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Original Article

Study on assessment of proximate composition and meat quality of fresh and stored *Clarias gariepinus* and *Cyprinus carpio*

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Abstract

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

Keywords: Clarias gariepinus, *Cyprinus carpio*, organoleptic evaluation, proximate analysis, different temperatures.

Estudo da avaliação da composição centesimal e da qualidade da carne de *Clarias gariepinus* e *Cyprinus carpio*

Resumo

A avaliação organoléptica e a análise aproximada de *Clarias gariepinus* e *Cyprinus carpio* foram determinadas em peixe fresco e refrigerado a duas temperaturas diferentes (-21 °C e 4 °C) por um período de seis semanas. Um painel de doze juízes treinados avaliou a cor (ao vivo), textura, maciez e sabor da carne de peixe após dois minutos de cozimento a vapor. O escore médio revelou um declínio geral nas propriedades organolépticas, como cor, textura, frescor e sabor de C. gariepinus e C. carpio armazenados a duas temperaturas em comparação com o peixe fresco. A análise imediata revelou uma maior diminuição nos teores de proteína bruta e lipídios e aumento no teor de cinzas em C. gariepinus e C. carpio nas duas temperaturas de armazenamento em comparação com o músculo do peixe fresco. O teor de umidade diminuiu nas amostras de músculo de peixe de ambas as espécies de peixes armazenadas a -21 °C, mas aumentou nas amostras armazenadas a 4 °C. O pH dos peixes aumentou nas duas temperaturas armazenadas. Houve diferenças significativas (P <0,05) na composição organoléptica e próxima do gelo armazenado e fresco C. gariepinus e C. carpio, a mesma temperatura e entre as duas temperaturas diferentes. A qualidade do músculo do peixe armazenado a 4 °C deteriorou-se mais rapidamente do que a temperatura de -21 °C. Assim, a temperatura e duração do armazenamento têm efeitos adversos na qualidade nutricional da carne de peixe.

Palavras-chave: Clarias gariepinus, *Cyprinus carpio*, avaliação organoléptica, análise aproximada, diferentes temperaturas.

1. 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; Ayisi et al., 2017). Aquaculture practices are considered today as one of the most promising sources of animal protein. In the recent past fish culture is a newly developed sector in developing countries due to economic returns to commercial fish farmers. A reason for the slow increase in expansion of freshwater fish culture practices was due to lack of research, awareness, technical inputs and advisory services for the farmers (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 a considerably lower fat content than beef (Nargis, 2006; Ndome et al., 2010a; Al-Ghanim, 2016; Tsironi and Taoukis, 2017). Iheanacho et al. (2017) reported a reduction in moisture content and higher protein content in fish after smoking.

Nutritional quality and organoleptic acceptability in terms of color, texture, smell, flavor 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; Gram and Huss, 1996; Grigorakis et al., 2003). Freshness quality includes all parameters related to appearance, taste, odor, flavor, and texture which can effect on consumer before purchase of fish (Al-Ghanim, 2016). Hence, fish freshness is very important to evaluate before fish is sold to the consumer. Meyers (1975) reported the characteristics of off-flavor of freshwater fish cultured by feeding treatments and quality of water chemistry with special reference to consumer likeness instead of traditional parameters such as flavor, taste and appearance. The fish meat may be spoiled due to various metabolic changes that regress fish quality and made it unacceptable and unsuitable for human eating because of changes in flavor, taste, and biochemical properties (Ndome et al., 2010b; Al-Ghanim, 2016). 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 (Sherratt et al., 2006; Braun and Sutherland, 2005; Mahboob et al., 2004; Agbabiaka et al., 2016). Sahu et al. (2016) reported extra good quality immediately after the harvest, thereafter gradual deterioration during transportion under cold chain and at the retail shop in *Catla catla*. Mchazime and Kapute (2018) mentioned that the processed fish were liked by the consumers up to 12 hours of ambient storage. They also reported a significant correlation between sensory scores and storage time at ambient temperature and suggested the time is important factor in maintain the freshness and quality of fish meat. 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 main aim of this study was to determine overall changes in proximate composition and organoleptic quality of the flesh of *Clarias gariepinus* and *Cyprinus carpio* in fresh and stored at two temperature conditions (-21 °C and 4 °C).

2. Material and Methods

2.1. Sample collection and preparation

Seven fish samples with three replicates of *Clarias gariepinus (C. gariepinus)* and *Cyprinus carpio (C. carpio)* with an average weight of 1200-1500 g were procured from the local market. The fish 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. The standard guidelines for animal experiments prepared by the department and the university were followed in this study.

2.2. Proximate analysis

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

2.3. Organoleptic assessment

The sensory properties of the ice stored and fresh (ambient temperature) *C. gariepinus* and *C. carpio* were evaluated by a panel of 12 trained Judges selected from the Department of Food Sciences, and Department of Zoology. Assessment of color, 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; 2-2.9, Fair; 3-3.9, Medium; 4-4.9, Good; 5-6.0, Very good.

2.4. Statistical analysis

The data were analyzed through analysis of variance by using software Minitab version 15. The means were compared to see the differences with the help of Tukey's test.

3. Results

3.1. pH

There were significant changes in pH levels of the meat of *C. carpio* and *C. gariepinus* with time. The pH of fish stored at -21 °C decreased to 6.79 ± 0.34 and 6.82 ± 0.24 after one week of storage of *C. carpio* and *C. gariepinus*, respectively. After third week it started rising at the end of sixth week final pH was recorded as 7.05 ± 0.39 and 7.21 ± 0.43 in *C. carpio* and *C. gariepinus*, respectively. The pH of fish at 4 °C was decreased to 6.81 ± 0.25 and 6.85 ± 0.25 after one week of storage of *C. carpio* and *C. gariepinus*, respectively. Later on, after the third week it started rising and final pH was determined at the end of the sixth week as 7.31 ± 0.41 and 7.32 ± 0.40 in *C. carpio* and *C. gariepinus*, respectively. The fish sample was observed to reduce in acidity, while tending towards an alkaline state with an increase in storage period. Statistical analysis revealed significant differences ($P<0.05$) in pH levels in *C. carpio* and *C. gariepinus* stored at the 4 °C temperature and between the two temperatures (Table 1). The pH increased with an increasing storage time. The increase was higher at 4 °C in meat samples of *C. carpio* and *C. gariepinus* compared to -21 °C stored sample was due to microbial and chemical changes were faster in the meat at 4 °C stored fish. The increase in pH in this experiment may be due to the fermentation of carbohydrate to acid as observed within the first week in the -21 °C stored sample (Table 1).

Table 1. pH levels of fresh and stored *Catla catla* and *Labeo rohita.*

Storage time (Weeks)	***Labeo rohita***			***Catla catla***		
	Fresh	**Storage temperature**		**Fresh**	**Storage temperature**	
	6.85 ± 0.32	**-21 °C**	**-4 °C**	**6.87 ± 0.22**	**-21 °C**	**-4 °C**
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”.

3.2. Proximate composition

Proximate analysis of fish muscle of *C. gariepinus* and *C. carpio* exhibited a decrease in the crude protein and lipid content compared to the fresh fish from 2nd to 6th week (Tables 2, 3). The crude protein content in *C. gariepinus* in muscle samples stored at -21 °C was observed to decrease from 15.44 ± 0.70% to 9.62 ± 0.78% after the sixth week of storage, while in fish muscle sample stored at 4 °C the crude protein decreased from 15.86 ± 1.48% to 10.37 ± 0.73% after the sixth week (Table 2). The crude protein content in *C. carpio* in muscle samples stored at -21 °C was observed to decrease from 16.51 ± 1.80% to 8.72 ± 0.90% after the sixth week of storage. The crude protein decreased from 16.51 ± 1.80% to 8.25 ± 0.61% after the sixth week in the fish muscle sample stored at 4 °C (Table 3). Similarly, the lipid content in fish muscle samples of *C. gariepinus* stored at -21 °C was decreased from 5.08 ± 0.88% to 2.60 ± 0.42%, while in the same stored at 4 °C the lipid content was decreased from 5.08 ± 0.88% to 2.93 ± 0.66% after the sixth week (Table 2). The lipid content in the muscle samples of *C. carpio* stored at -21 °C was decreased from about 4.43 ± 0.91% to 2.15 ± 0.64%, while in fish muscle samples stored at 4 °C the lipid content was decreased from 4.43 ± 0.91% to 1.87 ± 0.71% after the sixth week (Table 3). The moisture content in meat samples of *C. gariepinus* stored at -21 °C was decreased from 71.30 ± 2.60% to 51.13 ± 2.99%, while in meat samples stored at 4 °C the moisture content was decreased from 71.30 ± 2.60% to 52.18 ± 2.70% after the sixth week (Table 2). The moisture content in meat samples of s *C. carpio* stored at -21 °C was decreased from about 70.91 ± 2.60% to 48.90 ± 2.90%, while in meat samples stored at 4 °C the moisture content was decreased from 70.91 ± 2.60% to 51.25 ± 2.84% after the sixth week (Table 3). Ash content of *C. gariepinus* stored at -21 °C increased from 4.18 ± 0.71% to 9.45 ± 0.57%, while for the 4 °C stored sample, ash content was increased from 4.18 ± 0.71% to 9.21 ± 0.70% after six weeks. Similarly, ash content in meat samples of *C. carpio* stored at 4 °C increased from 5.23 ± 0.94% to 8.80 ± 0.95%, while for the muscle samples stored at 4 °C stored sample, the ash content increased from 5.23 ± 0.94% to 9.21 ± 0.70% after sixth weeks (Table 3). Statistical analysis of the constituents of proximate composition: crude protein, crude lipid, moisture and ash exhibited significant differences (P<0.05) in the different compositions at the same storage temperatures and between the two temperatures in C. gariepinus and C. carpio (Tables 2, 3).

3.3. Organoleptic evaluation

The results of the present study showed a gradual reduction in the organoleptic characteristics such as color, texture, freshness and taste of *C. gariepinus* and *C. carpio* evaluated by a panel of trained judges (Tables 4, 5). The physical attributes such as color in *C. gariepinus*, the score reduced from 4.8 ± 0.40 to 1.9 ± 0.27 in the fish meat samples stored at -21 °C and from 4.8 ± 0.40 to 1.6 ± 0.41 in the 4 °C stored sample (Table 4). The grade for color of the meat of *C. carpio* was reduced from 4.9 ± 0.55 to 2.1 ± 0.40 in the fish meat samples stored at -21 °C and from 4.9 ± 0.55 to 1.9 ± 0.48 in the 4 °C stored sample (Table 5). The grade for texture in *C. gariepinus* and *C. carpio* fluctuated from 5.5 ± 0.85 to 2.4 ± 0.52 and 5.9 ± 0. 90 to 1.9 ± 0.55 in the meat samples stored at -21 °C and from 5.5 ± 0.85 to 2.0 ± 0.52 and 5.9 ± 0.90 to 1.5 ± 0.25, respectively in the samples stored at 4 °C (Tables 4, 5). The grade for freshness in *C. gariepinus* and *C. carpio* dropped significantly from 5.7 ± 0.48 to 2.4 ± 0.64 and 5.8 ± 0. 70 to 1.8 ± 0. 51, respectively in the meat samples stored at -21 °C. While the grade for freshness in the meat samples of *C. gariepinus* and *C. carpio* stored at 4 °C was dropped significantly from 5.7 ± 0.48 to 2.1 ± 0.47 and 5.8 ± 0. 70 to 1.5 ± 0. 72, respectively (Tables 4, 5). The grade for taste in in the meat samples of *C. gariepinus* and *C. carpio* stored at -21 °C dropped significantly from 5.6 ± 0.98 to 2.6 ± 0.62 and 5.9 ± 0.88 to 2.2 ± 0.51, respectively. While the score for taste in the meat samples of *C. gariepinus* and *C. carpio* stored at 4 °C dropped significantly from 5.6 ± 0.98 to 2.6 ± 0.62 and 5.9 ± 0.88 to 1.8 ± 0.31, respectively (Tables 4, 5). The comparison of means for the four parameters studied for the organoleptic evaluation: color, texture, freshness and taste showed significant differences (P<0.05) in the organoleptic characters within the same storage temperatures

Table 2. Proximate Composition of fresh and stored *Catla catla*.

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
0	71.30 ± 2.60	71.30 ± 2.60	71.30 ± 2.60	15.86 ± 1.48	15.86 ± 1.48	15.86 ± 1.48	5.08 ± 0.88	5.08 ± 0.88	5.08 ± 0.88	4.18 ± 0.71	4.18 ± 0.71	4.18 ± 0.71
1		67.52 ± 1.98	69.68. ± 1.80		15.44 ± 0.70	15.37 ± 0.61		4.53 ± 0.55	4.38 ± 0.66		3.98 ± 0.76	3.87 ±0.62
2		64.62 ± 2.40	66.14 ± 1.70		14.77 ± 0.90	14.44 ± 0.74		4.12 ± 0.71	3.79 ± 0.82		3.75 ± 0.62	3.65 ± 0.92
3		61.30 ± 2.80	63.52 ± 2.80		14.44 ± 0.86	14.20 ± 0.81		3.88 ± 0.61	3.59 ± 0.51		4.55 ± 0.71	4.45 ± 0.52
4		58.59 ± 3.32	59.85 ± 2.86		13.52 ± 0.76	13.22 ± 0.90		3.56 ± 0.52	3.48 ± 0.42		5.25 ± 0.60	5.07 ± 0.52
5		55.48 ± 2.80	56.78 ± 2.52		11.97 ± 1.18	11.22 ± 0.92		2.89 ± 0.42	3.57 ± 0.40		7.90 ± 0.55	7.75 ± 0.62
6		51.13 ± 2.99	52.18 ± 2.70		10.37 ± 0.73	9.62 ± 0.78		2.60 ± 0.42	2.93 ± 0.66		9.45 ± 0.57	9.21 ± 0.70

Table 3. Proximate Composition of fresh and stored *Labeo rohita*.

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
0	70.91 ± 2.60	70.91 ± 2.60	70.91 ± 2.60	16.51 ± 1.80	16.51 ± 1.80	16.51 ± 1.80	4.43 ± 0.91	4.43 ± 0.91	4.43 ± 0.91	5.23 ± 0.94	5.23 ± 0.94	5.23 ± 0.94
1		66.57 ± 2.70	68.20 ± 2.55		16.07 ± 1.24	15.81 ± 1.19		4.05 ± 0.87	3.90 ± 0.82		4.89 ± 1.11	4.67 ± 0.88
2		67.07 ± 2.52	65.36 ± 1.77		15.29 ± 0.90	14.93 ± 0.89		3.61 ± 0.72	3.47 ± 0.82		4.59 ± 0.82	4.38 ± 0.70
3		61.90 ± 2.52	63.86 ± 2.41		14.70 ± 1.25	12.87 ± 1.02		3.45 ± 0.78	3.30 ± 0.84		4.25 ± 0.77	3.76 ± 0.91
4		56.07 ± 2.90	58.72 ± 2.88		12.87 ± 0.70	11.93 ± 0.69		2.80 ± 0.42	2.66 ± 0.55		3.60 ± 0.71	3.42 ± 0.95
5		53.36 ± 2.90	54..87 ± 2.60		10.84 ± 1.10	9.87 ± 0.48		2.50 ± 0.60	2.25 ± 0.64		5.96 ± 0.91	5.67 ± 0.68
6		49.90 ± 2.40	51.25 ± 2.84		8.72 ± 0.90	8.25 ± 0.61		2.15 ± 0.64	1.87 ± 0.71		8.80 ± 0.95	7.85 ± 0.91

Table 4. Organoleptic evaluation of fresh and stored *Catla catla*.

Storage Time (weeks)	Colour			Texture			Freshness			Taste		
	Fresh fish	**-21 °C**	**4 °C**	**Fresh fish**	**-21 °C**	**4 °C**	**Fresh fish**	**-21 °C**	**4 °C**	**Fresh fish**	**-21 °C**	**4 °C**
0	4.9 ± 0.55	4.9 ± 0.55	4.9 ± 0.55	5.5 ± 0.85	5.5 ± 0.85	5.5 ± 0.85	5.7 ± 0.48	5.7 ± 0.48	5.7 ± 0.48	5.6 ± 0.98	5.6 ± 0.98	5.6 ± 0.98
1		4.5 ± 0.42	4.1 ± 0.44		4.9 ± 0.71	4.5 ± 0.38		4.8 ± 0.64	4.3 ± 0.37		4.9 ± 0.68	4.4 ± 0.72
2		3.9 ± 0.55	3.6 ± 0.35		4.4 ± 0.75	5.3 ± 0.86		4.3 ± 0.77	4.1 ± 0.88		5.3 ± 0.76	5.0 ± 0.74
3		3.5 ± 0.32	3.2 ± 0.32		3.9 ± 0.44	3.4 ± 0.56		3.4 ± 0.46	3.1 ± 0.38		4.7 ± 0.68	4.0 ± 0.82
4		3.1 ± 0.46	2.8 ± 0.44		3.4 ± 0.62	3.4 ± 0.54		3.1 ± 0.51	2.7 ± 0.46		3.9 ± 0.81	3.4 ± 0.70
5		2.3 ± 0.15	2.0 ± 0.25		2.9 ± 0.47	2.3 ± 0.48		2.5 ± 0.49	2.1 ± 0.61		3.0 ± 0.47	2.3 ± 0.62
6		2.1 ± 0.40	1.9 ± 0.48		2.4. ± 0.52	2.0 ± 0.52		2.4 ± 0.64	2.1 ± 0.47		2.6 ± 0.62	2.3 ± 0.42

Table 5. Organoleptic evaluation of fresh and stored *Labeo rohita*.

Storage Time (weeks)	Colour			Texture			Freshness			Taste		
	Fresh fish	**-21 °C**	**4 °C**	**Fresh fish**	**-21 °C**	**4 °C**	**Fresh fish**	**-21 °C**	**4 °C**	**Fresh fish**	**-21 °C**	**4 °C**
0	5.2 ± 0.67	5.2 ± 0.67	5.2 ± 0.67	5.9 ±0.90	5.9 ± 0.90	5.9 ± 0.90	5.8 ± 0.70	5.8 ± 0.70	5.8 ± 0.70	5.9 ± 0.88	5.9 ± 0.88	5.9 ± 0.88
1		4.9 ± 0.55	4.5 ± 0.71		5.3 ± 0.75	45.0 ± 0.82		5.4 ± 0.68	5.2 ± 0.55		5.5 ± 0.90	5.3 ± 0.60
2		4.3 ± 0.62	4.2 ± 0.31		4.7 ± 0.72	4.3 ± 0.85		4.9 ± 0.48	4.3 ± 0.80		4.9 ± 0.70	4.3 ± 0.69
3		3.9 ± 0.52	3.1 ± 0.56		4.0 ± 0.53	3.4 ± 0.66		3.0 ± 0.73	2.4 ± 0.47		4.1 ± 0.72	3.3 ± 0.52
4		3.2 ± 0.59	3.0 ± 0.69		3.3 ± 0.62	2.9 ± 0.47		2.8 ± 0.36	2.4 ± 0.47		3.9 ± 0.39	3.4 ± 0.67
5		2.7 ± 0.38	2.1 ± 0.44		2.2 ± 0.60	1.9 ± 0.34		2.3 ± 0.52	1.9 ± 0.62		2.9 ± 0.52	2.2 ± 0.28
6		1.9 ± 0.45	1.7 ± 0.52		1.9. ± 0.55	1.5 ± 0.25		1.8 ± 0.51	1.5 ± 0.72		2.2 ± 0.51	1.8 ± 0.31

and among the freshest fish and stored at two temperatures and in the two fish species (Tables 4, 5).

4. Discussion

Eyo (2001) reported that pH might be used as an indicator to the extent of microbial spoilage in fish. This increase in pH may be due to increase in accumulation of ammonia compounds, mainly due to increased microbial activities. The increase in pH can also cause an increase in the volatile compounds due to 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 the evaluation of the quality of fish. Iheanacho et al. (2017)

The decrease in crude protein in the two fish species during the storage could be due to the slow denaturation of the crude protein to more volatile compounds such 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 variation in protein and lipid amount could be due to the leaching out of ice of few lipid constituents (Emokpae, 1979). The decrease in protein in the meat of fish could be due to reduction in salt and water soluble (Chomnawang et al., 2007) or because of autolytic degradation combine with endogenous enzymes and bacteria (Hultmann and Rustad, 2004). The decrease in protein content was probably due to leaching of soluble components especially water proteins and urea as fresh fish spoil in storage (Osibona and Ezekiel, 2014; Iheanacho et al., 2017).

The decrease in lipid content may be linked with the oxidation of polyunsaturated fatty acids found in fish tissues in other products such as aldehydes, free fatty acids, ketones, and peroxides (Horner, 1992; Mahboob et al., 2004). Ash content increased during the experimental period. The result of proximate analysis revealed that moisture formed the highest component of the proximate composition of *C. gariepinus* and *C. carpio*. The moisture content was observed to decrease considerably at -21 °C stored samples, but decreased slightly in the 4 °C stored samples during the storage period, which is probably due to absorption of moisture from the cool atmosphere.

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 *C. gariepinus* as compared to *C. carpio* stored 4 °C stored. The most pronounced changes were observed in freshness and taste which became unacceptable after three weeks of storage at 4 °C stored fish samples (Sahu et al., 2016; Yin et al., 2017). 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 *C. carpio* feeding niche. The texture of the body was loose and odor, increased in *C. gariepinus* and *C. carpio* at 4 °C and these changes were due to an increment of storage period (George and Gopakumar, 1988; Huss, 1995; Al-Ghanim, 2016; Sahu et al., 2016). Mchazime and Kapute (2018) mentioned that the processed fish were liked by the consumers up to 12 hours of ambient storage. They also reported a significant correlation between sensory scores and storage time at ambient temperature and suggested the time is important factor in maintain the freshness and quality of fish meat. The findings of this study were in line with the results of Mchazime and Kapute (2018). Increase in spoilage with the reduction of quality in the major substrates caused rapid deterioration of carps. The similar findings were also reported by Hassan (1996), Jayaram et al. (1980) and Tahir (2008). The organoleptic assessment has proven to be an invaluable tool in the evaluation of freshness of fishes. Different biochemical, physical (Gill, 1992, 1997; Mahboob et al., 2004; Agbabiaka et al., 2016) and microbiological methods (Al-Ghanim, 2016) are practical to determine freshness. The sensory evaluation of fish meat is still considered one of the most reliable method to determine the taste and flavor of fish meat (Hassan and Ali, 2011).

5. Conclusion

We concluded that there is a significant change in the pH and proximate composition of the fish meat with an increase in a storage time, even at these (-21 °C and 4 °C), which ultimately effect on the organoleptic quality of fish meat. However, more decline in the proximate composition and organoleptic parameters was observed in fish, meat samples of both the fish species stored at 4 °C. Thus, it is better to either consume the fresh fish or is stored under freezing conditions on -21 °C.

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