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Effect of Spice Treatment on the Quality of Solar Dried African Catfish, *Clarias Gariepinus* (Burchell, 1822) In Sokoto, Nigeria

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ABSTRACT
An experiment was conducted to determine the efficiency of garlic and ginger spice mixtures at 0%, 1%, 2%, and3% levels (per gram of fish) in retarding lipid oxidation on the proximate composition, Total Volatile Bases Nitrogen, Microbial level and organoleptic quality of solar dried catfish (*Clarias gariepinus)* in Sokoto, Nigeria. Fresh fish samples were purchased and washed thoroughly to remove sand and slime; they were humanely killed and eviscerated. Muscles of bigger fish were silt and dipped in 15% brine for 10 minutes. They were then divided into four batches S0 S1, S2, and S3 (replicated three times) representing un-spiced, 1% spiced, 2% spiced, and 3% spiced respectively then Solar dried at 45 °C for 6 days, cooled, stored at room temperature (26°C -32°C) for 5 weeks and used for proximate analysis, Total Volatile Bases Nitrogen, microbial and sensory evaluation analysis. Untreated samples served as control treatment. The results of this research indicated that samples treated with garlic and ginger mixtures (1:1 ratio) were microbiologically more stable than the control samples as these had longer shelf-life and were not covered by visible mouldy mass of *mycelium* during the five week storage period. The anti-oxidant activity of garlic, or garlic and ginger spice mixtures was evident from lower Total Volatile Bases Nitrogen (TVBN) values of treated samples relative to untreated (control) samples. Results of sensory evaluation showed a general preference for spice-treated samples. In conclusion, ginger and garlic, two abundant spices in this geographical zone, when combined, as paste, in solar dried *Clarias gariepinus* exhibit anti-oxidant and anti-fungal properties especially at 3% (per weight of fish). It is therefore recommended that in preservation of fish, 3 percent ginger and garlic mixture in addition to salting should be used to prevent fish spoilage.

Introduction

Fish is a highly nutritious food and it is particularly valued for its protein of high quality better than those of meat and eggs. Fish is a highly digestible food, due to its low collagen level. It contains high quality protein, amino acids and absorbable dietary minerals (Buhuiyan *et al*., 1993). It is an important component of average Nigerian diet, contributing more than 40% of the total animal protein intake (Adeniyi, 1987)

Fish spoilage stability remains a serious factor affecting fish supply in Nigeria. Oladosu *et al.*, (1992) reported that 40% of the total catch in Nigeria is lost annually due to improper storage and inadequate preservation techniques. A greater proportion is preserved by smoking and sun drying to prevent the growth of spoilage organisms (Ihuahi *et al.*, 2005)

The use of synthetic antioxidants has been very effective in controlling rancidity. However, synthetic antioxidants are not available to the public and have been prohibited in many countries of the world because of its undesirable effect on the enzymes of the liver and lung (Ikeme and Bhandary, 2001). Sun drying is one of the traditional methods employed to preserved fish. It has been the most convenient and cheapest form of preservation in Nigeria (Eyo, 2001). The need to use solar radiation/energy for fish drying has become even more than necessary at the present time because of the huge competitive demand for fuel wood to be used in fish smoking. Spices are edible plant materials that possess antioxidative, antiseptic and bacteriostatic properties. They are added to food to delay the onset of deterioration such as rancidity.

The broad objective of the study is to determine the efficiency of garlic and ginger spice mixture in the extending the shelf-life by retarding lipid oxidation and on the organoleptic quality of solar dried *Clarias gariepinus.* The abundant production of garlic and ginger in this geopolitical zone necessitates its choice. Similarly, potentials of solar radiation which appears abundant, convenient and cheapest form of preservation informed the conduct of this study.

Materials and Methods

For each experiment, fresh catfish samples (*Clarias gariepinus*) were purchased from Forestry and Fisheries departmental fish farm. The fish samples were washed thoroughly to remove sand and slime, and were humanely killed and eviscerated. Muscles of large samples were silted using knives according to the method of Roger *et al*. (1975). The fish were cleaned and dipped in 15% sodium chloride for 10minutes as suggested by Ikeme and Bhandary (2001) drained and divided into 4 batches.

Fresh garlic (*Allium sativum*) and ginger (*Zingiber officinalae*) were bought and the outer coats of the garlic were scrapped off. These were cleaned, ground properly into fine pastes and were applied as garlic and ginger (1:1)

spice mixture at 0%, 1%, 2% and 3% levels per gram of fish. The cleaned, brined, and spiced fish samples were arranged on the dry racks within the solar box dryer. Ambient temperature of 33^0C was used while temperature of 45^0C within the rack was used. The relative humidity of 780mmHg was recorded

Experimental Design

Each concentration level of garlic and ginger spice mixture (1.0% 2.0% and 3.0%) represented the treatments in a Completely Randomized Design (CRD) while 0% served as control replicated three times.

Fish Storage

Dried samples were packaged in bulk and separated by treatment in sealed polythene bags, and stored at ambient temperature (26-32^{o}C) for 5 weeks. Samples were subjected to visual observation, chemical, microbiological analysis and sensory evaluations.

Chemical Analysis

Protein, lipid and moisture content of dried products were determined according to A.O.A.C. (1995) procedure.

Total volatile bases nitrogen (TVBN) Analysis:

A 10g sample was washed into the distillation flask and 1gram magnesium oxide will be added, follow by two drops of antifoam solution. The Samples were boiled and distilled into 10ml of hydrochloric solution with added indicator in a 500ml conical flask. After the distillation, the content of conical flask was titrated with 0.1 sodium hydroxide (Schormüller, 1968).

Microbiological Analysis

Mould counts were determined according to standard procedures (Speck, 1976). Visual examination of the products was carried out daily. Products with visible mouldy mass of mycelium was removed on observation to prevent contamination of other products.

Organoleptic Assessement

Subjective evaluations of product quality were carried out in accordance with Ihuahi *et al*. (2005) by an experienced panel composed of 10. Coded samples accompanied by questionnaires were presented to the panelists. Quality attributes studied include appearance, saltiness, rancidity (off flavour), taste, texture and general acceptability. Panel members scored all factors on a 5-point Hedonic Scale as depicted on the score sheet below:

Sample Score Sheet Used By Taste Panel

Factor	1	2	3	4	5
Appearance	Bad	Fair	Medium	Good	Excellent
Texture	Very Soft	Soft	Fairly firm	Firm	Very firm
Saltiness	Salty	Slightly salty	medium salty	Acceptable salty	Not salty
Rancidity	Extremely rancid	Moderately rancid	Medium rancid	Slight detectable rancidity	No detectable rancidity
Taste	Extremely undesirable	Moderately undesirable	Medium	Moderately desirable	Extremely desirable
General Acceptability	Extremely unacceptable	Moderately unacceptable	Medium acceptable	Moderately acceptable	Extremely acceptable

Statistical Analysis

The data obtained were subjected to analysis of variance (ANOVA) using S.P.S.S. version 16.0 (2007) computer packages. Duncan Multiple Range Test (DMRT) was then used to separate treatment means where there is a significant difference. Tables and figures were also used to illustrate results as appropriate.

Results

The solar drying processes of the samples took a total of six days period to achieve a constant weight, plate 1 and 2 showed drying session.

The results of the proximate composition of the solar dried spiced fish samples are contained on table 1. There was no significant difference (P>0.05) in the proximate components of the samples in all the treatments. However, moisture ranged between 3.50±0.14 in solar dried samples without spice and 3.65±0.13 in samples dried with 1% spice concentration. The pattern exhibited similar trend in the other components.

The results of the Total Volatile Bases Nitrogen (TVBN) on the effect of the different concentrations of ginger and garlic pastes on the solar dried *C. gariepinus* are depicted on Table 2. The TVBN values varied significantly (P<0.05) between the treatments. The control (SO) was found to be significantly higher (13.77±0.98mg/100g) than both S1 and S3.

Table 3 showed the values of TVBN during the five (5) weeks of storage period. The TVBN values were found to be significantly different (P<0.05) between the five weeks storage period. The values after the first week of storage was significantly lower (12.21±0.09mg/100g) than the values of the fifth week (14.99±0.12mg/100g)

Table 4 shows the mean values of Total Viable Counts (TVC) of the bacteria found on the stored products. The values were within the range of 3.7×10^4 to 1.21×10^6 for S0 (control), 1.8×10^4 to 2.4×10^5, for 1% spice (S1), 1.4×10^4 to 2.8×10^5 for 2% spiced (S2) and range from 1.2×10^4 to 1.7×10^5 (S3) for 3% spice.

The results of the organoleptic assessment of the solar dried products during the five weeks storage period are presented on Table 5. The taste panels scores varied significantly (P<0.05) in the parameters assessed. Lower values were recorded for the control than all the other three treatments.

DISCUSSION

Proximate Compositions

Moisture content is an important factor in the preservation of dried foods. The moisture contents reported in the solar dried catfish in this study fall within the range reported by Frazier and Westhoff (1988). These authors observed that moisture content of less than 10% is usually adequate to preserve most dry foods. The significantly higher protein content of 45.55% was recorded in sample with 3 % spiced over the 45.10% of un-spice treated sample. Magawata and Oyelese (2000) also reported that moisture loss was responsible for the concentration of other nutrients especially proteins. However, the present study showed that there was no significant difference among the treatments. The result of the study on the protein content was also within the range (44-46%) reported by Forester (1999) in the dried samples of some species of fish he analysed. Fish samples used in this research could be classified as fatty fish based on the report Ikeme and Bhandary (2001) who reported that fish samples with more than 5% fat are generally regarded as fatty. Since the samples were sourced from the departmental farm, the fish must have been fed adequately; reason why fat concentration was found to be high.

Total Volatile Bases Nitrogen

The results of Total volatile bases nitrogen (TVBN) values obtained in this research showed that untreated (control) samples were higher than treated samples. All samples showed increase in TVBN with storage period. This is in agreement with the findings of Magawata and Oyelese (2000) who observed that TVBN values increased with the increase in the storage period. It was also observed that higher concentrations of spices were more effective in retarding rancidity. Lower TVBN value was obtained in 2% and 3% spice treated samples. Stansby (1963) reported TVBN values of less than 12 for fresh fish, while values ranging from 12 to 20 indicate slight decomposition but entirely edible product, with badly decomposed and inedible products having TVBN values above 30, such as the results of Magawata and Obafemi (2010) who reported TVBN values 56.01mg/100g of shredded fish muscles during the sixth week of storage. The product was completely inedible. Gökoğlu, *et al.*, (1998) found that TVBN value in fresh sardine increased from 13.2 mg/100g to 64.8mg/100 g during refrigerated storage. Aksu *et al*., (1997) reported that TVBN value of 8.3 mg/100g in anchovy marinated using acetic acid of 2% increased to 15.1 mg/100g at the storage of 150 days. While the initial TVBN values in this study were similar to findings of other researchers, the increase in TVBN values during the storage was lower than others. The probable reason for these differences may be due to differences in fish species and that

ginger and garlic pastes were very effective in retarding the development of rancidity in foods such as fish. Ikeme and Bhandary, (2001) and Ihuahi *et al*., (2005) had reported that the effectiveness of spices as antioxidants is directly related to their concentration.

Microbiological Analysis

There was a steady increase in mould count as storage period progresses in all the treatments. However, spice treated samples showed lower count as compared to un-spiced samples. A combination of preservative treatment with solar drying resulted in variations of microbial levels. The observation of large visible mouldy mass of mycelium from the first week of storage under ambient condition obtained in the un-spiced samples indicated the effectiveness of spices as anti-fungal agents which resulted in the extended shelf life of spice treated samples. 3% spice treatment gave the highest extended shelf life. Nevertheless, the microbial populations for all the treatment observed in this study were within the recommended limits for good quality fish product according to ICSMF, (1986).

Organoleptic Assessment

The results of taste panel of solar dried catfish *C. gariepinus* during a 5-week storage period showed that the un-spiced samples received lower panel scores than the spice treated samples with regards to appearance, rancidity, saltiness, texture and general acceptability. Lipid oxidation in the control samples could have been responsible for the development of rancidity which affected general acceptability of the untreated samples. Samples treated with 3% spice mixture recorded highest acceptability. The result obtained was similar to the report by (Ikeme and Bhandary, 2001) in which treated samples were generally preferred over others. Also Ihuahi *et al*., (2005) reported a similar results in which treated samples with 4% and 5% spice mixture recorded highest acceptability. Analysis of variance showed that treatments were significantly different at ($P<0.05$) with regard to appearance, rancidity, texture and general acceptability.

Conclusion

The results of the present experiment showed that ginger and garlic; two abundant spices in this geographical zone, when combined, as paste, in solar dried C. *gariepinus* exhibited antioxidant and anti-fungal properties especially at 3% (per weight of fish). In addition to the above, these spices can also be used in medication against rheumatism, cold and many other ailments. Based on this, more in depth research that will allow a more lengthy period of storage can be explored with a view to standerdising the spices as well as establishing the exact shelf life of the product.

Table 1**:** Result of proximate composition solar dried catfish (*Clarias gariepinus*)

Treatment	Parameters (%)				
	Moisture	Crude protein	Lipids	Ash	Crude fiber
S0	3.50±0.14	45.10±0.66	5.06±0.31	11.13±0.25	1.10±0.1
S1	3.65±0.13	45.30±0.20	5.50±0.20	11.28±0.20	1.60±0.10
S2	3.43±0.20	45.21±0.14	5.58±0.31	11.87±0.5	1.60±0.20
S3	3.52±0.15	45.55±0.41	5.71±0.27	11.82±0.16	1.57±0.5

S0= Solar dried fish without spice (control); S1= Solar dried fish with 1.0% spice; S2= Solar dried fish with 2.0% spice; S3= Solar dried fish with 3.0% spice

Table 2**:** Effect of different concentrations of ginger and garlic pastes on TVBN value (mg/100g of sample) of solar dried *Clarias gariepinus* during a 5weeks storage period

Treatment	Total Volatile Base Nitrogen (TVBN)
S0	13.77 ± 0.98^{a}
S1	13.69 ± 0.99^{b}
S2	13.54 ± 1.25^{c}
S3	13.52 ± 1.26^{c}

Means with the same letter(s) along the column are significantly the same ($P < 0.05$)

S0 = Solar dried fish without spice (control); S1= Solar dried fish with 1.0% spice; S2 = Solar dried fish with 2.0% spice; S3= Solar dried fish with 3.0% spice

Table 4 interaction of TVBN values (mg/100g of sample) of solar dried *Clarias gariepinus* during a 5-weeks storage period

Storage Period (Weeks)	Total Volatile Nitrogen (TVBN)
1	12.21 ± 0.09^{e}
2	12.77 ± 0.59^{d}
3	13.55 ± 0.05^{c}
4	14.62 ± 0.29^{b}
5	14.99 ± 0.12^{a}

Means with the same letter(s) along the columns are significantly the same ($P < 0.05$)

Table 4**:** Effect of concentrations of ginger and garlic pastes on mould counts of solar dried *Clarias gariepinus* during a 5 weeks of storage period

Period of storage (Weeks)	Mould count (c f u/ g)			
	S0	S1	S2	S3
1	3.7×10^{4}	1.8×10^{4}	1.4×10^{4}	1.2×10^{4}
2	5.4×10^{4}	2.5×10^{4}	2.2×10^{4}	2.1×10^{4}
3	7.5×10^{4}	3.9×10^{4}	3.6×10^{4}	2.6×10^{4}
4	3.03×10^{5}	2.1×10^{5}	7×10^{4}	4.25×10^{4}
5	1.21×10^{6}	2.4×10^{5}	2.8×10^{5}	1.7×10^{5}

S0 = Solar dried fish without spice (control); S1= Solar dried fish with 1.0% spice; S2 = Solar dried fish with 2.0% spice; S3 = Solar dried fish with 3.0% spice

Table 5**:** Taste panel rating of solar dried *Clarias gariepinus* during a 5 weeks of storage period

Treatment	Appearance	Rancidity	Saltiness	Taste	Texture	General Acceptability
S0	3.50 ± 1.08^{b}	2.90 ± 0.74^{b}	2.64 ± 0.52^{c}	3.80 ± 1.12	2.20 ± 0.92^{b}	2.90 ± 0.74^{b}
S1	4.40 ± 0.84^{a}	3.70 ± 1.16^{a}	3.60 ± 0.70^{b}	3.90 ± 0.86	3.00 ± 0.82^{b}	3.70 ± 1.16^{ab}
S2	4.40 ± 0.70^{a}	3.80 ± 0.63^{a}	3.70 ± 0.82^{b}	4.50 ± 0.53	2.80 ± 1.32^{b}	3.70 ± 0.95^{ab}
S3	4.60 ± 0.52^{a}	4.40 ± 0.84^{a}	4.40 ± 0.52^{a}	4.20 ± 0.79	3.90 ± 0.57^{a}	4.50 ± 0.53^{a}

Means with the same letter(s) along the column are significantly the same ($P > 0.05$)

S0 = Solar dried fish without spice (control); S1= Solar dried fish with 1.0% spice; S2 = Solar dried fish with 2.0% spice; S3 = Solar dried fish with 3.0% spice

Plate1**:** Solar dryer with samples

Plate 2: cross section of solar dried *Clarias gariepinus*

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