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EFFECTS OF GINGER (*Zingiber officinale*) and CLOVE (*Syzygium aromaticum*) EXTRACTS ON THE QUALITY OF *Clarias gariepinus* PROCESSED WITH KAINJI MODIFIED DRUM KILN

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ABSTRACT

The research was aimed to evaluate the preservative effects of Ginger and Clove extract on the quality and shelf-life of *Clarias gariepinus* processed with Kainji Modified Drum Kiln. Thirty six (36) *Clarias gariepinus* species were obtained from Kabod Fish Farm, Jimeta-Yola. Phytochemical compositions of ginger and clove extract indicated the presence of Saponins, Flavonoids and Tannins in both Ginger and Clove, while Glycosides, Steroids and Trepenoids were only detected in Cloves. The Catfish samples were immersed in the aqueous solution prepared (Ginger Aqueous Solution (GAS) and Clove Aqueous Solution (CAS)) separately and transferred to the Kiln for smoking. Data were analyzed using ANOVA. There was no significant difference (P>0.05) in all the fish samples treated with ginger, clove and combine (ginger and clove). The proximate composition of freshly processed and preserved *C. gariepinus* showed low crude protein (36.31 – 42.47 g/100g Dry matter) and crude lipid (16.65 – 24.35g/100g Dry matter) while crude protein (50.80– 56.87 g/100g Dry matter) and crude lipid decreases (14.98 – 19.00 g/100g Dry matter). The results show that the Catfish samples treated with ginger, clove and combined (ginger and clove) as preservatives prior to processing indicates the effectiveness of these preservatives in controlling yeast and mold growth and capable of inhibiting microbial growth in stored Catfish products that was processed by Kiln. The improvement and development of packaging (using low cost local packaging materials) and good storage conditions will protect the products against spoilage and breakages for more than twelve (12) weeks without any insect infestation.

Keywords: *Clarias gariepinus*, Kainji Modified Drum Kiln, GAS – Ginger Aqueous Solution, CAS – Clove Aqueous Solution

INTRODUCTION

Fish makes up about 60% of world protein supply and developing countries derive more than 30% of their annual protein from fish, Food and Agricultural Organization (2010). Fish demand is increasing as a result of the increasing world population, higher living standards and the good overall image of fish among consumers (FAO, 2010). In addition, the demand for fish is on the increase due to the health benefits of eating fish and due to increase in human population.

In Nigeria, fish is eaten fresh and smoked and much cherished delicacy that cut across socio-economic, age, religions and educational barriers (Adebayo *et al.,* 2008) and it is a rich source of protein commonly consumed due to the higher cost of meat and other sources of animal protein (Omolara and Omotayo, 2009). However, fish is highly perishable because it provides favorable medium for the growth of microorganisms after death (Aliya *et al*., 2012). Fish spoilage in Nigeria is influenced to a large extent by high ambient temperatures, considerable distances of landing ports to points of utilization and poor as well as inadequate infrastructure for postharvest processing and landing (Saliu, 2008). Thus, it is imperative to process and preserve some of the fish caught in the period of abundance, so as to ensure an all year-round supply. This will invariably reduce post-harvest losses, increase the shelf-life of fish, and guarantee a sustainable supply of fish during off season with concomitant increase in the profit of the fishermen (Eyo, 2010). Proper preservation starts the moment fish is harvested until reaches the consumer's table (Oluborode *et al*., 2013).

Smoking is the oldest and most common method of fish preservation in many developing countries (Kumolu-Johnson *et al*., 2010). The smoke is produced by the process of incomplete combustion of wood in order to impart a characteristic flavour and colour to the fish (Kumolu-Johnson *et al*., 2010). Dried fish spoilage has been characterized by reddening, browning, or other discoloration, mould attack, and development of rancidity. The use of synthetic antioxidant has been very effective in controlling rancidity. However, synthetic antioxidants have frequently been associated with certain health problems (Siripongvutikorn *et al.,* 2009). Spices (ginger, onion, garlic, clove, etc.) are edible plant materials that possess anti-oxidant, antiseptic and antibacterial properties. They are added to foods to delay onset of deterioration, such as rancidity, and also function as seasonings to foods as well as impart flavor to the foods (Abdel-hamied *et al*., 2009).

Ginger as a spice has a geographical spread that covers every part of the globe and it is consumed whole as a delicacy, used in traditional oriental medicine, or as spice in foods, such as fish. Ginger contains spectra of biologically active compounds, such as curcumin, 6-gingerol, 6-shagaols, zingiberene, bisabolene and several other types of lipids that confer on it, the properties of being pungent and a stimulant. These compounds are responsible for the unique aroma and flavour of ginger, and account for about 1-3% of the weight of fresh ginger (Akram *et al.,* 2011).

Cloves (*Syzygium aromaticum*) belong to the family *Myrtaceae*, it is widely cultivated in Spice Islands, Indonesia, Pemba and Zanzibar, though earlier production of the plant was in China. It is used in the seasoning of food (Shan *et al.,* 2005). Its antimicrobial potential was established when its essential oil extracts killed many Gram positive and Gram negative organisms including some fungi (Shan *et al*., 2005). The antimicrobial activity of *Syzygium aromaticum* is attributable to eugenol, oleic acids and lipids found in its essential oils, (Shan *et al.,* 2005). *Syzygium aromaticum* in particular has attracted attention due to the potent antioxidant and antimicrobial activities standing out among the other

spices (Shan *et al.,* 2005). It is one of the most valuable spices that have been as food preservative and for many medicinal purposes. *Syzygium aromaticum* is an important medicinal plant due to the wide range of pharmacological effects consolidated from traditional use for centuries.

The use of insecticides and chemicals to control insect infestation in injurious to the health of the consumers, most of these insecticides are toxic. Since these insecticides constitute a danger to human health, their use should be discouraged. Ginger and Clove are spices that contribute to the taste and aroma to foods, also contain variety of bioactive substances which are of considerable use from the standpoint of food science and technology. Recently, the use of plant extracts as natural antioxidants has gained increasing interest because of the global trend of restriction in use of synthetic substance, also antioxidant rich plant extracts have potential benefits in food preservations (Uhart *et al.,* 2006).The Nigerian Export Promotion Council (NEPC) has identified adequate training programs, quality packaging and innovative technology as a way that will promote Nigerian fish export. According to NEPC (2011), poor processing and packaging of smoked fish from Nigeria have made the product unacceptable to the international market. The improvement of packaging (using low cost local effective packaging materials) and good storage conditions can protect fish products against spoilage and damage. The aim of this research is to evaluate the preservative effects of Ginger and Clove extracts on the quality and shelf-life of *Clarias gariepinus* using Improved Kainji Drum Kiln.

MATERIALS AND METHODS

Study Area

The experiment was conducted at the Department of Fisheries, Modibbo Adama University (MAU) Yola, Adamawa State. It is bounded between latitude $9^0$21''1''N to $9^0$21˙20¨N and longitude $12^0$28˙45¨E to $12^0$30˙28¨E.

Collection and Processing of *Clarias gariepinus*

Thirty-Six *Clarias gariepinus* samples was purchased from Kabod Fish Farm in Jimeta-Yola, Adamawa state. The fish sample was transported live using three (3) 50 litre jerricans to the Department of Fisheries, Modibbo Adama University, Yola, Adamawa State. The fish samples collected were weighed to determine its average mean weight, washed in clean water, degutted and dipped in a brine solution (5% NaCl) for 10 minutes and were allowed to drain as suggested (Sogbesan *et al.,* 2012)

Qualitative Phytochemical Analysis of Ginger and Clove

Phytochemical analysis of the organic extract was carried out according to the general method of Harbone (1998). Basic phytochemical screening was carried out using simple chemical tests to detect the presence of secondary plant constituents such as alkaloids, tannins, flavonoids, saponins, triterpenes, sterols, phenols, glycoside, reducing sugar and soluble carbohydrate in the sample. The methods used was those outlined by Harbone (1998).

Preparation of Ginger and Cloves

Dried Ginger and Cloves were obtained from the Jimeta modern market, Adamawa State. They were washed, peeled and blended separately using a blender, 50g of the powered ginger and cloves were added to 1 liter of water to form 5% of ginger aqueous solution (GAS) and 5% of clove aqueous solution (CAS) respectively. The fish were submerged into the GAS and CAS separately and transferred to the Kiln for processing.

Fish Processing Procedure

The fish samples were processed using Kainji Improved Drum Kiln. The drying rate or moisture loss was measured at the end of the dying process, there was frequent checking of the fish in other to take precaution against charring of the fish product until the fish was completely smoked and dried. The fish were then allowed to cool at an ambient temperature before they were packaged using a polyethylene leather for preservation.

Packaging Materials

Polyethylene packing rolls were obtained from Jimeta Modern Market, Adamawa state. The packaging material that was used for the period of 12 weeks (3 months) preservation of the processed fish was 10×6 cm polyethylene and 12x10x 10cm carton similar to Oluborode *et al.,* (2013).

Determination of Chemical Analysis

Chemical analysis of samples was done for fresh and dried samples in accordance to the method of Association of Official Analytical Chemists (A.O.A.C) (1998). The chemical components determined were moisture content, crude protein, ether extract and ash.

Sensory Analysis

Organoleptic attributes of taste, texture, colour, rancidity and general acceptability of the fish samples were evaluated by 10 trained panelists, selected from the department of Fisheries Department, Modibbo Adama University, Yola using a 9-point hedonic scale (Peryam and Pilgrim, 1957).

Microbiological Analysis

The following procedures were used for the specific microbes:

One gram (1g) representative sample was obtained aseptically from the muscle of the smoked catfish samples. The samples were grounded and serial dilutions of the homogenized samples were made using sterile distilled water. All chemicals used were of analytical grade and supplied by Sigma Co. (St Louis, USA). Each analysis was carried out in triplicates. All microbial analysis were done following the methods prescribed by (A.O.A.C., 2000).

Total Plate Count (TBC)

This was done using the pour plate method of (A.O.A.C. 2000). One milliliter of the serially diluted samples was taken in duplicates and plate count agar was poured at 40 on the plates. The samples and the medium were properly mixed, allowed to set and incubated at 35 and 37 for 24h. The number of colonies on the plates was counted. The colonies were sub cultured to get pure cultures which were further screen for the presence of indicator organisms as described below;

Escherichia coli Count

This was done using MacConkey agar, the plates were incubated at 35 and 37 for 24h. Colonies with pinkish red growth having a metallic sheen or reflection confirms the presence of E. coli

Salmonella Count

Samples for detection of salmonella were plated out on brilliant green Agar. The plates were incubated at 35 and 37 for 24h. Reddish white colonies with a pinkish zone confirmed the presence of Salmonella sp.

Yeast and Mould Counts
This was done by plating out serially diluted samples on Yeast and mould Agar at room temperature (30- 35) for 72hours.

Data Analysis
Means of data generated were represented using tabular, graphical representations. Mean weekly weight loss were subjected to ANOVA at 5% and separated using the Least Significant Differences (LSD).

RESULTS
Qualitative Analysis of Ginger and Clove
The results in Table 1 shows the qualitative phytochemical screening of ginger and clove, which indicates the presence of saponins, flavonoid and tannins in both ginger and cloves. The absence of glycoside, steroid and terpenoid in ginger and its presence in clove. The absence of oxalates, phenols and protein in both ginger and clove.

Mean chemical composition of the freshly processed catfish treated with ginger and clove.
The results in Table 2 shows the mean value of the proximate composition of the freshly processed catfish. Sample SGG (drum kiln with ginger) has the highest mean value of 42.47 g/100g D.M in terms of crude protein and sample SCL (drum kiln treated with clove) has the lowest mean value of 36.31g/100g D.M. In terms of mean value of Ash, sample SCT (drum kiln/ control) has the highest mean value of 23.15g/100g D.M and sample SGG (drum kiln with ginger) having the lowest mean value of 14.98g/100g D.M. The fat content shows that sample SCB (drum kiln with combine) has the highest mean value of 24.35g/100g D.M and sample SCL (drum kiln with clove) has the lowest mean value of 16.65g/100g D.M. The moisture content of sample SGG (drum kiln with ginger) has the highest mean value of 10.31g/100g D.M compare to sample SCT (drum kiln/control) having the lowest moisture content of 4.02g/100g D.M. In terms of nitrogen free extracts sample SCL (drum kiln with clove) has the highest mean value of 15.12g/100g D.M and sample SGG (drum kiln with ginger) is the lowest in terms of nitrogen free extract of 3.20g/100g D.M. In terms of energy, sample SCB (drum kiln with combine) has the highest mean value of 423.01Kcal/g and sample SCL (drum kiln with clove) having the lowest mean value of 355.99Kcal/g.

Mean chemical composition of the preserved catfish with bio-preservative
The results in Table 3 shows the mean value of the proximate composition of the preserved catfish. Sample SCL (drum kiln treated with clove) has the highest mean value of 56.87g/100g D.M in terms of crude protein and sample SCT (drum kiln/ control) has the lowest mean value of 50.81g/100g D.M. In terms of mean value of Ash, sample SCB (drum kiln with combination of ginger and clove) has the lowest mean value of 15.80g/100g D.M and sample SCL (Drum Kiln with clove) having the highest mean value of 18.00g/100g D.M . The fat content shows that sample SCT (drum kiln/control) has the highest mean value of 19.00g/100g D.M and sample SGG (drum kiln with ginger) has the lowest mean value of 14.98g/100g D.M. The moisture content of sample SCL(drum kiln with clove) has the highest mean value of 5.50g/100g D.M compare to sample SGG (drum kiln with ginger) having the lowest moisture content of 3.98g/100g D.M.
In terms of nitrogen free extracts sample SCL (drum kiln with clove) has the highest mean value of 3.40g/100g D.M and sample SGG (drum kiln with ginger) is the lowest in terms of nitrogen free extract of 0.03g/100g D.M. In terms of energy, sample SCT (drum kiln/ control) has the highest mean value of 407.58 Kcal/g and sample SGG (drum kiln with ginger) having the lowest mean value of 357.48Kcal/g.

Mean Sensory evaluation of the freshly processed catfish with bio-preservatives
The results in Table 4 shows the mean value of the sensory evaluation of the freshly processed samples in terms of appearance, taste, color, aroma, dryness and overall acceptability. In terms of appearance, sample SCB (drum kiln with combination of ginger and clove) has the highest value of 7.79 and the lowest is SGG (drum kiln with ginger) with a mean value of 7.14. In terms of taste, sample SCB (Drum Kiln with combination of ginger and clove) has the highest value of 7.86 and the lowest is SCL (Drum Kiln with clove) with a mean value of 7.11.
In terms of aroma, sample SCB (drum kiln with combination of ginger and clove) has the highest value of 7.61 and the lowest Mean value of 6.79 in sample SCL (Drum Kiln with clove). In terms of dryness, sample SCT (drum kiln/ control) has the highest mean value of 7.85 and the lowest mean value of 6.25 in sample SGG (drum kiln with ginger). Overall acceptability shows the highest mean value of 7.79 in sample SCB (drum kiln with combination of ginger and clove) and the lowest mean value of 6.86 in sample SCT (drum kiln/ control). However, statistically there was no significant difference in all the samples.

Mean sensory evaluation of the preserved catfish with bio-preservative
The results in Table 5 shows the mean value of the sensory evaluation of the preserved samples in terms of appearance, taste, color, aroma, dryness and overall acceptability. In terms of appearance, sample SCL (drum kiln with clove) has the highest value of 7.56 and the lowest is SCB (drum kiln with combine) with a mean value of 7.22. In terms of taste sample SGG (drum kiln with ginger) has the highest value of 7.56 and the lowest is SCT (drum kiln/ control) with a mean value of 6.22.
In terms of aroma, sample SCB (drum kiln with combination of ginger and clove) has the highest value of 7.13 and the lowest mean value of 6.63 in sample SCT (drum kiln /control). In terms of dryness, sample SGG (drum kiln with ginger) has the highest mean value of 7.67 and the lowest mean value of 6.89 in sample SCT (drum kiln/ control). Overall acceptability shows the highest mean value of 7.63 in sample SCL (drum kiln with clove) and SCB (drum kiln with combination of ginger and clove) and the lowest mean value of 6.25 in sample SCT (drum kiln/ control). However, statistically there was significant difference ($p>0.05$) between the control samples and other samples.

Weekly mean weight loss of catfish during preservation with bio-preservative
The results in Table 6 shows the weekly reduction in the weight of the samples. In week 1, the sample with the highest mean value of 433.33grams in SCB (Drum Kiln with ginger and Clove) and the lowest mean value of 400gram in SCT (drum kiln/ control) and SGG (drum Kiln with ginger). In week 2, sample SCL (Drum Kiln with clove) was the highest mean value of 400grams and sample SCT, SCB, SGG having the lowest mean value of 366.67grams. In week 3, the sample with the highest mean value of 333.33grams in SCB (drum kiln with combination of ginger and clove) while sample SCL (drum kiln with clove) having the lowest mean value of

300grams. In week 4 and 5, sample SCB (drum kiln with combination of ginger and clove) having the highest mean value of 333.33grams and sample SCL (drum kiln with ginger) having the lowest mean value of 293.33 grams. In week 6, sample with the highest mean value of 303.33grams in SGG (drum kiln with ginger) and sample SCL (drum kiln with clove) having the lowest mean value of 286.67 grams. In week 7 and 8, sample SCB (drum kiln with combination of ginger and clove) and SCT (drum kiln/ control) having the highest mean value of 293.33grams and sample SCL (drum kiln with clove) having the lowest mean value of 276.67 grams. In week 9, sample with the highest mean value of 283.33grams in SGG (drum kiln with ginger) and sample SCL (drum kiln with clove) having the lowest mean value of 256.67 grams. In week 10, 11 and 12, sample SGG (drum kiln with ginger) having the highest mean value of 276.67 and the lowest mean value of 256.67 in sample SCT and SCL.

Microbial Analysis of the preserved catfish

The results in Table 7 shows the microbial analysis of the preserved samples. In terms of Total bacterial count (TBC), the highest mean value is 3.0 x10^4 Cfu/g in SCT (Drum Kiln / control) and sample SCL (drum kiln with clove) having the lowest mean value of 1.0 x 10^4 Cfu/g. In terms of *E. coli* and *Salmonella spp*, all the samples were negative. In terms of Yeast and mould, the highest mean value is 1.0 x 10^4 Cfu/g in SCT (Drum Kiln/ control) and sample SCL (drum kiln with clove) having the lowest mean value of 0.6 x 10^4 Cfu/g.

Table 1: Phytochemical analysis of Ginger and Cloves

Phytochemicals	Ginger	Cloves
Saponins	+	++
Glycosides	-	++
Flavonoid	+++	+
Oxalates	-	-
Phenols	-	-
Tannins	+	+++
Steroid	-	++
Terpenoids	-	++
Protein	-	-

Key:
+ = Slightly present
++ = Moderately present
+++ = Highly present
- = Absent

Table 2: Mean proximate composition of the freshly processed catfish with bio-preservatives

Samples	g/100g D.M Moisture content	g/100g D.M Dry matter	g/100g D.M Ash	g/100g D.M Crude protein	g/100g D.M Fat	g/100g D.M Crude fibre	g/100g D.M Nitrogen Free Extract	Energy (kcal/g)
SCT	4.02±0.59^b	95.97±0.61^a	23.15±1.80^a	41.10±2.13^a	21.30±2.06^a	1.03±3.78^b	9.32±4.21^a	365.87^a
SGG	10.31±0.59^a	89.65±0.61^a	14.98±1.80^a	42.47±2.13^a	23.69±2.06^a	5.31±3.78^a	3.20±4.21^b	395.71^a
SCL	9.02±0.59^a	91.02±0.61^a	18.19±1.80^a	36.31±2.13^a	16.65±2.06^a	4.64±3.78^a	15.12±4.2^a	355.99^a
SCB	6.02±0.59^a	93.98±0.61^a	18.35±1.80^a	40.28±2.13^a	24.35±2.06^a	0.31±3.78^b	10.77±4.2^a	423.01^a

Value with the same subscript along column are not significantly different (p >0.05)
KEY:
NEG: Negligible
SCT – Drum Kiln whole control, SGG –Drum Kiln ginger, SCL- Drum Kiln Clove, SCB- Drum Kiln Combine ginger and clove.

Table 3: Mean proximate composition of the preserved catfish with bio-preservatives

Samples	g/100g D.M Moisture content	g/100g D.M Dry matter	g/100g D.M Ash	g/100g D.M Crude protein	g/100g D.M Fat	g/100g D.M Crude fibre	g/100g D.M Nitrogen Free Extract	Energy (kcal/g)
SCT	4.50±0.59^a	95.50±0.61^a	17.60±1.80^a	50.80±2.13^a	19.00±2.06^a	8.00±3.78^a	1.20±4.21^c	407.58^a
SGG	3.98±0.59^a	95.98±0.61^a	17.60±1.80^a	55.54±2.13^a	14.98±2.06^a	6.48±3.78^a	0.03±4.21^c	357.48^a
SCL	5.50±0.59^a	94.50±0.61^a	18.00±1.80^a	56.87±2.13^a	18.50±2.06^a	4.50±3.78^b	3.40±4.21^c	391.74^a
SCB	5.30±0.59^a	94.70±0.61^a	15.80±1.80^a	52.30±2.13^a	16.30±2.06^a	8.30±3.78^a	1.20±4.21^c	365.00^a

Value with the same subscript along column are not significantly different (p >0.05)
KEY:
SCT – Drum Kiln whole control, SGG –Drum Kiln ginger, SCL- Drum Kiln Clove, SCB- Drum Kiln Combine ginger and clove.

Table 4: Mean sensory evaluation of Freshly Processed catfish with bio-preservatives

Samples	Appearance	Taste	Colour	Aroma	Dryness	Overall Acceptability
SCT	7.64±1.28^{a}	7.57±1.39^{ab}	7.50±0.94^{ab}	6.93±1.21^{a}	7.85±1.23^{b}	6.86±0.77^{a}
SGG	7.14±1.41^{a}	7.43±1.28^{ab}	7.07±1.77^{ab}	7.29±1.20^{a}	6.25±1.58^{a}	7.50±1.09^{a}
SCL	7.43±1.28^{a}	7.11±1.71^{ab}	7.21±0.97^{ab}	6.79±1.05^{a}	7.21±0.89^{ab}	6.71±1.44^{a}
SCB	7.79±1.05^{a}	7.86±0.77^{ab}	7.79±1.12^{b}	7.61±0.88^{a}	7.64±1.22^{b}	7.79±1.12^{b}

Value with the same superscript along column are not significantly different (p >0.05)
KEY:
SCT – Drum Kiln whole control, SGG –Drum Kiln ginger, SCL- Drum Kiln Clove, SCB- Drum Kiln Combine ginger and clove.

Table 5: Mean sensory evaluation of preserved catfish with bio-preservative

Samples	Appearance	Taste	Colour	Aroma	Dryness	Overall Acceptability
SCT	7.44±1.13^{b}	6.22±0.83^{a}	6.00±0.71^{ab}	6.63±1.41^{a}	6.89±0.93^{a}	6.25±0.71^{a}
SGG	7.33±0.77^{ab}	7.56±1.33^{a}	7.44±0.88^{c}	7.00±1.51^{a}	7.67±1.11^{a}	7.50±0.71^{b}
SCL	7.56±0.88^{b}	6.89±1.27^{a}	7.22±1.48^{bc}	6.75±1.49^{a}	7.22±0.97^{a}	7.63±0.74^{b}
SCB	7.22±0.67^{ab}	6.33±1.94^{a}	7.22±0.83^{bc}	7.13±0.83^{a}	7.56±0.88^{a}	7.63±0.74^{b}

Value with the same superscript along column are not significantly different (p >0.05)
KEY:
SCT – Drum Kiln whole control, SGG –Drum Kiln ginger, SCL- Drum Kiln Clove, SCB- Drum Kiln Combine ginger and clove.

Table 6: Mean weight loss of processed catfish during twelve weeks of storage.

WKS	SCT (g)	SGG (g)	SCL (g)	SCB (g)
Week 1	400.00^{a}	400.00^{a}	416.67^{a}	433.33^{a}
Week 2	366.67^{a}	366.67^{a}	400.00^{a}	366.67^{a}
Week 3	316.67^{a}	310.00^{a}	300.00^{a}	333.33^{a}
Week 4	300.00^{a}	310.00^{a}	293.33^{a}	333.33^{a}
Week 5	300.00^{a}	310.00^{a}	293.33^{a}	333.33^{a}
Week 6	300.00^{a}	303.33^{a}	286.67^{a}	296.67^{a}
Week 7	293.33^{a}	286.67^{a}	276.67^{a}	293.33^{a}
Week 8	293.33^{a}	286.67^{a}	276.67^{a}	293.33^{a}
Week 9	263.33^{a}	283.33^{a}	256.67^{a}	280.00^{a}
Week 10	256.67^{a}	276.67^{a}	256.67^{a}	273.33^{a}
Week 11	256.67^{a}	276.67^{a}	256.67^{a}	273.33^{a}
Week 12	256.67^{a}	276.67^{a}	256.67^{a}	273.33^{a}

Value with the same superscript along row are not significantly different (p >0.05)
KEY:
SCT – Drum Kiln whole control, SGG –Drum Kiln ginger, SCL- Drum Kiln Clove, SCB- Drum Kiln Combine ginger and clove.

Table 7: Microbial analysis of the preserved catfish with bio-preservatives

Samples	TBC (Cfu/g)	*E. coli* (Cfu/g)	*Salmonella spp* (Cfu/g)	Yeast and Mould (Cfu/g)
SCT	3.0 x 10^4	0.0 x 10^4	0.0 x 10^4	1.0 x 10^4
OCT	3.5 x 10^4	0.0 x 10^4	0.0 x 10^4	1.1 x 10^4
SGG	2.0 x 10^4	0.0 x 10^4	0.0 x 10^4	0.8 x 10^4
OGG	2.0 x 10^4	0.0 x 10^4	0.0 x 10^4	0.7 x 10^4
SCL	1.0 x 10^4	0.0 x 10^4	0.0 x 10^4	0.6 x 10^4
OCL	1.7 x 10^4	0.0 x 10^4	0.0 x 10^4	0.6 x 10^4
SCB	2.3 x 10^4	0.0 x 10^4	0.0 x 10^4	0.9 x 10^4
OCB	2.1 x 10^4	0.0 x 10^4	0.0 x 10^4	0.8 x 10^4

Key:
TBC- Total bacterial count, Cfu/g - colony forming unit per gramme.
SCT – Drum Kiln whole control, SGG –Drum Kiln ginger, SCL- Drum Kiln Clove, SCB- Drum Kiln Combine ginger and clove

DISCUSSION

The phytochemicals of ginger and cloves reveals that saponins and Tannins were slightly present in ginger and moderately present in cloves. Flavonoid was highly present in ginger and slightly present in cloves. According to Pruthi (2009), properties of spices include bactericidal, bacteriostatic, fungistatic, anthelmintic, medicinal and flavouring. Glycoside, Steroid and Terpenoid were

moderately present in cloves and absent in ginger, while Oxalates and Protein were both absent in ginger and cloves.

It is widely reported that drying increases protein content of fish due to heat dehydration which concentrates proteins, thus increasing the nutritional value of the processed fish product, as earlier studied by Ahmed *et al.*(2011). It was also observed that protein levels increased with decreasing moisture content as earlier reported by (Aliya *et al.,* 2012 and Daramola *et al.,* 2007).

Highest and lowest crude fat was obtained in SCB (24.35g/100g D.M) and (16.65g/100g D.M) for SCL. It is reported that fat increases with heat processing and reduction in moisture content (Chukwu and Shaba, 2009; Akintola *et al.,* 2013), reduction in fat could also be attributed to possible loss of fat due to high temperature (Idah and Nwankwo, 2013). Fish species with more than 20g/100g D.M fat content are considered fatty (Aliya *et al.,* 2012).

Ash content is generally influenced by size of fish. Smaller sized fish species tend to have higher ash content due to higher bone to flesh ratio as studied by Daramola *et al.* (2013). High Ash content in SCT (23.15g/100g D.M) and lowest Ash content in SGG (14.98g/100g D.M) could be due to size as well as loss of moisture.

Low and high moisture content in smoke and dried could be attributed to differences in moisture of the smoked fish relative to the surroundings as suggested by Longwe and Kapute (2016). Lowest moisture (4.02g/100g D.M) in SCT and highest in SGG (10.31g/100g D.M) was within the acceptable limit for prevention of microbial spoilage as earlier reported by Immaculate *et al.* (2012), because water activity determines storage life of fish (Daramola *et al.,* 2013).

Lowest level of protein observed after preservation in SCT (50.80g/100g D.M) and highest level of protein in SCL (56.87g/100g D.M) has earlier been reported by Chukwu and Shaba (2009). Highest and lowest crude fat was obtained in SCT (19g/100g D.M) and SGG (14.98g/100g D.M) after preservation. It is reported that fat increases with heat processing and reduction in moisture content (Chukwu and Shaba, 2009; Akintola *et al.,* 2013), reduction in fat could also be attributed to possible loss of fat due to high temperature (Idah and Nwankwo, 2013).

Ash content is generally influenced by size of fish. Smaller sized fish species tend to have higher ash content due to higher bone to flesh ratio as studied by Daramola *et al.* (2013). High Ash content in SCL (18.00g/100g D.M) and lowest Ash content in SCB (15.80g/100g D.M) could be due to size as well as loss of moisture during preservation.

Low and high moisture content in smoke and dried fish could be attributed to differences in moisture of the smoked fish relative to the surroundings as suggested by Longwe and Kapute (2016). Lowest moisture (3.98g/100g D.M) in SGG and highest in SCL (5.5g/100g D.M) was within the acceptable limit for prevention of microbial spoilage as earlier reported by Immaculate *et al.* (2012), because water activity determines storage life of fish (Daramola *et al.,* 2013).

Sensory parameter such as appearance, taste, colour, aroma, dryness and overall acceptability were examined 24 hours after processing. The results for all the parameters in the samples follows a similar trend. However, statistically there was no significant difference ($P > 0.05$) in all the parameters of the samples. This agrees with the findings of Bilgin *et al.* (2008).

Highest and lowest taste mean value was obtained in SGG (7.5±1.33) and 6.22±1.09 in SCT. The lowest and highest aroma was obtained in SCT (6.63±1.41) and 7.00±1.51 in SGG. Highest dryness was obtained in SGG (7.67±1.11) and lowest value was obtained in SCT (6.89±0.93) after preservation. The highest overall acceptability was obtained in SCL and SCB (7.63±0.74) and the lowest overall acceptability was obtained in SCT (6.25±0.71) after preservation. This agrees with the findings of (Bilgin *et al.,* 2008).

The results show that there is no significant difference in the weekly weight loss of all the samples processed Kanji Modified Drum Kiln within the weeks. Weight loss in fish increases the shelf-life, maintains the quality of the fish in terms of nutrients and flavor (Sogbesan *et al.* 2012).

The moisture content of the preserved Catfish samples, which was between 3.98g/100g D.M to 5.5g/100g D.M falls within the allowable limit (6-8g/100g D.M) for Smoked dried fish as this is of paramount importance in preventing spoilage during storage and it enhances the shelf life of the smoked fish, this observation is in agreement with the findings of (Salan *et al.,* 2006) and (Kumolu Johnson *et al.,* 2009) who reported that spoilage of fish resulting from the action of enzymes and bacteria can be slowed down by the addition of salt as well as reduction in moisture through smoking .

The total mean bacteria count ranges from 1.0×10^4 to 3.5×10^4 colony forming unit per gram of the fish sample, this value falls within the maximum recommended value of bacteria count for good quality fish products which is 5×10^5 colony forming unit per gram according to (ICMSF, 2005) and the Microbiological Guideline for Ready to –eat – Food which is less than 10^6 (Microbiological Guideline for Ready to –eat – Food, 2007). The result also indicated that there was no contamination with enteric organisms by handlers during preservation as there was no coliform found after preservation. The absence of *E. coli* and Salmonella species which are indicative organisms indicating contamination by microorganisms from enteric origin further confirms the effectiveness of the smoking kiln.

According to Eyo (2010) microbial action plays a large part in the spoilage of fish and fish products. The value of yeast/ mould recorded after preservation was found to falls within the acceptable limit of acceptable number of colonies forming unit of mould/yeast of smoked fish (Microbiological Guideline for Ready to –eat – Food, 2007).

CONCLUSION

Bio-preservation is an alternative preservation offered by natural biochemical or biological system or combinations of biological system with a much-reduced use of salt and chemical additives to extend the shelf-life and improved the safety of fish by employing antimicrobials or their metabolites.

The results of this study have showed the effect of ginger and clove extracts proximate composition, microbial loads and organoleptic qualities of processed and preserved catfish (*Clarias gariepinus*) at a room temperature. Proper packaging as shown in this work also help to promote sub regional trade of fishery products as well as enhance reliable information network for effective marketing in an organized industry. The use of ginger extracts, clove extracts or both can be used in reducing microbiological activities, improving the shelf-life and consumer acceptability of processed *Clarias gariepinus* and it was concluded that samples processed by KMDK for both whole clove(SCL) and whole ginger (SGG) extracts would positively influence shelf-life and reduce or prevent pathogens in processed and preserved catfish.

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