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NUTRITIONAL COMPOSITION, MICROBIAL AND SENSORY PROPERTIES OF *FURA* TREATED WITH *Aframomum danielli*

***Sogunle, K. A., Ismaila A. R. and Adebayo, Q.**
Dept. of Food Science and Technology, Federal University, Dutsin-Ma,
Katsina State.
*Corresponding author: bsogunle@gmail.com

ABSTRACT

Spices have been reported to impart nutrients, improve shelf life and overall sensory properties of foods. The incorporation of naturally occurring materials like spices in food production has proved to be a promising alternative to the use of chemicals due to public health concern. The effects of aqueous extract of *Aframomum danielli* at varying level of concentration on the nutritional, microbial and sensory properties of *fura* were investigated and analysed using standard methods. The moisture, protein, fat, crude fibre and ash content of the *fura* samples ranged from 51.39-54.62%, 7.49-12.02%, 1.41-1.80%, 0.41-0.99% and 0.19-0.57% respectively. The calcium, sodium, potassium, iron, manganese, magnesium and phosphorus content of the *fura* samples ranged from 1.9-2.4 mg/100g, 0.94-1.2 mg/100 g, 0.23-0.29 mg/100 g, 48.25-63.2 mg/Kg, 8.25-8.86 mg/kg, 1225-1352.7 mg/kg and 16.72-18.44 mg/kg respectively. The bacteria and mould count ranged from 15-30 x 10^5 cfu/g and 10-20 x 10^5 cfu/g respectively. The bacteria count of the untreated *fura* increased 10-fold while the mould count tripled after 48 hours of production. There existed significant differences (P>0.05) between the untreated and treated *fura* samples in all the parameters examined. The treated *fura* samples compared favourably with untreated sample in all the sensory properties evaluated, while being more acceptable after 48 hours of production. The use of the aqueous extract of *Aframomum danielli* brought about a general increase in the nutritional properties of *fura* samples, reduced microbial load, thus improve shelf stability and general acceptability of *fura* analysed.

Keywords: Spice, *Aframomum danielli*, *Fura*, Quality, Acceptability

INTRODUCTION

Fura is a cooked ball of dough cereals (Jideani *et al*., 1995a). It is a traditional staple food produced mostly from pearl millet (*Pennisetun typhoides)* flour blended with spices and water, compressed into dough balls and cooked for 30 minutes (Jideani *et al.*, 2001). Sorghum (*sorghum bicolor L.)* may replace millet flour or sometimes a mixture of both is used. The cooked dough balls are broken up and made into porridge by mixing with yoghurt (*Nono)*, fresh milk (Jideani *et al.*, 1995a) or water (Kordylas, 1990). The mixture is called *Fura da Nono* in Nigeria (Northern States) and it is a popular mid-day meal and a refreshing drink among the populace (Jideani *et al*., 2002). *Fura* is relatively cheap compared to other foods such as cornflakes or oats, and it lacks proteins and other essential nutrients needed for growth and other body metabolism. The poor handling of *fura* during processing coupled with its high moisture content exposes it to microbial contamination. Thus, *Fura* has a limited shelf life of one day at ambient temperature, after which changes in flavour, taste and appearance are noticed (Jideani *et al.*, 1995a).

It is encouraging that attention is continually being focused on the use of plant products as alternatives to synthetic additives particularly as consumers are increasingly concerned about synthetic additives. Of emerging importance is the spice *Aframomum danielli*, a local spice consumed in Nigeria and some other Africa countries. It is commonly known as guinea grain or black amomum in English and *atare oburo* by the Yorubas. The natural spice *Aframomum danielli*, it is rich in nutrients such as amino acid, calcium, zinc, magnesium, among others (Adegoke and Skura, 1994) and also known to possess preservative properties (Adegoke *et al*., 2002).

Aframomum danielli, (Hook, F) K. Schum (family, Zingiberaceae) is a large, robust perennial plant 3-4 m tall which grows in central and west African countries (Adegoke *et al*., 2000). The nutritive status of *Aframomum danielli* and the antimicrobial activities of its crude extract against a number of micro organisms have been established (Adegoke and Skura, 1994; Fasoyiro *et al*., 2001) while Ashaye *et al*. (2006) and Adegoke *et al*. (2007) also reported that *Aframomum danielli* can be used in food processing and preservation. Thus, the aim of this study is to determine the effect of aqueous extract of *Aframomum danielli* on the nutritional, microbial and sensory properties of *fura*.

MATERIALS AND METHODS

Millet, ginger (*Zingiber officinale*, Roscoe) and cloves (*Syzygium aromaticum*) were purchased from Monday market in New Bussa, Niger State, while *Aframomum danielli* seeds were purchased from Bode market in Ibadan, Oyo State. All the chemicals and reagents used were of analytical grade.

Preparation of aqueous extract of *Aframomum danielli*

Aframomum danielli seeds were pulverized into powder using warring blender. The powder was sieved with a mechanical shaker using 90 mesh sieves to obtain a fine powder (Figure 1). Aqueous extract of *Aframomum danielli* from its powder was obtained according to the method described by Adegoke *et al.* (2000) with little modifications as follow: The milled spice (1 g, 2 g, and 3 g) was dissolved in 100 ml of sterile deionized water in separate conical flasks in order to obtain 1%, 2% and 3% concentrations respectively. The suspensions were kept in the refrigerator at 4 °C for five days, after which they were centrifuged at 10,000 g for 10 mins (sorval super speed RC_2-B centrifuge) and the supernatants filtered through whatman no. 4 filter papers. The filtrates were kept at 4 °C until use.

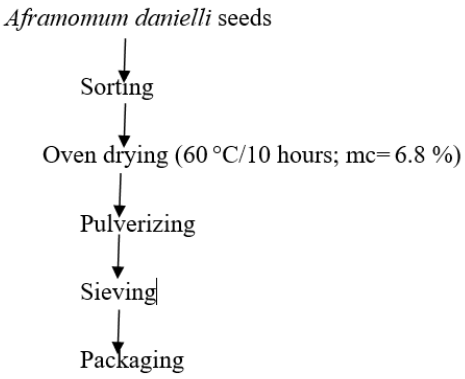

Figure 1: Preparation of *Aframomum danielli* Powder
Source: Adegoke *et al.* (2002)

Preparation of millet flour

Millets grains were sorted to remove stone and other extraneous substances using an aspirator. The kernels were then dehulled after mild wetting of the grain using a rice dehuller (India) at the Monday Market, Bew Bussa. After dehulling, the grains were washed and then dried in a convection oven at 50 °C for 24 h to about 14 % moisture content. The dried grains were milled into flour using a hammer mill, and the flour sifted using a sieve with a size of 425 µm.

Production of *Fura*

Fura was produced according to the method described by Jideani (2005) with little modification (Figure 2). Pearl millet flour (500 g), ginger (10 g) and cloves (2.5 g) were mixed thoroughly. The flour – spice mixture was hydrated to 40 – 50% moisture content for 1 hour by adding 50–60% (w/v) deionized water to the flour. The hydrated flour was compressed between the palms of the hands, and dropped into boiling water. The flour balls were cooked for 30 mins. The cooked balls were thereafter pounded to smooth, slightly elastic and cohesive dough while still hot. The dough was reshaped into smaller balls and dusted with flour to give the final product, which was packaged in a low density polyethene bag prior to analysis. For the treated samples, aqueous extract of *Aframomum danielli* was added to the boiled flour – spice mixture prior to the second kneading operation to achieve 1%, 2% and 3% concentrations respectively. After which the treated samples were allowed to go through the rest of the processing operations.

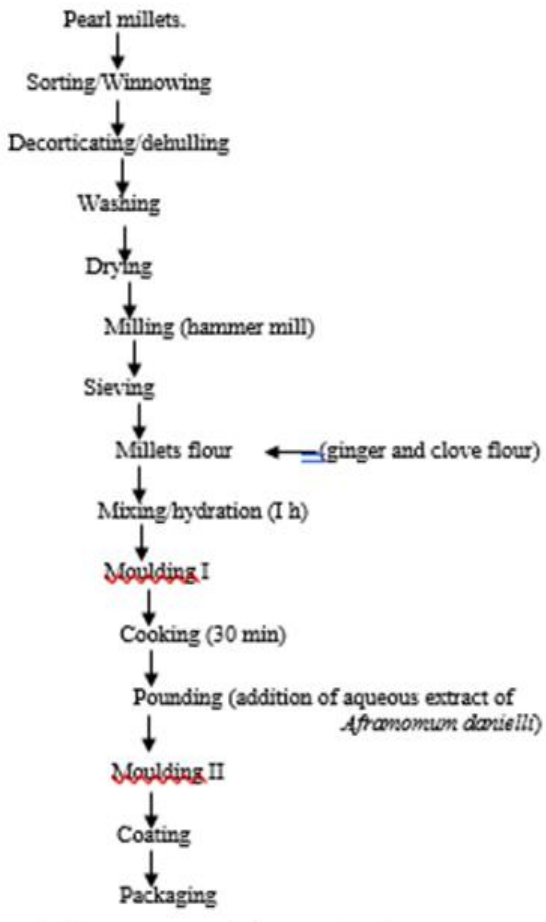

Figure 2. Preparation of *fura* treated with aqueous extract of *Aframomum danielli*
Source: Jideani (2005)

Chemical Analysis
Moisture, protein, fat, ash, crude fiber and carbohydrate content were determined according to the method of AOAC (2012), while pH was determined by the method of AOAC (2000). Calcium, potassium, zinc, iron, magnesium, manganese and sodium were determined using Atomic Absorption Spectroscopy (USING BUCK 200 AAS) while phosphorus was determined routinely by the spectrophotometric method of AOAC (2000). Energy content (kJ/100 g) of the *fura* samples was estimated using the Atwater factor [(4 × protein) + (4 × carbohydrate) + (9 × fat)] × 4.2, where protein, carbohydrate and fat contents are expressed in g/100 g dry basis; 4, 4, and 9 are kilocalories from protein, carbohydrate, and fat respectively, while 4.2 is a factor for converting from calories to joules (Okafor *et al.,* 2014).

Microbial Analysis
Bacteria, mould and coliform counts were carried out using standard plate count method after 3 and 48 hours of production respectively. Bacteria were grown on nutrient agar, coliforms on macConkey agar and moulds on Potato Dextrose Agar. Plates for the bacteria and coliform counts were incubated at 37 °C for 24 hours while the ones for mould count were incubated at room temperature for between 48 hours to 5 days. After appropriate incubation period, the petri-dishes were examined for the colonial growths using the colony counter.

Sensory Evaluation
Sensory evaluation of the *fura* samples was conducted in a well-lit sensory laboratory within ten minutes of preparation. A 15-man sensory panel who are familiar with the consumption of *fura* were raised among the students of Federal College of Freshwater Fisheries, New Bussa, Niger State. Each of the samples coded with a three-digit non-bias number were placed in separate identical plates. Each panelist assessed the coded samples independently in separate sensory booths and they were asked to indicate their preference for colour, taste, texture, aroma and overall

acceptability. The panelists were provided with water to rinse their mouths before and after each testing. A 9-point Hedonic scale was employed to evaluate the samples' degree of likeness, with 9 indicating extreme like, 5 indicating neither like nor dislike, and 1 indicating extreme dislike.

Statistical analysis

All the data obtained were analyzed by using one-way Analysis of Variance (ANOVA). Means were separated by Duncan's multiple range test ($p < 0.05$) using Statistical software package, SPSS version 22.0.

RESULT AND DISCUSSION

The proximate composition of the *fura* samples was as shown in Table 1. The moisture content of the *fura* samples ranged from 51.39% to 54.62%. The moisture content of the *fura* samples differed significantly at $p \leq 0.05$. The untreated *fura* sample had the lowest moisture content (51.39%) while *fura* treated with 1% aqueous extract of *Aframomum danielli* had the highest moisture content (54.62%). The moisture content of *fura* treated with 2% and 3% of the extract was 53.79% and 53.78% respectively. *Fura* have been reported to have a short shelf life of 1 day at ambient temperature (Jideani *et al*. 2002), and the high moisture contents recorded in this work is a pointer in this direction as it predisposes the *fura* samples to rapid deterioration, increased microbial spoilage, and subsequent short shelf life (Adepoju and Onasanya, 2008). The protein content of the *fura* samples ranged from 7.49% for the untreated *fura* sample to 12.02% for the *fura* treated with 3% aqueous extract of *Aframomum danielli. Fura* samples treated with 1% and 2% of the extract had protein content 7.90% and 9.01% respectively. The protein contents of all the *fura* samples obtained in this work was within the range reported by Inyang and Zakari (2008) for *fura* produced through different processing operations. As the concentration of the aqueous extract of *Aframomum danielli* used in treating the *fura* samples increases, the protein content also increases. *Aframomum danielli* had been reported to be rich in amino acids (Adegoke and Skura, 1994) and had been used to improve the protein contents of *warakanshi* (Ashaye *et al*., 2006); hence, the increment in the protein contents of the treated *fura* samples.

The percentage crude fat content of the *fura* samples was 1.41%, 1.49%, 1.59% and 1.80% for the control, 1%, 2% and 3% treated *fura* samples respectively. In the same manner, the crude fat content of the *fura* samples increases as the concentration of the extract increases and the values differed significantly at 5% probability level. The crude fibre content of the *fura* samples also differed significantly at $p \leq 0.05$ and it increased generally as the concentration of the aqueous extract increased. The crude fibre content of the untreated *fura* samples was 0.41% while the 1%, 2% and 3% treated *fura* samples had 0.74%, 0.96% and 0.99% respectively. Crude fibre measures the cellulose, hemicellulose and lignin content of food. Lignin comprises polymers of phenolic acids and hemicellulose is made up of hetero-polymers of polysaccharides (Zakpaa *et al*., 2010). The ash content of the *fura* samples ranged from 0.19% to 0.57%. The untreated *fura* sample had the lowest ash content (0.19%) while the sample treated with 3% aqueous extract of *Aframomum danielli* had the highest ash content (0.57%). The 1% and 2% treated samples had 0.52% and 0.53% ash contents respectively. Although, there exist no significantly difference in the ash content of the treated *fura* samples, but they differed significantly from the untreated *fura* sample at 5% probability level. *Aframomum danielli* had been reported to be rich in a number of minerals (Adegoke and Skura, 1994). The energy contents of the *fura* samples ranged from 189.36 to 200 cal/100g. untreated *fura* sample was denser in energy compared to the *fura* samples treated with the aqueous extract of *Aframomum danielli.*

Table 1: Proximate composition of the *fura* samples treated with different concentrations of *Aframomum danielli*

Samples	Moisture content %	Crude protein %	Crude fat %	Crude fibre %	Ash content %	Carbohydrates %	Energy cal/100 g
Untreated *fura*	51.09±.52^{b}	7.49±.33^{c}	1.41±.07^{c}	0.41±.09^{c}	0.19±.02^{b}	39.41±.74^{a}	200.29
Fura+1% extract	54.62±43^{a}	7.90±.68^{c}	1.49±.08^{bc}	0.74±.12^{b}	0.52±.03^{a}	37.94±.02^{b}	196.77
Fura+2% extract	53.79±.31^{a}	9.01±.83^{b}	1.59±.08^{b}	0.96±.09^{a}	0.53±.02^{a}	34.80±1.04^{c}	189.55
Fura+3% extract	53.78±.68^{a}	12.02±.33^{a}	1.80±.05^{a}	0.99±.04^{a}	0.57±.04^{a}	31.27±.66^{d}	189.36

Mean with same superscripts in a column are not significantly different ($P < 0.05$)

Table 2 shows the result of mineral compositions of the *fura* samples. The calcium, sodium, potassium, iron, manganese, magnesium and phosphorus content of the *fura* samples ranged from 1.9 - 2.4 mg/100g, 0.94 - 1.2 mg/100g, 0.23 - 0.29 mg/100g, 48.25 - 63.2 mg/Kg, 8.25 - 8.86 mg/kg, 1225 - 1352.7 mg/kg and 16.72 - 18.44 mg/kg respectively. The general increments in the mineral contents of the samples confirm the work of Adegoke and Skura (1994), which reported that the spice contains mineral elements such as calcium, phosphorus, sodium, magnesium, manganese; among others. The percentage increase in the mineral contents of the untreated and treated *fura* samples was 26.32%, 27.66%, 26.09% 30.98%, 10.42%, 7.39% and 10.3% for calcium, sodium, potassium, iron, magnesium, manganese and phosphorus respectively. The importance of minerals in staple food like *fura* could not be over emphasized. Calcium and phosphorus are very important in the formation of strong bones and teeth, heart function and cell metabolism (Roth and Townsend, 2003; Rolfe *et al*., 2009), potassium plays a protective role against several diseases such as hypertension, kidney stones, and osteoporosis in humans (Demigné *et al*., 2004), while the salt of magnesium, sodium along with potassium and calcium are known to regulate the acid–base balance in the body (Lewu *et al*., 2010).

Table 2: Mineral contents of the *fura* samples treated with different concentrations of *Aframomum danielli* extract

Samples	Ca (mg/100g)	Na (mg/100g)	K (mg/100g)	Fe (mg/kg)	Mn (mg/kg)	Mg (mg/kg)	P (mg/kg)
Untreated *fura*	1.9	0.94	0.23	48.25	8.25	1225	16.72
Fura+1% extract	2.1	0.95	0.26	56.5	8.75	1312.5	17.34
Fura+2% extract	2.2	1.0	0.27	62.75	8.81	1337.6	18.44
Fura+3% extract	2.4	1.2	0.29	63.2	8.86	1352.7	18.44

Table 3: pH Values of the *Fura* Samples Treated with different Concentrations of *Aframomum danielli*

Samples	0 HOUR	24 HOURS	48 HOURS
A	6.55	4.15	4.41
B	6.70	4.13	4.17
C	6.45	4.21	4.21
D	6.54	4.20	4.14

The pH of the *fura* samples at production and after 48 hours of production ranged from 6.45 to 6.70 and 4.14 and 4.41 respectively (Table 3). Owusu-Kwarteng et al. (2010) reported a pH range of 4.77 and 5.55 for *fura* produced from different processing methods. The low pH of the *fura* samples treated with aqueous extract of *Aframomum danielli* could have contributed to the reduced microbial load of the treated samples. Table 4 showed the effect of the aqueous extract of *Aframomum danielli* on the microbial contents of the *fura* samples. *Fura* sample treated with 3% aqueous extract of *Aframomum danielli* had the least bacteria count (15 x 10^5 cfu/g) while the untreated *fura* sample had the highest bacteria count (30 x 10^5 cfu/g) after the first three hours of production. The result showed that there was reduced microbial load on the treated samples compared with the untreated sample at ambient temperature. Similar findings have been reported by Adedeji and Ade-Omowaye (2013) for fried beans cake. After 48-hour of production, the bacteria load of the untreated *fura* sample increased more than 10-fold to a population of 382 x 10^5 cfu/g. *Fura* has been reported as a food with short shelf life (Jideani *et al*., 2002; Durojaiye *et al*., 2010), owing to its high microbial load (Owusu-Kwarteng *et al*., 2010). However, the microbial load of all the *fura* samples treated with aqueous extract of *Aframomum danielli* only increased marginally within the same period. Adedeji and Ade-Omowaye (2013) had reported effective inhibition of growth of micro-organisms in fried bean cake snacks by spices *Aframomum danielli* and *Zingiber officinale* crude extract. Absence of coliform growth during the microbial analysis of the *fura* samples showed that the samples were produced under hygienic conditions (Frazier and Westhoff, 1988).

Table 4: Microbial analysis of *fura* treated with different concentrations of *Aframomum danielli*

Sample	Bateria count (cfu/g)		Coliform count (cfu/g)		Mould count (cfu/g)	
	3-hour	48-hour	3-hour	48-hour	3-hour	48-hour
Untreated *fura*	$30x10^5$	$382x10^5$	-	-	-	-
Fura+1% extract	$22x10^5$	$30x10^5$	-	-	-	-
Fura+2% extract	$17x10^5$	$25x10^5$	-	-	-	-
Fura+3% extract	$15x10^5$	$22x10^5$	-	-	-	-

As the concentration of the extract increases, the total plate count of all the microorganisms' decreases. This result shows that the antimicrobial effect of the *Aframomum danielli* extract increased with increase in concentration. *Aframomum danielli* had been reported to possess antimicrobial properties by a number of authors (Fasoyiro *et al*., 2001; Adegoke *et al*., 2000; 2002). While the shelf life of *fura* can be extended using synthetic chemicals (Jideani *et al.,* 1995b), the safety of some of these additives is of public health concern (Adegoke *et al.,* 1998).

Table 5 shows the result of the sensory evaluation carried out on the freshly prepared *fura* samples treated with aqueous extract of *Aframomum danielli*. The untreated and treated *fura* samples were not significantly different from one another in taste, colour, flavour, texture and overall acceptability at 5% probability level. Though, the untreated *fura* sample had higher values in all the tested attributes compared with the treated samples; the values were closely related with the treated samples. The results of sensory evaluation after 48 hours of storage shows that *fura* samples treated with aqueous extract of *Aframomum danielli* competed favourably with the untreated while the microbial load had been reduced substantially (Table 6). Thus, the acceptance of the *fura* samples treated with the aqueous extract of *Aframomum danielli* means that the spice extract can be incorporated into the processing of *fura*, so as to extend its shelf life as low microbial loads translates into longer shelf life. This study also confirmed the reports of Ashaye *et al*. (2006) that *Aframomum danielli* can be used in food processing and preservation.

Table 5: Effect of *Aframomum danielli* extract on the sensory properties of freshly prepared *fura*

Samples	Taste	Colour	Flavour	texture	Overall
Untreated *fura*	$8.70 \pm .67^a$	$8.00 \pm .47^a$	$8.20 \pm .78^a$	$8.00 \pm .94^a$	$8.50 \pm .70^a$
Fura+1% extract	$8.30 \pm .94^a$	$7.90 \pm .87^a$	$7.70 \pm .82^a$	7.80 ± 1.31^a	$8.40 \pm .51^a$
Fura+2% extract	$8.50 \pm .52^a$	$7.50 \pm .97^a$	$8.00 \pm .94^a$	$8.00 \pm .94^a$	$8.40 \pm .51^a$
Fura+3% extract	$8.40 \pm .96^a$	$7.90 \pm .99^a$	$7.90 \pm .99^a$	$7.79 \pm .94^a$	$8.30 \pm .94^a$

Mean with same superscripts in a column are not significantly different ($P < 0.05$)

Table 6: Effect of *Aframomum danielli* extract on the sensory properties of stored *fura*

Samples	Taste	Colour	Flavour	texture	Overall
Untreated *fura*	7.10 ± 1.85^a	6.40 ± 2.22^a	5.90 ± 1.85^a	5.10 ± 1.79^a	6.90 ± 1.72^a
Fura+1% extract	7.10 ± 1.59^a	7.50 ± 1.90^a	6.50 ± 1.58^a	5.70 ± 2.00^a	7.20 ± 1.39^a
Fura+2% extract	$7.10 \pm .99^a$	7.30 ± 1.05^a	6.30 ± 1.05^a	5.20 ± 1.47^a	$6.70 \pm .48^a$
Fura+3% extract	6.70 ± 1.56^a	6.30 ± 1.88^a	5.90 ± 1.91^a	5.90 ± 2.28^a	7.40 ± 1.17^a

Mean with same superscripts in a column are not significantly different ($P < 0.05$)

CONCLUSION

The results obtained in this work showed not only the potentials of the spice *Aframomum danielli* to improve the nutritional contents of *fura*, but also reduced microbial load, hence, improved shelf stability when employed in processing. Therefore, it could be concluded that the aqueous extract of the spice, *Aframomum danielli* can be employed in food processing and preservation.

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