Shelf Life Extension Studies of Fried Plantain Chips Treated with Crude Antioxidants Extracts of *Aframomum danielli*

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ABSTRACT--- ***The effect of Aframomum danielli crude antioxidants extracts on storability of plantain chips were investigated under ambient and refrigerated conditions. Proximate composition, microbial, physiochemical characteristics and sensory attributes of the treated plantain chips were investigated. Plantain chips were spiced with Aframomum danielli crude antioxidant extract at; 200ppm, 300ppm, 500ppm and 1000ppm. Untreated sample without Aframomum danielli were also prepared. There was no significant (P<0.05) different among the samples in terms of moisture and protein contents except for ash and fat were found to be significantly different (P>0.05). sensory evaluation revealed significant different between 300ppm and 500ppm in terms of taste colour, appearance, flavour and over all acceptability but sample treated with 1000ppm was found to be unacceptable in terms of flavour by the panelist. Results shows that at treatment of 300ppm-1000ppm crude extracts of Aframomum danielli extended the induction period of lipid oxidation and inhibit the spoilage microorganisms both at ambient and more especially refrigeration conditions. The storage stability test indicated that fried plantain chips treated with crude antioxidant extracts of Aframomum danielli had percentage effectiveness that ranged between 44.12% and 72.8% at ambient condition and 44.57% and 87.33% refrigeration condition for storage periods of eight weeks. This study justifies that the stability of fried plantain chips can be enhanced with incorporation of crude antioxidants extracts of Aframomum danielli at levels of between 200 to 500ppm.***

Keywords--- Shelf life extension, proximate, fried plantain chips, *aframomum danielli*

1. INTRODUCTION

Plantains and other cooking bananas (Musa spp.) are staple food growth throughout the tropics, they constitute a major source of carbohydrates for millions of people in Africa, the Caribbean Latin America, Asia and the pacific. Plantain is the common name for herbaceous plants of the genus Musa (Adeniji, 2007). The fruit they produce is generally used for cooking in contrast to the soft sweet banana which is sometimes referred to as the desert banana. All members of the genus Musa are indigenous to the tropical regions of south East Asia and Oceania including Malay Archipelago Indonesia, Malaysia, Brunei and the Philippines. Plantains are a major staple food in equatorial Africa and Andean regions. Their attractiveness as food is that they fruit all year round making them a more reliable all season staple food. Various parts of the plantain plant have been consumed as human food since prehistory. Steamed boiled, grilled baked or fried. In Nigeria, plantain is eaten boiled, fried or roasted plantain called "Boli" it is usually eaten with palm oil or groundnut. In countries located in Central American and the Caribbean such as Trinidad and Tobago, plantain is simply fried, boiled or added to soup. (Randy et al, 2011). Plantain chips are the most popular plantain products in Nigeria. They are prepared by slicing the unripened or slightly ripened plantain with a diameter (2mm thick) in vegetable oil at the temperature between 160-170^{0}c for 3 to 5minutes. The plantain chips prepared in this way are packed in plastics or in polyethylene bags and stored at 30+/-2 degrees C for 2-3months at room temperature respectively. (Akubor and Adejo,2000). However, the shelf life of plantain chips is greatly reduced when exposed to light and air. The poor shelf life at plantain chips is due to lipid oxidation occasioned by the heat, oxygen, light, heavy metals, pigments, alkaline condition and degree of unsaturation are catalyst in this process producing off flavors and odors called rancidity". Antioxidants are free radical scavengers. Antioxidant helps curtail or contain the activities of free radicals in our body. The use of naturally occurring materials as preservatives is a promising alternative to the use of chemicals (Akinola,2013). Spices such as red chili pepper, cinnamon lead, cloves, Rosemary, sage, *aframomum danielli* have been reported to have antioxidants properties. (Falola et al, 2008). *Aframomum danielli*, is a natural spice commonly called "Atare oburo" in Yoruba. And it has been found to inhibit the growth microorganisms. The seeds have pungent peppery taste due to aromatic ketones (Adegoke et al, 2002). Aframomum danielli it is a plant with high medicinal value. The plant extract of aframomum danielli is known to have antioxidants properties and antimicrobial agent. *Aframomum danielli* possesses antioxidant properties which controlled lipid oxidation in soybean and roasted peanuts, mayonnaise and akara, browning in apple slices to enhance their shelf stability (Adegoke and Skura, 1994). Plantain chips have come to stay as an important staple food in Nigeria, therefore, it will be of immense benefit if there is a natural antioxidant that

will be added to it to enhance its shelf stability there by encouraging the production and distribution of plantain chips at commercial level. Therefore, the study was carried out to assess the effects of *A. danielli* on physical, chemical and microbiological properties of plantain chips and to examine the preservative effects of *A. danielli* on plantain chips.

2. MATERIALS AND METHODS

2.1 Materials

Aframomum danielli dried fruits were obtained from a local market in Oyingbo. Freshly harvested plantain fingers were obtained from a local farm at Isolo, Lagos State. The chemicals, equipment and apparatus used, all the experiment, storage tests and sensory evaluation were carried at the Laboratory of Food Technology Department, Yaba College of Technology, Yaba, Lagos State.

2.2 Spice Preparation

The method described by Adegoke and Skura (1994) was adopted as follows: *Aframomum danielli* seeds were removed from pods, sorted and cleaned from all extraneous materials and adhering particles. The cleaned seeds were dried in the sum to 10$\pm$2% moisture content, air skinned and winnowed. The cleaned dried seeds were milled into fine powdery from (0.5mm) using a hammer mill within few minutes extraction was carried out to prevent loss of flavor. The milled spice was packed in polyethylene film and stored at refrigeration (5^0C) until used.

2.3 Extraction of Crude Antioxidant extract from Aframomum danielli powder

10g of finely ground spice was weighed into a thimble and extracted with 150ml of diethyl ether in soxhlet extractor for 2 hours. The crude extract was obtained by evaporation of the associated solvent and it was packed in polyethylene bags and stored at refrigeration temperature at 5^0C until it was used. The percentage yield of the extract was calculated as described by Adegoke and Skura, 1994

2.4 Preparation of plantain chips treated with Aframomum danielli extract

The whole unripe, matured plantain was washed thoroughly with portable water. The unripe plantain was peeled, and then sliced longitudinally into small sizes with the aid of sterile stainless steel kitchen knife with a diameter (2mm) thickness .After that, it was placed in a sterile stainless plate covered with foil paper. The unripe plantain was then spiced with *Aframomum danielli* anti-oxidant extracts in different concentrations ranging from 200ppm, 300ppm, 500ppm and 1000ppm for 20mins which was properly mixed to obtain uniform distribution and then fried. After frying, it was allowed to cool and then packaged in polyethylene nylon which was stored at ambient and refrigeration condition for 8 weeks respectively.

2.5. Proximate composition of plantain samples

Moisture, protein, fat, crude fiber, ash contents of plantain chips treated with antioxidant extract and the control were determined by methods described by AOAC (2005). Carbohydrate was calculated by difference.

2.6. Chemical analysis of samples

The peroxide, acid and free fatty acid values of the plantain chip samples were determined using AOAC (2005) method of analysis. The percentage effectiveness of the antioxidant activity of *Aframomum danielli* was calculated by determining the percentage difference in the peroxide value of plantain chips not treated with *Aframomum danielli* extract over the storage period.

2.7. Microbiological Assay

The determination of the microbial quality (total viable count and mold counts) of the plantain chips were performed by the method outlined in compendium of methods for the microbiological examination of foods (AMPH, 1992) with some modifications.

2.8. Sensory analysis

A preference test was carried out to determine the most acceptable sample. The plantain chips were coded and presented to a ten-member semi-trained panel of judges who were chosen from the staff and students of Yaba College of Technology, Lagos who were familiar with plantain chips. The samples were scored for the appearance, flavour, texture and overall acceptability using a nine point hedonic scale where 9 indicated liked extremely, 5 indicated like nor disliked, and 1 indicated disliked extremely as described by Iwe (2010).

2.9. Storage stability test

Storage stability of treated and untreated plantain chips were monitored by storing the samples at ambient conditions and refrigeration conditions. The plantain chips were sealed in high density polyethylene films of about 0.92g/cm3 of high resistance to moisture, fat and vapour permeation. Oxidative stability was monitored by determining the peroxide value of the extracted oil using the method of Pearson (1976) from the stored treated and untreated plantain chips samples

immediately after frying and at 48 hours interval thereafter. Microbial stability was determined by the total plate count and total mould count method of Rosa (1974).

***2.10 Statistical Analysis*:** Data generated were statistically analysed using one way analysis of variance (ANOVA) and mean separation was done by Duncan Multiple Range Test at 95% confidence interval using statistical package of Social Sciences (SPSS) version 16.0.

3. RESULTS AND DISCUSSION

3.1 Changes in proximate composition of fried plantain chips

Result of proximate composition of plantain chips is presented in Table 1. The results in Table 1 show that the level of treatment and the type of oil used in frying did not significantly affect the proximate composition of fried plantain chips($p<0.05$). Control sample had the highest moisture content of 3.15±0.04 while samples treated with 500ppm had the lowest moisture of 3.01±2.14. This conforms to the work reported by Akubor and Adeejo, 2000 who opined that fried plantain chips has a little chemically bound water that makes it appeared as dry and crispy. The ash content of the samples were found not to be significant at $P>0.05$. The ash content was highest in sample treated with 500ppm of the *A. danielli* extract (1.85±0.03) and lowest in sample treated with 200ppm of the extract (39±0.01).This indicate the ash obtained is almost the same in composition as the mineral matter present in the original food may not have been lost due to volatisation or some interaction between constituents. The fat content of the samples did not show any significant different at $P>0.05$. The fatty constituents of food consist of a number of lipid substances such as triglycerides and free fatty acids. The protein content of the samples was not significantly different at $P<0.05$ from other samples. Protein contents of foods can also be determined by organic nitrogen content. The carbohydrate content of the samples was not significant different at $P<0.05$. The crude fibre content of the samples was not significant at $P<0.05$. Crude fibre is the insoluble and combustible organic residue which remains after the samples has been treated under prescribed conditions. After treatment, it was discovered that the crude fibre content of the samples were not significantly different ($P>0.05$).

Table 1: of Proximate Analysis of fried plantain chips treated with Aframomum danielli

Samples	Moisture %	Ash %	Fat %	Protein %	N_2 %	Carbohydrate %	Crude Fibre %
Control	3.15±0.04[a]	1.39±0.01[a]	22.62±0.03[a]	1.65±0.01[a]	0.30±0.01[a]	68.66±6.55[a]	1.91±0.02[a]
200ppm	3.14+0.03a	1.50±0.01[a]	24.73±0.01[a]	1.70±0.03[a]	0.31±0.01[a]	68.575±6.47[a]	1.86±0.08[a]
300ppm	3.09±0.03[a]	1.76±0.01[a]	24.97±0.01[a]	1.70±0.02[a]	0.31±0.02[a]	70.14±4.27[a]	1.95±0.01[a]
500ppm	3.01±2.14[a]	1.85±0.03[a]	22.34±0.01[a]	1.76±0.01[a]	0.30±0.01[a]	69.165±2.88[a]	1.88±0.2[a]
1000ppm	3.09±0.02[a]	1.55±0.03[a]	21.87±0.01[a]	1.77±0.03[a]	0.29±0.03[b]	71.81±0.81[a]	1.95±0.06[a]

Mean score ± SD Mean value with the same letter within the same columns are not significantly ($P>0.05$) different

3.2 Changes in chemical analysis of plantain chips treated with Aframomum danielli

The result obtained from the assessment of peroxide value and free fatty acids of stored fried plantains chips is presented in Table 2. The antioxidants activity of *Aframomum danielli* on the stored fried plantain chips was found to increase as the concentration of the *Aframomum danielli* crude extract increases. Result shows that the free fatty acids the samples were very low in all the samples which ranged from 0.21 to 0.31 in control and treated samples respectively. Untreated sample (control) had the highest free fatty acids of 0.31±0.00 and this shows that the untreated samples produced more free fatty acids when compared with the treated samples. This confirms the effectiveness of *Aframomum danielli* extract which is able to extend the shelf life of the treated samples as reported by Adegoke *et al., 2004* and Falola *et al*, 2008. The production of peroxides occurs at a very slow but steady rate during period of storage with the values decreasing as the concentration increased both at ambient and refrigeration condition. The lowest values of peroxides were recorded with the samples stored under refrigeration condition. The treatment with *Aframomum danielli* on stored plantain chips has been able to extend the induction period of lipid oxidation especially at the refrigeration condition with the lowest peroxide value recorded for sample treated with 1000ppm (0.73 meq/kg), at the end of 8^{th} weeks of the storage. This result is in agreement with work of Fasoyiro *et al*; 2001 who reported that *Aframomum danielli* extract prevented lipid oxidation in soybean and roasted peanuts. Also Falola *et al.*, 2008 reported that *Aframomum danielli* is able to extend the shelf life of akara by preventing lipid oxidation. This could be attributed to the stability of vegetable oil used in frying the plantains chips. The antioxidants effectiveness increased with increase in days of storage. Sample treated with 1000ppm extract had the highest antioxidant efficiency (72.841%) at ambient condition compared to sample treated with 200ppm which has antioxidant effectiveness of (44.12%). At refrigeration condition, sample 1000ppm extract had the highest antioxidant effectiveness (87.33%) while sample treated with 200ppm had the lowest (44.57%). This further confirms that *Aframomum danielli* can used in the control of lipid oxidation. The result of titratable acidity show that the titratable acidity of the samples stored at ambient condition were significantly different ($P>0.05$). Untreated sample (control) had the highest (0.79) while sample treated with 1000ppm was lowest (0.69). Furthermore, at refrigeration condition, the titratable acidity was highest in untreated sample (0.698) and lowest in sample treated with 1000ppm antioxidant extract (0.658) which shows that titratable acidity is a better indicator of microbiological stability among the samples.

Table 2: Chemical analysis of fried plantain chips treated with *Aframomum danielli*

Samples	Acid value	Free fatty acids meq/kg	Peroxide meq/kg
Control	0.61 ± 0.01^{c}	0.31 ± 0.00^{c}	5.38 ± 0.01^{a}
200ppm	0.55 ± 0.02^{b}	0.29 ± 0.02^{bc}	2.365 ± 0.57^{b}
300ppm	0.56 ± 0.03^{bc}	0.27 ± 0.00^{b}	-
500ppm	0.37 ± 0.02^{a}	$0.21+0.2^{a}$	-
1000ppm	10.55 ± 0.01^{b}	$0.28+0.01^{bc}$	-

Mean value with the same letter within the same columns are not significantly (P>0.05) different.

Table 3: Chemical Analysis of stored fried plantain chips treated with *Aframomum danielli*

Sample	TTA Ambient condition	TTA Refrigeration (5^0C)	PV (meq/kg) Ambient condition	PV (meq/kg) Refrigeration (5^0C)
Control	0.70 ± 0.17^{a}	0.79 ± 0.29^{a}	7.26 ± 1.95^{e}	6.51 ± 6.47^{e}
200ppm	0.69 ± 0.21^{a}	0.73 ± 0.28^{ab}	4.06 ± 2.01^{d}	5.61 ± 4.82^{d}
300ppm	0.68 ± 0.27^{a}	0.75 ± 0.31^{ab}	3.18 ± 1.49^{c}	3.76 ± 0.00^{c}
500ppm	0.73 ± 0.15^{a}	0.73 ± 0.29^{ab}	2.30 ± 0.02^{b}	2.03 ± 1.24^{b}
1000ppm	0.66 ± 0.19^{a}	0.69 ± 0.31^{b}	1.06 ± 2.41^{a}	0.83 ± 0.00^{a}

Mean value with the same letter within the same columns are not significantly (P>0.05) different.
TTA=Titratable acidity, PV= Peroxide value,

3.3. Changes in Microbial profile of plantain chips treated with aframomum danielli during storage

Tables 4 and 5 showed that the extract of Aframomum danielli had inhibitory effect on the bacteria and mold contents of various samples of fried plantain chips. The antibacterial increased with increase in the concentration of the extract. Result shows that there was reduced spoilage rate in the treated samples than the untreated samples under both refrigeration storage and ambient storage, the microbiological analysis showed that the bacterial load was absent in the sample in 0 week which was the starting point and 2nd weeks respectively both at ambient and refrigeration condition in treated samples except for the untreated samples with values of ($1x10^1$cfu/g) in the untreated sample (control). However, the growth of bacterial began to occur in the fourth week in the treated samples but lower compared to the untreated samples which has the same value for both ambient and refrigeration condition ($5x10^1$cfu/g) which is a proof that refrigeration condition does not inhibit the growth of bacteria at 5^0C but only deactivate them but when kept at optimum condition the growth was then noticeable. In week 6, sample treated with 1000ppm extract which has the highest concentration had the lowest growth of bacteria at ambient condition with the value of ($2x10^1$cfu/g) and at refrigeration condition, the bacterial load was absent which is also a proof that *Aframomum danielli* extract had inhibitory effect on the food sample. Samples treated with 300ppm and 500ppm had a minimal growth both at ambient and refrigeration condition. At week 8, there was no significant different between samples treated with 200ppm ($10x10^1$cfu/g) and untreated ($10x10^1$cfu/g) under ambient condition and refrigeration condition and sample treated with 200ppm ($8x10^1$cfu/g) and untreated sample ($10x10^1$cfu/g) respectively. The microbiological analysis of the samples also showed that the fungi (mould and yeast) load was absent only in untreated sample (control) at ambient condition, while fungi growth was observed in the 2nd week. At week 4, the values for the mould and yeast count were lower in the treated samples compared to the untreated sample (control) at both ambient and refrigeration condition. At week 6, the sample treated with 1000ppm had no counts which indicates that crude extract suppressed (mould and yeast) growth both at ambient and refrigeration condition. Finally, at week 8, generally the fungi load was lower in the treated samples compared to the untreated samples at ambient condition which had the highest and exceeded the recommendation limits for bacterial and mould contamination for ready to eats food by the international commission on microbiological specification for foods (1CMSF, 1998) which must not be more than (10^5cfu/g) of food for total bacterial plate count and mould count

3.4 Sensory results of plantain chips treated with Aframomum danielli

The result of the sensory evaluation is presented in Table 6. The panelist found no significant different among the samples spiced with 200ppm and samples spiced with 1000ppm and also with the untreated samples (control) in terms of taste, appearance colour flavour and overall acceptability. But as the concentration of the treatment increased, the rating of the samples decreased in terms of flavour and texture. It was observed that, except for the sample treated with the crude antioxidant extracts of 1000ppm, there was no difference among the untreated and other treated samples. Also, there was significant difference (P>0.05) among the samples in

Table 4: Changes in total plate count (cfu/g) plantain chips spiced with *Aframomum danielli* and stored under ambient and refrigeration condition

	Period of week Storage				
	Ambient Storage				
Samples	0	2	4	6	8
Untreated	1.00×10^1	1.00×10^1	5.00×10^1	9.00×10^1	11.00×10^1
200ppm	Nill	Nill	3.00×10^1	6.00×10^1	10.00×10^1
300ppm	Nill	Nill	2.00×10^1	3.00×10^1	7.00×10^1
500ppm	Nill	Nill	1.00×10^1	2.00×10^1	4.00×10^1
1000ppm	Nill	Nill	Nill	2.00×10^1	2.00×10^1
	Refrigerated Storage				
Untreated	1.00×10^1	2.00×10^1	5.00×10^1	7.00×10^1	10.00×10^1
200ppm	Nill	Nill	2.00×10^1	5.00×10^1	8.00×10^1
300ppm	Nill	Nill	1.00×10^1	3.00×10^1	5.00×10^1
500ppm	Nill	Nill	Nill	1.00×10^1	4.00×10^1
1000ppm	Nill	Nill	Nill	Nill	2.00×10^1

Table 4: Changes in mould count of fried plantain chips spiced with *Aframomum danielli* and stored under ambient and refrigeration condition

	Period of week storage				
	Ambient Storage				
Samples	0	2	4	6	8
Untreated	Nill	1.00×10^1	4.00×10^1	8.00×10^1	12.00×10^1
200ppm	Nill	Nill	2.00×10^1	5.00×10^1	7.00×10^1
300ppm	Nill	Nill	1.00×10^1	3.00×10^1	5.00×10^1
500ppm	Nill	Nill	Nill	1.00×10^1	3.00×10^1
1000ppm	Nill	Nill	Nill	Nill	1.00×10^1
	Refrigerated Storage				
Untreated	Nill	Nill	2.00×10^1	5.00×10^1	5.00×10^1
200ppm	Nill	Nill	1.00×10^1	2.00×10^1	3.00×10^1
300ppm	Nill	Nill	Nill	2.00×10^1	2.00×10^1
500ppm	Nill	Nill	Nill	1.00×10^1	1.00×10^1
1000ppm	Nill	Nill	Nill	Nill	Nill

terms of texture. The low acceptance of fried plantain chips treated with the highest concentration in terms of flavour might have been as are result of the flavour component like terpenes, phenols as reported by Adegoke and Gopalaskrhna, 1998. However, results shows that samples spiced 300ppm and 500ppm was highly accepted by the panelist while samples spiced with 500ppm was the most acceptable samples and samples spiced with 100ppm was the least acceptable samples in terms of the attributes measured.

Table 5: Sensory analysis of fried plantain chips treated *Aframomum danielli*

Samples	Taste	Texture	Colour	Appearance	Flavour	Overall acceptability
100ppm	6.25 ± 1.16^a	6.00 ± 1.52^a	6.15 ± 1.14^a	6.70 ± 1.22^a	$6.48a\pm1.8^{ab}$	6.65 ± 1.18^a
200ppm	71.5 ± 0.99^b	71.5 ± 1.18^b	6.75 ± 1.02^a	6.75 ± 1.29^a	7.15 ± 0.95^a	7.05 ± 1.23^{ab}
300ppm	6.65 ± 1.09^{ab}	6.65 ± 1.14^{ab}	6.80 ± 1.01^a	6.65 ± 1.27^a	6.35 ± 1.02^{ab}	7.15 ± 0.93^{ab}
500ppm	6.45 ± 1.32^{ab}	6.60 ± 1.23^{ab}	6.65 ± 1.42^a	7.20 ± 1.11^a	6.35 ± 1.38^{ab}	7.45 ± 1.19^b
Control	6.60 ± 1.09^{ab}	6.15 ± 1.35^a	6.70 ± 1.22^a	7.20 ± 0.77^a	6.50 ± 1.02^b	6.95 ± 0.95^{ab}

Mean value with the same letter within the same columns are not significantly (P>0.05) different.

4. CONCLUSION AND RECOMMENDATION

The result of this research has shown that treatment of fried plantain chips with Aframomum danielli at (300ppm-500ppm) concentration was able to reduce lipid oxidation and microbial spoilage in fried plantain chips to the extent of 6 weeks the thereby extending the shelf life of the product. It was also seen that the fried plantain chips produced were still organoleptically acceptable when treated with Aframomum danielli extracts to the level of 500ppm. Therefore, natural preservative like Aframomum danielli has the potential of being used as preservative for fried plantain chips which will enhance there shelf stability by controlling lipid oxidation and microbial spoilage thereby encouraging the production and distribution of plantain chips at commercial level. It be used to create variety in the market, hence it is recommended

that appropriate attention should be given to the use of it in the processing and preservation of foods both locally and internationally.

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