleptic properties (Sherrat *et al*., 2006; Braun and Sutherland, 2005). Due to the increase in fish consumption, there seems to be a habit of storage for a long period with an assumption, that the fish maintains the nutritional quality and safe for human consumption. The objective of this study was to assess overall changes in proximate composition and organoleptic quality of flesh of fresh *Cyprinus carpio* and *Clarias gariepinus* and those stored at two temperatures -21ºC and 4ºC.

MATERIALS AND METHODS

Sample collection and preparation

Seven fish samples with three replicates of *Cyprinus carpio* and *Clarias gariepinus* with an average weight of 1200-1500 g were procured from the angler. The fish

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were gutted and washed with the tap water. The sampled fish was dressed and cut down into two halves; one was used for the proximate analysis and the other for organoleptic evaluation.

Chemical analysis

The moisture, protein, lipid and ash content of the fish samples were assayed determined by following method as described by the AOAC (2000).

Organoleptic assessment

The sensory properties of the ice stored and fresh *Cyprinus carpio* and *Clarias gariepinus* were evaluated by a panel of 12 trained Judges. Assessment of colour, texture, freshness and taste were based on both cooked and uncooked fish samples. Questionnaires for the panelists were prepared using the modified 5- point hedonic scale described by Eyo (2001) as follows: 1-1.9, unacceptable; 2.0-2.9, fair; 3.0-3.9, medium; 4.0-4.9, good; 5.0-6.0, very good.

Statistical analysis

ANOVA was performed using the Minitab version 15 software package, and the means were compared by Turkey's test.

RESULTS AND DISCUSSION

pH of fish flesh

There were significant changes in pH levels of the fish flesh of both the species with time. The pH of fish stored at -21ºC decreased to 6.79±0.34 and 6.82±0.24 after one week of storage of *Clarias gariepinus* and *Cyprinus carpio*, respectively. After third week it started increasing at the end of sixth week and final pH recorded was 7.05±0.39 and 7.21±0.43 in *Clarias gariepinus* and *Cyprinus carpio*, respectively. The pH of fish at 4ºC decreased to 6.81±0.25 and 6.85±0.25 after one week of storage of *Clarias gariepinus* and *Cyprinus carpio*, respectively. Later on, after the third week it started rising and was recorded as 7.31±0.41 and 7.32±0.40 in *Clarias gariepinus* and *Cyprinus carpio*, respectively at the end the sixth week. The fish sample was acidic, but became alkaline with the increase in storage time. Statistical analysis revealed significant differences ($P<0.05$) in pH levels in *Clarias gariepinus* and *Cyprinus carpio* stored at 4ºC and -21°C (Table I). The pH increased with increasing storage time. The increase in pH was higher at 4ºC in both fish species compared to ones stored at -21ºC indicating that biochemical and microbial changes were occurring faster in the flesh stored at 4ºC. The increase in pH may be attributed to fermentation of carbohydrate to from acid during the first week of storage at -21ºC (Table I). Eye (2001) reported that pH might be used as an indicator for the extent of microbial spoilage in fish. The increase in pH may also express the accumulation of alkaline compounds such as ammonia, mainly derived from microbial actions. The increase in pH may also be attributed to an increase in volatile compounds from the decomposition of nitrogenous compounds by endogenous or microbial enzymes (Erkan and Ozden, 2008). Our results are in line with the findings of above-mentioned workers. Pacheco-Aguilar *et al.* (2000) reported pH as an index, which is important in determining the quality of fish, and it can be used as a guide. The pH of fish muscles and gills has an important effect on its freshness because of its influence on bacterial growth.

Table I.- pH levels of fresh **and stored *Cyprinus carpio and Clarias gariepinus.***

Storage time (Weeks)	*Clarias gariepinus*		*Cyprinus carpio*	
	-21ºC	-4ºC	-21ºC	-4ºC
0	6.85±0.32cA	6.83±0.25eA	6.87±0.22eA	6.87±0.22fA
1	6.79±0.34dB	6.81±0.29eB	6.82±0.24eA	6.85±0.28fA
2	6.88±0.30cC	7.02±0.34dA	6.93±0.31dB	7.01±0.38eA
3	6.95±0.35bD	7.14±0.26cB	7.02±0.35cC	7.16±0.40dA
4	6.99±0.37bD	7.19±0.28bB	7.11±0.37bC	7.22±0.35cA
5	7.02±0.36aD	7.23±0.36bB	7.15±0.41bC	7.28±0.42bA
6	7.05±0.39aD	7.31±0.41aB	7.21±0.43aC	7.35±0.40aA

a-c Different letters in the same column indicate significant difference ''P<0.05''.
A-B Different letters in the same row indicate significant difference ''P<0.05''

Chemical composition

Proximate analysis of fish muscle of *Cyprinus carpio* and *Clarias gariepinus* exhibited a decrease in the crude protein and lipid content compared to the fresh fish from 2nd to 6th week (Table II). The crude protein content in *Cyprinus carpio* in muscle samples stored at -21ºC was observed to decrease from 15.44±1.41% to 9.95±0.67% after the sixth week of storage, while in fish muscle sample stored at 4ºC the crude protein decreased from 15.44±1.41% to 9.20± 0.70% after the sixth week. The crude protein content in *Clarias gariepinus* in muscle samples stored at -21ºC was observed to decrease from 16.66±1.60% to 8.87±0.75% after sixth week of storage. The crude protein decreased from 16.66±1.60% to 8.40±0.55% after sixth week in the fish muscle sample stored at 4ºC (Table II). Similarly, the lipid content in fish muscle samples of *Cyprinus carpio* stored at -21ºC was decreased from 5.53±0.82% to 3.02±0.35%, while in the same stored at 4ºC the lipid content was decreased from 5.53±0.82% to 3.35± 0.51% after the sixth week (Table II). The lipid content in the muscle samples of

Clarias gariepinus stored at -21ºC was decreased from 4.88±0.77% to 2.60±0.52%, while in fish muscle samples stored at 4ºC the lipid content was decreased from 4.88±0.77% to 2.32±0.67% after the sixth week (Table II). The moisture content in meat samples of *Cyprinus carpio* stored at -21ºC was decreased from 70.22±2.27% to 50.05±2.90%, while in meat samples stored at 4ºC the moisture content was decreased from 70.22±2.27% to 51.10±2.88% after the sixth week (Table II). The moisture content in meat samples of *Clarias gariepinus* stored at -21ºC was decreased from about 69.86±2.44% to 48.85±2. 10%, while in meat samples stored at 4ºC the moisture content was decreased from 69.86±2.44% to 50.10±2.88% after the sixth week (Table II). Ash content of *Cyprinus carpio stored* at -21ºC increased from 5.23±0.63% to 10.50±0.51%, while for the 4ºC stored sample, ash content was increased from 5.23±0.63% to 9.26±0.62% after six weeks. Similarly, ash content in meat samples of *Clarias gariepinus* stored at 4ºC increased from 5.68±0.90% to 11.90±0.60%, while for the muscle samples stored at 4ºC stored sample, the ash content increased from 5.68±0.90% to 10.70±0.68% after six weeks (Table II). Statistical analysis of the constituents of proximate composition: crude protein, crude lipid, moisture and ash revealed significant differences (P<0.05) in the different compositions within the same storage temperatures and between the two temperatures in *Cyprinus carpio* and *Clarias gariepinus.*

The decrease in crude protein of the fish during the storage could be attributed to the gradual denaturation of the crude protein to more volatile products as total volatile bases (TVB), trimethyl amine (TMA) hydrogen sulphide and ammonia. These findings were in line with the results reported by Eyo (2001). The changes in protein and lipid content may be associated with the leaching out to ice of some of the lipid fractions (Emokpae, 1979). The reduction in crude protein content of the fish may also have been due to a decrease in salt soluble protein and water soluble protein (Chomnawang *et al.*, 2007; Mahboob *et al.*, 2015) or due to autolytic deterioration associated with the actions of endogenous enzymes and bacteria (Hultman and Rustard, 2004).

The decrease in lipid content may be linked with the oxidation of polyunsaturated fatty acids found in fish tissues to other products such as aldehydes, free fatty acids, ketones, and peroxides (Horner, 1992). Ash content decreased during the experimental period. The result of proximate analysis revealed that moisture formed the highest component of the proximate composition of *Cyprinus carpio* and *Clarias gariepinus.* The moisture content was observed to decrease considerably at -21ºC stored samples, but increased slightly in the 4ºC stored samples during the storage

Table II.- Chemical Composition of fresh and stored *Cyprinus carpio* and *Clarias gariepinus*.

Storage time (weeks)	Moisture %			Protein %			Lipid %			Ash %		
	Fresh fish	-21ºC	4ºC	Fresh fish	-21ºC	4ºC	Fresh fish	-21ºC	4ºC	Fresh fish	-21ºC	4ºC
Cyprinus carpio												
0	70.22±2.27	70.22±2.27	70.22±2.27	15.44±1.41	15.44±1.41	15.44±1.41	5.53±0.82	5.53±0.82	5.53±0.82	5.23±0.63	5.23±0.63	5.23±0.63
1		66.44±1.90	68.60.±1.90		15.02±0.65	14.95±0.55		4.95±0.51	4.80±0.60		5.03±0.70	4.92±0.55
2		63.54±2.23	65.06±1.52		14.35±0.77	14.02±0.85		4.54±0.60	4..21±0.90		4.80±0.55	4.70±0.85
3		60.22±2.60	62.44±2.70		14.02±0.80	13.78±0.77		4.30±0.56	4.01±0.44		4.60±0.62	4.50±0.40
4		57.51±3.05	58.77±2.90		13.10±0.70	12.80±0.75		3.98±0.44	3.90±0.30		4.30±0.50	4.12±0.48
5		54.40±2.80	55.70±2.55		11.55±1.03	10.80±0.88		3.33±0.37	3.57±0.40		3.95±0.60	3.80±0.50
6		50.05±2.90	51.10±2.88		9.95.±0.67	9.20±0.70		3.02±0.35	3.35±0.51		3.50±0.51	3.26±0.62
Clarias gariepinus												
0	69.86±2.44	69.86±2.44	69.86±2.44	16.66±1.60	16.66±1..60	16.66±1.60	4.88±0.77	4.88±0.77	4.88±0.77	5.68±0.90	5.68±0.90	5.68±0.90
1		65.52±2.55	67.15.±2.80		16.22±1.02	15.96±1.10		4.50±0.80	4.35±0.90		5.34±1.05	5.12±0.70
2		62.02±2.80	64.31±1.90		15.44±0.66	15.08±0.92		4.06±0.80	3.92±0.95		5.04±0.60	4.83±0.66
3		60.85±2.60	62.81.±2.25		14.70±1.25	13.02±0.96		3.90±0.70	3.75±0.78		4.70±0.85	4.21±0.82
4		55.02±2.90	57.67±2.58		13.02±0.90	12.08±0.58		3.25±0.38	3.11±0.40		4.05±0.67	3.87±0.72
5		52.31±3.14	53..82±2.91		10.95±1.52	10.02±0.81		2.95±0.44	2.70±0.51		3.41±0.85	3.12±0.82
6		48.85±2.10	50.20±2.84		8.87.±0.75	8.40±0.55		2.60±0.52	2.32±0.67		2.90±0.60	2.70±0.68

a-c Different letters in the same column indicate significant difference ''P<0.05'',
A-B Different letters in the same row indicate significant difference ''P<0.05''

period, which is probably due to absorption of moisture from the cool atmosphere.

Organoleptic evaluation

The results of the present study showed a gradual decline in the organoleptic characteristics such as colour, texture, freshness and taste of *Cyprinus carpio* and *Clarias gariepinus* evaluated by a panel of trained judges (Table III). The physical attributes such as colour in *Cyprinus carpio*, the score reduced from 4.8±0.40 to 1.9±0.27 in the fish meat samples stored at -21ºC and from 4.8±0.40 to 1.6±0.41 in the sample stored at 4°C (Table III). The grade for colour of the meat of *Clarias gariepinus* was reduced from 4.9±0.35 to 1.8±0.36 in the fish meat samples stored at -21ºC and from 4.9±0.35 to 1.5±0.16 in the 4ºC stored sample (Table III). The grade for texture in *Cyprinus carpio* and *Clarias gariepinus* fluctuated from 5.6±0.60 to 2.2±0.35 and 5.8 ±0. 75 to 1.8±0.46 in the meat samples stored at -21ºC and from 5.6±0.60 to 1. 8±0.42 and 5.8±0.75 to 1.4±0.13, respectively in the samples stored at 4ºC. The grade for freshness in *Cyprinus carpio* and *Clarias gariepinus* dropped significantly since 5.3±0.31 to 2.2±0.35 and 5.5 ±0.38 to 1.7±0.27, respectively in the meat samples stored at -21ºC stored sample. While the grade for freshness in the meat samples of *Cyprinus carpio* and *Clarias gariepinus* stored at 4ºC was dropped significantly from 5.3±0.31 to 1.9±0.38 and 5.5 ±0. 38 to 1.4 ±0. 27, respectively. The grade for taste in in the meat samples of *Cyprinus carpio* and *Clarias gariepinus* stored at -21ºC dropped significantly from 5.4±0.62 to 2.4±0.54 and 5.7±0.55 to 2.0±0.42, respectively. While the score for taste in the meat samples of *Cyprinus carpio* and *Clarias gariepinus* stored at 4ºC dropped significantly from 5.4±0.62 to 2.1±0.28 and 5.7 ±0.55 to 1.7±0.22, respectively. The comparison of means for the four parameters studied for the organoleptic evaluation: colour, texture, freshness and taste showed significant differences (P<0.05) in the organoleptic characters within the same storage temperatures and among the fresh fish and stored at two temperatures and in the two fish species (Table III).

Organoleptic assessment in this study exhibited that the decline in the score of graded parameters such as: color, texture, freshness, and taste varied with storage temperature and time. This reduction may be due to the increasing activities of spoilage agents and the biochemical changes occurring therein with increasing time and as reported by Oriakpono *et al.* (2011). These changes were observed at the two storage temperatures, but occurred more sharply in the fish samples of *Cyprinus carpio* as compared to *Clarias gariepinus* stored 4ºC stored. The most pronounced changes were

Table III.-Sensoryvaluation of fresh and stored *Cyprinus carpio* and *Clarias gariepinus*.

Storage time (weeks)	Moisture %			Protein %			Lipid %			Ash %		
	Fresh fish	-21°C	4°C	Fresh fish	-21°C	4°C	Fresh fish	-21°C	4°C	Fresh fish	-21°C	4°C
Cyprinus carpio												
0	4.8±0.40	4.8±0.40	4.8±0.40	5.6±0.60	5.6±0.60	5.6±0.60	5.3±0.31	5.3±0.31	5.3±0.31	5.4±0.62	5.4±0.62	5.4±0.62
1		4.4±0.35	3.9.±0.32		4.7±0.52	4.3±0.14		4.6±0.52	4.1±0.25		4.7±0.52	4.2±0.45
2		3.8±0.32	3.5±0.22		4.2±0.66	5.08±0.92		4.1±0.80	3.92±0.95		5.04±0.60	4.8±0.66
3		3.4±0.15	3.1.±0.18		3.7±0.25	3.2±0.41		3.2±0.28	2.9±0.12		4.5±0.52	3.8±0.47
4		2.9±0.33	2.70±0.12		3.2±0.42	2.8±0.35		2.9±0.28	2.5±0.34		3.7±0.43	3.2±0.0.62
5		2.3±0.15	1.9±0.18		2.7±0.32	2.1±016		2.3±0.36	1.9±0.25		2.8±0.29	2.1±0.51
6		1.9±0.27	1.6±0.41		2.2.±0.35	1.8±0.0.42		2.2±0.45	1.9±0.38		2.4±0.54	2..1±0.28
Clarias gariepinus												
0	4.9±0.35	4.9±0.35	4.9±0.35	5.8±0.75	5.8±0.75	5.8±0.75	5.5±0.38	5.5±0.38	5.5±0.38	5.7±0.55	5.7±0.55	5.7±0.55
1		4.6±0.41	4.2.±0.52		5.2±0.63	4.9±0.77		5.2±0.58	5.1±0.42		5.3±0.72	5.1±0.29
2		4.1±0.52	3.9±0.28		4.6±0.82	4.2±0.61		4.7±0.48	4.2±0.72		4.8±0.50	4.1±0.52
3		3.6±0.44	2.8.±0.35		3.9±0.47	3.3±0.72		2.8±0.56	2.3±0.33		3.9±0.26	3.1±0.47
4		2.9±0.33	2.70±0.12		3.2±0.42	2.8±0.35		2.9±0.28	2.5±0.34		3.7±0.43	3.2±0.32
5		2.4±0.22	1.8±0.28		2.1±0.49	1.8±0.22		2.4±0.30	2.0±0.28		2.7±0.38	2.0±0.40
6		1.8±0.36	1.5±0.16		1.8.±0.46	1.4±0.13		1.7±0.27	1.4±0.30		2.0±0.42	1.71±0.22

a-c Different letters in the same column indicate significant difference ''P<0.05'',
A-B Different letters in the same row indicate significant difference ''P<0.05''

observed in freshness and taste which became unacceptable after three weeks of storage at 4ºC stored fish samples. The judges' scores for color and texture also reduced within the range of very good before storage, to the poor range after six weeks in both the fish species. The comparison of two species also indicated some differences in color, texture, freshness and taste that might be due to their inherent potential and feeding niche. Our findings corroborate with the findings of Hassan (1996), Jayaram *et al*. (1980) and Tahir (2008), they studied the organoleptic characteristics of Indian major carps and found non-significant differences among species in taste and overall quality. The organoleptic assessment has proven to be an invaluable tool in the evaluation of freshness of fishes. Although a variety of biochemical, physical (Gill, 1992, 1997; Okeoyo *et al.*, 2009) and microbiological methods (Gram and Huss, 1996) have been used to assess freshness. The sensory evaluation of fish meat is still considered the most satisfactory and reliable method to assess the taste and flavor of fish meat (Hassan and Ali, 2011).

CONCLUSION

It is concluded that there is a significant change in the pH and proximate composition of the fish meat with an increase in storage time, even at -21ºC and 4ºC, which ultimately affect the organoleptic quality of fish meat. The storage at 4°C resulted in more decline in the proximate composition and organoleptic parameters. Thus, fish either be consumed fresh or stored at -21ºC.

Conflict of interest:

Authors have no conflict of interest.

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