Quality assessment of smoke-dried *Clarias gariepinus* and *Chrysichthys nigrodigitatus* stored in two storage facilities

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Abstract

The quality of smoke-dried fish can be enhanced by storing the products in good storage facilities. This research was carried out to determine the proximate composition, microbiological quality and sensory properties of smoke-dried *Clarias gariepinus* and *Chrysichthysis nigrodigitatus* stored in refrigerator and kitchen cabinet during a 6-week storage period. Sensory properties were assessed using panel of assessors. Bacterial load was done using plate count agar spread plate technique. Fish were purchased alive, washed, sacrificed and smoked for 72 hours. Percentage weight loss after smoking *C. gariepinus* and *C. nigrodigitatus* were 57.42% and 65.91%, respectively. Results for crude protein, moisture and lipid content of smoke-dried *C. gariepinus* stored in refrigerator ranged between 67.80-68.31%, 8.32-9.00% and 12.15-12.34% while the values for those stored in kitchen cabinet ranged from 67.04-68.30%, 8.30-8.49% and 12.15-12.34, respectively; for smoke-dried *C. nigrodigitatus* the ranges of the nutrients were 61.75-62.20%, 7.40%-8.00, 16.15-16.28% and 60.89-62.19%, 7.40-7.49%, 16.15-16.28% for those stored in refrigerator and kitchen cabinet, respectively. The results showed no significant difference ($p>0.05$) in proximate composition of the samples in the two storage facilities. Microbes isolated from the smoke-dried fish samples were *Staphyloccus aureus*, *Bacillus subtilis* and *Escherichia coli*. Total bacterial counts (TBC) at week 6 for *C. gariepinus* were 0.17×10^{-6} and 0.25×10^{-6}; *C. nigrodigitatus*, 0.24×10^{-6} and 0.31×10^{-6} in refrigerator and kitchen cabinet, respectively, and the values were not significantly different ($p>0.05$) in the two storage facilities. No fungal growth was present throughout the six-week storage period. The sensory quality ratings ranged between 8.00±0.00 for flavour and 4.67±0.58 for overall acceptability. Sensory quality was significantly different ($p<0.05$) in flavour, texture, appearance and aroma at week 2 and 6. The findings of this study show that the storage facilities retained good nutritional and sensory qualities as well as overall acceptability of the smoke-dried fish throughout storage.

Keywords: Smoked fish, storage quality, refrigerator, kitchen cabinet.

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Introduction

Fish is a high-protein, low-fat food that provides a range of health benefits. It is a major source of animal protein, providing a significant portion of the protein intake in human diets (Adeyeye *et al* 2016; Olagbemide 2015). In the tropical region, fish is one of the cheapest sources of animal protein which makes it more preferable over land animals (Akinwumi 2011). Fish contains Omega-3 and Omega-6 poly unsaturated fatty acids (PUFA) that play important role in human health for the prevention of coronary artery diseases (Ruxton *et al* 2004). Due to the fact that fish provides a range of health benefits, there is great increase in the global consumption of fish and fish products in recent decades. Total fish production in Nigeria is about 1.123 million tonnes while the annual consumption is about 3.6million tonnes (Akinsorotan *et al* 2019). Therefore, the total fish production including imports in Nigeria still does not satisfy the total fish demand, since it records a 2.5 million tonnes of fish deficit, a situation that may jeopardise protein intake amongst Nigerians.

In Nigeria, majority of the fish produced does not get to the consumers in good quality and acceptable state (FAO 2012). As a result of the deficit, there is need to reduce the huge wastage and losses of fish. For wastage to be reduced, harvested fish should be processed and preserved in order to retain quality and increase shelf-life. A number of methods are used to preserve fish (Omodara *et al* 2016). Currently in Nigeria, traditional smoking is the most common processing method of fish (Olayemi *et al* 2015). The smoked-dried fish should be properly packed and stored to avoid the problem of quality instability during the storage and distribution (Flick and George 2010).

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Clarias gariepinus (Burchell) of the Family Clariidae and *Chrysichthys nigrodigitatus* (Lacépède), a siluroid fish of the Family Claroteidae commonly known as African mud catfish and silver catfish, respectively are among the commercially important fish species in Nigeria. *Clarias gariepinus* has high economic value, being among the most important freshwater fishes in the tropical region with high consumer demand and a good species for aquaculture (Dada and Wonah 2003). It is widely distributed in Africa, from the Nile to West Africa and from Algeria to South Africa (Osibona *et al* 2009). *Chrysichthys nigrodigitatus*, is among the commercially abundant species found in the Lagos Lagoon (Holden and Reed 1991). These fishes are of great economic interest and are highly consumed in Nigeria (Olaosebikan and Raji 2013).

Deterioration starts immediately fish is out of water, this is caused by several factors such as enzymatic activities, bacterial growth, and chemical oxidation of fat, which lead to rancidity (Khoshmanesh 2006). Fish is also highly susceptible to spoilage due to poor processing methods and storage facilities, leading to loss of nutritional value of the fish or fish product (Eyo 2001). Smoking of fish is the oldest processing method and a lucrative business in Nigeria and in other West African countries (Adeyemi *et al* 2013). Smoked fish can be preserved longer by using proper storage facilities, which help to extend the shelf life and also retain nutritive composition that give satisfaction to the consumers.

In Nigeria, fish smoking business is still limited to small scale level, due to lack of good storage facilities. Smoked fish product will deteriorate if it is not properly stored, and it has the ability to absorb moisture when exposed to the atmosphere and also lose its oil content (Olayemi *et al* 2015). The storage materials must have the ability to prevent spoilage, insect infestation and protect the product from fragmentation (Byett 2006). Fish storage materials with water proof characteristics will prevent moisture penetration and contamination into the stored products.

Refrigeration is an essential food storage technique in developed countries. The low temperature in the refrigerator helps to lower the reproduction rate of bacteria in smoked-dried fish products. The optimum temperature range for perishable food storage is 3^{o}C to 5^{o}C. Kitchen cabinet is a storage compartment in which food items can be stored and prevented from rodents and insect infestation. There is need for proper hygiene during storage of smoked-dried fish in kitchen cabinet as this will ensure longer shelf-life and prevent contamination that may lead to spoilage.

Spoilage in smoked-dried fish products could be as a result of bacterial accumulation, which depends on handling, processing methods, packaging materials, storage facilities, temperature, humidity and oxygen level during storage (Ayuba and Dimeji 2006). The challenge on how to handle fish processing successfully and preserve fish in good storage facilities has been an issue in fisheries management. Therefore, the aim of this study was to determine the quality of smoked-dried *C. gariepinus* and *C. nigrodigitatus* stored in a refrigerator and kitchen cabinet by assessing their proximate composition, microbial load and sensory quality.

Materials and methods

Collection of fish samples

A total of sixteen (16) live samples each of *C. gariepinus* weighing 5.091kg and *C. nigrodigitatus* weighing 6.746kg used for this investigation were purchased from Better Life Fish Market, Makoko, Yaba Mainland Local Government Area, Lagos, Nigeria. The samples were carried in large plastic bowls, half filled with clean water to the Department of Marine Sciences, University of Lagos.

Fish preparation and smoking

Live fish samples purchased were sacrificed by clubbing on the head, gutted, thoroughly washed with clean portable water and smoked with a traditional drum smoking kiln for 72hours. During smoking, the fish samples were checked at intervals and turned over to avoid burning or charring. The hot smoked-dried fish were cooled for 30-40 minutes at ambient temperature.

Storage of smoke-dried fish

The smoke-dried fish samples of *C. gariepinus* and *C. nigrodigitatus* were packed each into transparent polyethylene bags and sealed using electrical sealing machine (SF-200). The smoke-dried samples were each divided into two groups of eight fish each and stored in a refrigerator (4^{o}C) and kitchen cabinet (room temperature) for 6 weeks. During the storage period the proximate analysis, microbial analysis and sensory assessment were conducted at week 0, 2, 4 and 6.

Proximate composition of fish

The proximate composition; crude protein, moisture, lipid, crude fibre and ash of the smoke-dried fish samples were determined according to the AOAC (2010) methods. The analysis was carried out in triplicate.

Microbial analysis of fish

Enumeration of bacterial load was done using plate count agar spread plate technique. Ten grams of the sample was mixed with 90 ml saline water; appropriate dilutions of fish homogenate were spread on plate count agar and incubated at 37°C for 48 hours. The colonies counted for total plate counts were expressed as Colony Forming Units per gram (CFU/g), bearing in mind the factors of dilution (Maturin and Peeler 2001). All media used for microbiological analysis were prepared as indicated by the manufacturer. Isolation and identification of *Staphyloccus aureus* were carried out by the method described by Gutierrez *et al* (2012) and *Bacillus subtilis* according to AOAC (1998) method. MacConkey agar media was used for *Escherichia coli* determination, the

plates were incubated at 37ºC for 24h. Colonies with pinkish red growth having a metallic sheen or reflection confirmed the presence of *E. coli* (AOAC 1998).

Fungal analysis was done by using Rose Bengal Chloramphenicol (RBC) agar. Twenty-five grams of the sample was blended with 225 ml of 0.1% peptone water and 0.1ml of the appropriate dilutions of the sample was spread on the surface of the medium and incubated at room temperature (28±1°C) for 5 days (Immaculate *et al* (2013), then examined for fungi.

Sensory assessment

The sensory assessment of the smoke-dried fish samples was carried out by a panel of six members. The members of the panel were randomly selected from students and staff of the Department of Marine Sciences, University of Lagos. Previously to this experiment, a special training was carried out concerning different quality conditions and to check the panellists' understanding of the descriptors. Samples were coded with random numbers and served on uniform plates. Members of the panels were made to carry out the analysis under controlled and conducive conditions, which allowed them to concentrate and avoid communication between themselves. They were provided with portable water to rinse their mouths in between the evaluation process. The samples were evaluated for quality attributes which included flavour, texture, appearance, aroma and overall acceptability by using 9-point Hedonic scale, 9=like extremely, 8=like very much, 7=like moderately, 6= like slightly, 5= neither like nor dislike, 4=dislike slightly, 3=dislike moderately, 2=dislike very much and 1=dislike extremely; score of 5.0 was considered the borderline of fish acceptability (Munoz and King 2007).

Statistical analysis

The data obtained during this study were subjected to One-way Analysis of Variance (ANOVA). Duncan multiple range test (DMRT) was used to separate means where differences exist at 95% confidence level ($p< 0.05$).

Results

The results of the percentage weight loss in *C. gariepinus* and *C. nigrodigitatus* is presented in Table 1. The result showed 57.42% average weight loss in *C. gariepinus* and 69.66% in *C. nigrodigitatus* after smoking. Tables 2 and 3 show the proximate composition of smoke-dried *C. gariepinus* and *C. nigrodigitatus* stored in refrigerator and kitchen cabinet for a period of six weeks. The ranges for crude protein, moisture, lipid content of smoke-dried *C. gariepinus* stored in the refrigerator were 67.80-68.31%, 8.32-9.00% and 12.15-12.34% and kitchen cabinet, 67.04-68.30%, 8.30-8.49%, and 12.15-12.34, respectively; the values for *C. nigrodigitatus* stored in refrigerator were, 61.75-62.20%, 7.40%-8.00 and 16.15-16.28% while those stored in kitchen cabinet were 60.89-62.19%, 7.40-7.49% and 16.15-16.28%, respectively. There was no significance difference between the proximate compositions of the samples stored in the two storage facilities.

The bacteria, *Staphylococcus saprophyticus*, *Bacillus subtilis* and *Escherichia coli* present on the smoke-dried fish during the 6 weeks of storage in the different facilities are presented in Tables 4 and 5 while the bacterial load are illustrated in Figures 1. *Staphylococcus saprophyticus* was present in *C. gariepinus* throughout the storage period and in both storage facilities, while it was *Bacillus subtilis* that was present in *C. nigrodigitatus* in both storage facilities throughout the storage period. The initial bacterial load in *C. gariepinus*, which were $0.11\pm0.02\times10^{-6}$cfu/g and $0.12\pm0.02\times10^{-6}$cfu/g in the refrigerator and kitchen cabinet respectively, gradually increased to $0.17\pm0.03\times10^{-6}$ and $0.25\pm0.13\times10^{-6}$ cfu/g in the two storage facilities, respectively throughout the storage period. In *C. nigrodigitatus*, the initial bacterial load was $0.17\pm0.05\times10^{-6}$cfu/g in the refrigerator and kitchen cabinet, respectively and they also gradually increased to $0.24\pm0.01\times10^{-6}$ and $0.31\pm0.11\times10^{-6}$cfu/g in the two storage facilities, respectively throughout the storage period. Fungi were not detected in the smoke-dried fish before and throughout the storage period in both facilities.

The sensory qualities of the smoke-dried *C. gariepinus* and *C. nigrodigitatus* under different storage facilities are shown in Tables 6 and 7. The sensory quality ratings of flavour and overall acceptability ranged between 8.00±0.00 and 5.00±0.00 in *C. gariepinus*, and 8.00±0.00 and 4.67±0.58 in *C. nigrodigitatus*. Significant difference ($p<0.05$) was recorded between the values of flavour, texture, appearance and aroma of *C. gariepinus* stored in the refrigerator and in flavour, appearance and aroma of samples stored in the kitchen cabinet during week 2 and 6 storage period. In *C.*

Table 1: Percentage weight loss in *C. gariepinus* and *C. nigrodigitatus* after smoking

Fish species	Number of samples	Initial total weight (kg)	Final total weight (kg)	Percentage weight loss %
Clarias gariepinus	8	2.330	1.110	52.36
	8	2.761	1.058	61.68
Total number of samples	16	5.091	2.168	57.42
Chrysichthys nigrodigitatus	8	2.946	1.147	61.07
	8	3.800	1.153	69.66
Total number of samples	16	6.746	2.300	65.91

Table 2: Proximate composition of smoke-dried *C. gariepinus* stored in two different storage facilities across the weeks

Storage facilities	Storage period week	Crude protein (%)	Moisture content (%)	Lipid content (%)	Crude fibre (%)	Ash (%)
Refrigerator (4°C)	0	68.31±0.43[a]	8.32±0.45[a]	12.23±0.33[a]	1.81±0.01[a]	1.35±0.07[a]
	2	68.28±0.39[a]	8.42±0.59[a]	12.23±0.32[a]	1.80±0.00[a]	1.35±0.08[a]
	4	68.15±0.21[a]	8.58±0.81[a]	12.18±0.25[a]	1.80±0.01[a]	1.38±0.11[a]
	6	67.80±0.34[a]	9.00±0.73[a]	12.15±0.21[a]	1.76±0.06[a]	1.40±0.13[a]
Kitchen cabinet (room temperature)	0	68.30±0.42[a]	8.30±0.42[a]	12.34±0.33[a]	1.81±0.01 [a]	1.35±0.07[a]
	2	68.20±0.28[a]	8.30±0.42[a]	12.28±0.39[a]	1.81±0.01 [a]	1.35±0.07[a]
	4	68.13±0.18[a]	8.48±0.67[a]	12.29±0.41[a]	1.82±0.03 [a]	1.37±0.09[a]
	6	67.04±1.36[a]	8.49±0.69[a]	12.15±0.21[a]	1.83±0.04 [a]	1.40±0.13[a]

Means with different superscripts along the same column are significantly different ($p<0.05$)

Table 3: Proximate composition of smoke-dried *C. nigrodigitatus* stored in two different storage facilities across the weeks

Storage facilities	Storage period week	Crude protein (%)	Moisture content (%)	Lipid content (%)	Crude fibre (%)	Ash (%)
Refrigerator (4°C)	0	62.20±0.28[a]	7.40±0.57[a]	16.28±0.39[a]	1.78±0.04[a]	6.21±0.29[a]
	2	62.13±0.18[a]	7.50±0.70[a]	16.23±0.32[a]	1.83±0.04[a]	6.26±0.36[a]
	4	62.05±0.07[a]	7.58±0.81[a]	16.20±0.28[a]	1.84±0.06[a]	6.28±0.39[a]
	6	61.75±0.35[a]	8.00±1.40[a]	16.15±0.21[a]	1.80±0.01[a]	6.30±0.42[a]
Kitchen cabinet (room temperature)	0	62.19±0.27[a]	7.40±0.57[a]	16.25±0.35[a]	1.78±0.04[a]	6.21±0.29[a]
	2	62.05±0.07[a]	7.40±0.57[a]	16.28±0.39[a]	1.83±0.04[a]	6.23±0.32[a]
	4	61.54±0.65[a]	7.48±0.67[a]	16.28±0.40[a]	1.84±0.05[a]	6.24±0.33[a]
	6	60.89±1.57[a]	7.49±0.69[a]	16.15±0.21[a]	1.85±0.06[a]	6.30±0.42[a]

Means with different superscripts along the same column are significantly different ($p<0.05$)

Table 4: Microbes present in smoke-dried *C. gariepinus* stored in the different storage facilities with time (weeks)

Storage facilities	Storage period week	*Staphylococcus aureus*	*Bacillus subtilis*	*Escherichia coli*
Refrigerator (4°C)	0	+	-	-
	2	+	+	-
	4	+	+	-
	6	+	-	+
Kitchen cabinet (room temperature)	0	+	+	-
	2	+	+	-
	4	+	+	+
	6	+	+	+

+ =Present; - =Absent

Table 5: Microbes present in smoke-dried *C. nigrodigitatus* stored in the different storage facilities with time (weeks)

Storage facilities	Storage period week	*Staphylococcus aureus*	*Bacillus subtilis*	*Escherichia coli*
Refrigerator (4°C)	0	-	+	+
	2	+	+	-
	4	+	+	+
	6	+	+	+
Kitchen cabinet (room temperature)	0	-	+	+
	2	+	+	-
	4	+	+	+
	6	+	+	+

+ =Present; - =Absent

nigrodigitatus, significant difference ($p<0.05$) was observed in flavour and aroma for samples stored in the refrigerator and flavour, appearance and aroma for those in the kitchen cabinet. There was no significant difference ($p>0.05$) in the overall acceptability of the two samples under the storage facilities.

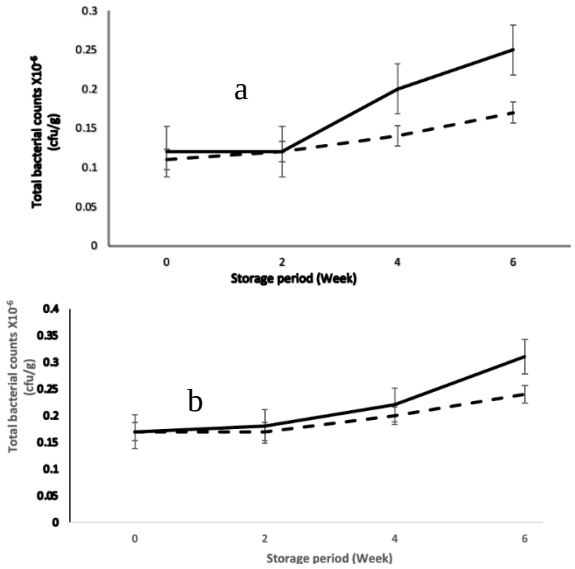

Figure 1. Total bacterial count in smoke-dried (a) *C. gariepinus* and (b) *C. nigrodigitatus* in two storage facilities (---- refrigerator and —— kitchen cabinet)

Discussion

The weight loss observed in the fresh fish after smoking was as a result of moisture evaporation. Davies and Davies (2009) reported that weight loss during smoking of fish was due to evaporation resulting from burning charcoal. Omodara and Olaniyan (2012) stated that drying rate increases with increase in drying temperature showing that temperature is a major factor affecting the drying rate of a product. In this study, the percentage weight loss for *C. nigrodigitatus* was more than that of *C. gariepinus*, this may be because the lipid content of *C. nigrodigitatus* is higher than that of *C. gariepinus*; in fish there is an inverse relationship between moisture and lipid, when the lipid is high, the moisture will be low (Nestel 2000). The processing method, quality and smoking conditions could also contribute to the variation. Aminullahi *et al* (2006) observed that weight variation during fish processing is determined by the type of raw material, manual processing methods, brine type, quality and smoking conditions (temperature, moisture, air flow and drying).

Yuseng and Poulsen (1988) stated that internal water movement control the drying rate of samples. The fact that storage of the smoke-dried *C. gariepinus* and *C. nigrodigitatus* in the refrigerator and kitchen cabinet showed no significant difference (p >0.05) in the proximate composition throughout the storage periods, indicates that the storage facilities were similarly good for preservation of the nutritional components of the samples in this study. Sajib Al-Reza, *et al* (2015) however reported significant difference in the proximate composition of *Laubuka dadiburjori* during storage at room temperature.

The microflora, *Staphylococcus aureus*, *Bacillus subtilis* and *Escherichia coli* encountered in smoked fish studied are common microflora associated with fish and

Table 6: Sensory assessment of smoke-dried *C. gariepinus* stored in the different storage facilities with time (weeks)

Storage facilities	Storage period week	Flavour	Texture	Appearance	Aroma	Overall acceptability
Refrigerator (4ºC)	0	8.00±0.00^{a}	7.33±0.58^{a}	7.67±0.58^{a}	7.67±0.58^{a}	7.00±0.00^{a}
	2	8.00±0.00^{b}	7.33±0.58^{b}	7.67±0.58^{b}	7.33±0.58^{b}	7.00±0.00^{a}
	4	7.33±0.58^{a}	7.00±0.00^{a}	7.00±0.00^{a}	7.00±0.00^{a}	6.00±0.00^{a}
	6	7.00±0.00^{b}	6.00±0.00^{b}	5.67±0.58^{b}	6.00±0.00^{b}	5.00±0.00^{a}
Kitchen cabinet (room temperature)	0	8.00±0.00^{a}	7.33±0.58^{a}	7.33±0.58^{a}	7.67±0.58^{a}	7.00±0.00^{a}
	2	7.67±0.58^{b}	7.33±0.58^{a}	7.67±0.58^{b}	7.33±0.58^{b}	7.00±0.00^{a}
	4	7.33±0.58^{a}	7.33±0.58^{a}	6.00±0.00^{a}	6.67±0.58^{a}	6.00±0.00^{a}
	6	6.33±0.58^{b}	6.33±0.58^{a}	5.33±0.58^{b}	5.68±0.58^{b}	5.00±0.00^{a}

Means with different superscripts along the same column are significantly different (p<0.05)

Table 7: Sensory assessment of smoke-dried *C. nigrodigitatus* stored in the different storage facilities with time (weeks)

Storage facilities	Storage period week	Flavour	Texture	Appearance	Aroma	Overall acceptability
Refrigerator (4ºC)	0	8.00±0.00^{a}	7.33±0.58^{a}	7.67±0.58^{a}	7.67±0.58^{a}	7.00±0.00^{a}
	2	8.00±0.00^{b}	7.33±0.58^{a}	7.67±0.58^{a}	7.33±0.58^{b}	7.00±0.00^{a}
	4	7.33±0.58^{a}	7.33±0.58^{a}	7.67±0.58^{a}	7.00±0.00^{a}	7.00±0.00^{a}
	6	7.00±0.00^{b}	6.67±0.58^{a}	6.67±0.58^{a}	6.00±0.00^{b}	5.00±0.00^{a}
Kitchen cabinet (room temperature)	0	8.00±0.00^{a}	7.33±0.58^{a}	7.67±0.58^{a}	7.67±0.58^{a}	7.00±0.00^{a}
	2	7.67±0.58^{b}	7.33±0.58^{a}	7.67±0.58^{b}	7.00±0.00^{b}	7.00±0.00^{a}
	4	7.33±0.58^{a}	7.33±0.58^{a}	7.00±0.00^{a}	6.00±0.00^{a}	5.00±0.00^{a}
	6	6.67±0.58^{b}	7.00±0.00^{a}	6.33±0.58^{b}	5.00±0.00^{b}	4.67±0.58^{a}

Means with different superscripts along the same column are significantly different (p<0.05)

are the same as those reported in smoked *Clarias sp*. in Benin metropolis by Abolagba *et al* (2011) and Odu *et al* (2012) on smoke-dried mangrove oysters (*Crassostrea gazar*) sold in Port Harcourt. The storage of the smoke-dried *C. gariepinus* and *C. nigrodigitatus* in the refrigerator and kitchen cabinet showed no significant growth of microorganisms throughout the storage period. The presence of *S. aureus*, *B. subtilis* and *E. coli* in the stored samples studied could be from the handling process; this calls for standard hygiene during fish handling and processing by the processors.

There was no significant increase in the bacterial load of the dried fish samples in the two storage facilities; the contamination of the samples by microorganisms did not increase indicating that the storage facilities were effective in storing the smoked fish. The highest total bacterial count of 0.31×10^{-6}cfu/g of the fish sample was lower than the maximum recommended value of bacteria counts for good quality fish products, which is 5×10^{5} cfu/g according to International Commission on Microbiological Specifications for Foods (ICMSF 2002) and < 10 cfu/g by the Microbiological Guideline for Ready-to-eat-Food (2007). Contamination with *E. coli*, an enteric bacterium may have been introduced during smoking and preparation for storage. Olaleye and Abegund (2015) stated that the presence of *E. coli* in food may be because food handlers failed to observe basic sanitary rules. There was no growth of fungi in the samples, indicating the safety of the products. This showed that the storage facilities could prevent the growth of spoilage organisms.

The sensory qualities of the smoke-dried fish samples from the two storage facilities throughout the storage period were acceptable to the panel members. The quality attributes observed by the panel members may be due to the fact that the samples were properly stored in the two storage facilities, thereby preventing the samples from exposure to oxygen and micro-organisms that can adversely affect the quality of the samples. The significant differences observed in some of the qualities during the week 2 and 6 of storage could be as a result of rancidity taking place in the samples. However, since there was no significant difference in the overall acceptability of the smoked fish throughout the storage period, it implies that, panel members did not observe any major difference in the quality of the fish; this indicates that the quality of the smoked fish was preserved effectively with the two storage facilities studied.

Conclusion

Refrigerator and kitchen cabinet similarly retained the nutritional properties, sensory qualities and overall acceptability of smoke-dried *Clarias gariepinus* and *Chrysitchyes nigrodigitatus* after six weeks of storage.

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