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Effect of Nixtamalization on Nutritional and Microbial Quality of Selected Food Stuff

Okeke Kingsley Susan[1, *], Sadiq Umar Maryam[1], Odor Chinenye Blessing[2], Richard UyieforJosephine[1]

[1]Department of Nutrition and Dietetics, the Federal Polytechnic, Bida, Nigeria
[2]Department of Hospitality, Leisure and Tourism Management, the Federal Polytechnic, Bida, Nigeria

Email address
susanokeke@gmail.com (O. K. Susan)
[*]Corresponding author

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Abstract
This study was aimed at evaluating the effect of nixtamal on the nutritional and microbial quality of some food stuff. Samples of okro and beans were cooked with potash. The untreated okro and beans as a control. The samples were analysed for proximate, mineral and total bacterial count content. Result obtained shows that variation ($p<0.05$) in the effect of potash on the proximate and mineral content of okro and beans as well as drastic reduction in microbial load of the food stuff. Protein content % ranges from 21.85-19.03 for beans and 2.48-2.76 for okro. A reduction of mineral was seen in mineral content of okro but potash enhanced mineral content of beans. Hence, the use of potash is said to improve certain food stuff but destroy nutrient of others. It is recommended that permissible concentration of potash should be determined to avoid adverse effect of the usage of this chemical in food preparation.

1. Introduction

Nixtamalization is the removal of pericarp from any grain using an alkaline process such as potash (potassium carbonate), lime and sodium hydroxide [11], [15], [19]. Potash has widely been used in Nigeria mostly in the food processing. It has however been used in the cooking and processing of some food stuff such as okro soup, cooked beans, meat African salad (abacha), tuwo etc. In Nigeria potash is added to okro soup to increase the viscosity of the soup. Many people also use it to increase the rate of cooking of some cereal such as beans as well as creating varieties in the preparation of some food stuff such as masa, wara and tuwon. Grain subjected to nixtamalization process has several benefits over unprocessed grain for food preparation [16], [18]. They are more easily ground. Their nutritional value is increased, flavor and aroma are improved and mycotoxins are reduced [1].

Little consideration and attention are however given to the effect of this potash on the nutritional value of the food product derived from them. Potash has been known to decrease protein quality, reduction in the value of dry matter, crude fiber and ash content of soy beans. Hence the need for consideration of the extent of nutritional denaturisation of some selected food stuff by potash in the study [2].

Other nixtamals use in food processing includes lime and sodium hydroxide which has been use in processing different food product. Nixtamalization of both cereal and oil seeds using different alkaline for nutritional improvement of food stuff for human, poultry and livestock utilization has been reported [12], [6]. [5] Reported the use of sodium carbonate solution, distilled water and potassium carbonate, potassium carbonate and sodium hydroxide in the removal of trypsin inhibitor activity in soya beans. The use of blanching and nixtamalization processes using potash to improve feeding quality and reduction in intrinsic anti-nutritional factor in food were also reported [2], [12], [14]. Many researchers have written on the use of nixtamal to enhance food preparation however little has been documented on the effect of potash on nutritional properties and microbial quality of food stuff. In order to understand the possible level of denaturing of nutritional value by the activity of this agent, Its effects on microbial spoilage of food or shelf life enhancement it is important to analyse the effect of potassium carbonate (potash) on some foodstuff such as beans and okro.

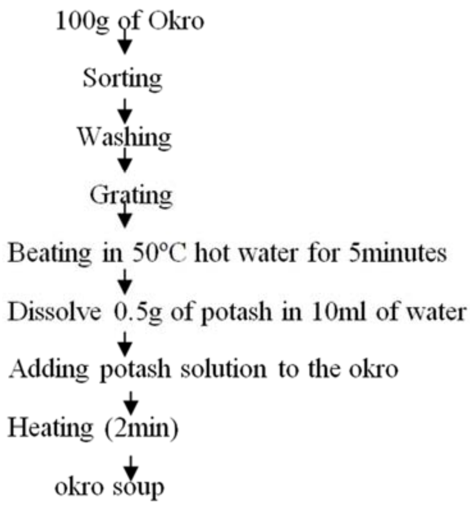
2. Materials and Methods

2.1. Sample and Sample Used

The sample used in the study was okra, beans seed, and potash. All of which was purchased from Old Market, Bida Niger state.

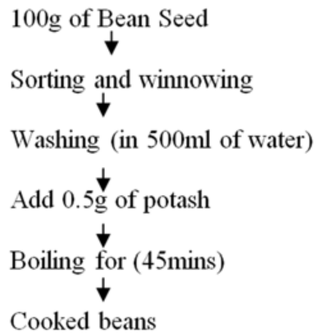
2.2. Preparation of Okro and Beans

Hundred grams of okra was purchased, sorted, washed grated and beaten with 50°C hot water. A 0.5g of potash was grounded and dissolved in 10ml of water after which the potash mixture was poured into the mixed okro and was allowed to boil for 2mins. Another 100g of okro was prepared without addition of potash. This served as the control. The preparation of the beans was done in the same way [10].



Source: [10], [11]

Figure 1. *Preparation of okro soup treated with potash.*



Source: [10], [11]

Figure 2. *Preparation of cooked beans (potash treatment).*

2.3. Determination of Proximate, Mineral and Microbiological Analyses

2.3.1. Proximate Analysis

Proximate analysis was carried out using standard procedures of the [3]. Moisture content was determined by drying the sample in a vacuum oven at 100°C and dried to a constant weight (5hrs). Ash content was determined by incinerations of 2g of the sample in a muffle Furnace at 600°C for 8hrs. The percentage residue weight was expressed as ash content. Crude fat was determined by Soxhlet Extraction method using hexane as solvent. Crude protein was determined by microkjeldah techniques. Carbohydrate was determined by difference after analysis of all the other items methods in proximate analysis (CHO=100-% moisture+% crude protein+% crude fat+% crude fiber+% ash). Energy content of the cake samples was determined by multiplying % crude protein, % crude fat, % carbohydrate by 4, 9 and 4 respectively (Kcal/100g).

2.3.2. The Mineral and Vitamin Analysis of Cake Samples

One gram of the samples was digested using nitric acid and perchloric acid and made to a final volume of 25ml. The digest was made up to 100ml in a standard flask. The atomic Absorption spectrophotometer was used to determine all the minerals (except phosphorus) using appropriate lamps. Phosphorus was determined with vandomolybdate using spectrophotometer at 425nm [7]. The vitamins were determined in triplicates titrimetrically and flourometrically as described by [7].

2.3.3. Microbiological Analysis

Microbiological analyses were conducted as follows; Twenty five grams of the samples was added to 225ml of sterile 0.1% peptone water and homogenize in sterile laboratory blender. 1ml of the homogenate was added to 9ml of 0.1% peptone water (1:10w/v). This was further diluted up to $10^6$for bacterial count and 10^4 for fungi count. The total viable count and coliform count of each of these samples was determined using pour plate techniques on nutrient agar and macConkey agar in triplicates. Plates were incubated aerobically at 37°C and colonies that developed were counted and recorded as colony forming unit (cfu/g) after 24h. The fungal count was however determined on potato dextrose agar plate using pour plate techniques. 4mg of chloramphenicol was added to 100ml of PDA prior to autoclaving. This was incubated at ambient temperature (37°C) for 6days [4], [9]. Developed colonies were counted as colony forming unit per gram (Cfu/g).

2.4. Result Analysis

The result obtained from proximate and mineral analysis of okro and beans samples was subjected to T-test analysis. The mean scores were computed and significant difference among mean were determined using packages for social sciences version 16.

3. Results and Discussion

The proximate content of nixtamalized and unnixtamalized beans using potash as shown in table 1. The result obtained shows variations among the samples. Sample A_1 had increased moisture and crude fibre content as compared to sample B_1. However, sample A_1 and B_1 did not differ ($p>0.5$) in crude protein and fat content. As shown in Table 2. There was significant differences ($p<0.05$) between sample A_2 and B_2. Sample B_2 had higher values of 2.76, 2.76 and 1.70% in terms of crude protein, fat and crude fibre content compared to sample B_2. Sample A_2 had more carbohydrate, energy and ash content than sample B_2

Table 1. *Proximate Content of Treated and Untreated Beans Samples.*

	Samples	
Parameters (%)	**A_1**	**B_1**
Moisture	64.60 ± 0.01^a	63.60 ± 0.60^b
Ash	1.67 ± 0.06^b	2.18 ± 0.96^a
Crude protein	21.85 ± 0.03^a	19.03 ± 0.67^b
Crude fiber	0.53 ± 0.02^a	1.03 ± 0.33^a
Fat	1.27 ± 0.02^a	1.38 ± 0.06^a
Carbohydrate	9.64 ± 0.16^b	12.02 ± 0.02^a
Energy	138.14 ± 0.70^b	139.88 ± 0.00^a

Each of the value of the sample on the table is mean ± S.E of three determinations, different letter along the row are significantly different ($p<0.05$)
keys
sample $A_{1::}$ untreated beans
sample B_1: treated beans

Table 2. *Proximate Content of Treated and Untreated Okro Samples.*

	Samples	
Parameters (%)	**A_2**	**$B_{1=2}$**
Moisture	91.51 ± 0.06^a	90.62 ± 0.02^b
Ash	0.88 ± 0.02^a	0.30 ± 0.04^b
Crude protein	2.48 ± 0.02^b	2.76 ± 0.10^a
Crude fiber	1.23 ± 0.02^b	1.70 ± 0.10^a
Fat	2.31 ± 0.04^b	2.76 ± 0.04^a
Carbohydrate	2.78 ± 0.03^a	0.88 ± 0.02^b
Energy	40.90 ± 0.00^a	40.04 ± 0.04^b

Each of the value of the sample on the table is mean ± S.E of three determinations, different letter along the row are significantly different ($p<0.05$)
keys
sample A_2: untreated okro
sample B_2: treated okro

The moisture content of the treated and untreated cooked beans reduced from 64.60% to 63.60%. Beans cooked without potash had higher moisture content than the beans cooked without potash. This could be due to gelatinization of the beans during cooking making hydration of endosperm easier and faster [10]. The treated beans had lower moisture content than the untreated beans in the presence of potash. There is possibility of an osmotic potential developing in the beans. The effect of lime on moisture absorption has also been studied by [1] who reported that maize cooked in lime (nixtamal) solution had lower moisture content. The result reported by this researcher is in conformity with the present findings. The moisture content of both the treated and untreated sample decrease with the use of potash indicating that potash absorbed water from the beans.

There was reduction in moisture content (91.51% to 90.62%) of the okro soup with addition of potash. The reduction in moisture content might be due to the inability of the okro to absorbed water when potash is added to the okro soup. [14] Postulated that potash could be used in reaction to maintain anhydrous condition without reacting with reactant product form. The moisture content affects the viscosity of the okro. The higher the moisture content the lower the viscosity and the lower the moisture content the higher the viscosity. This is ascribed to decrease in polymer concentration. Potash has been documented to increase viscosity of okro [14].

In terms of protein content, a decrease was recorded for beans treated with potash. Crude protein reduces from 21.85% to 19.03%. The value recorded in this study is at variance with the work of [1] were treated maize with lime had higher protein and nitrogen content. However, the decrease in protein revealed in this study is in agreement with the work of [13] were reduction of protein content was documented steeping soybean in potash. The low protein value may be because potash reacts with protein and forms complex which reduces the protein content of the treated beans. As for okro samples, the use of potash do not only increase the viscosity but bring out or increase the protein, crude fibre and fat content of okro. The low carbohydrate and energy content observed in treated okro samples may probably due to its higher protein crude fibre and fat content since the carbohydrate was determined by differences.

From Table 1, the ash content of treated beans increases more than untreated beans. The ash values ranged from 1.67 to 2.18%. This increase may be due to absorption of potassium ion from the cooking medium. This means consuming beans cooked with potash will increase mineral content. A similar occurrence was reported by [10], [20] when millet flour was nixtamalized using lime. In the case of okro the ash content reduces with usage of potash reflecting low mineral content or denaturation of mineral content of okro.

3.1. Mineral Content of Treated and Untreated Okro/Beans Sample

Represented in Table 3, the mineral content showed that sample B_1 increase drastically in phosphorus, calcium, sodium, and potassium content. However nitrogen content increased in sample A_1. According to the Table 4, potash has effect on the mineral content of treated and untreated okro. Phosphorus was reduce from 22.42 to 14.11mg/100mg in phosphorus content. While sodium content reduced from 13.32 to 11.19mg/100mg. There was no significant difference ($p < 0.05$) in nitrogen content of sample A_2 and B_2. The summary of the mineral content of treated and untreated okro and beans significant differences ($p<0.05$) where observed in the treated and untreated okro and beans. It was observed that potash affect the mineral content in okro. The phosphorous content of okro was reduced from 22.42 to 14.11mg/100mg whereas for beans an increase from 332.53 to 385.78% was observed. There was also a reduction in the sodium content of the okro while a drastic increase in calcium, sodium and potassium content of the beans; this may be due to break down of bond holding molecules of the amino acid and polymer bonds [11], [19].

As revealed in this present study, there was an increase in mineral composition of treated bean samples. According to the work done by [6]alkaline treated soybeans increased in mineral content. This may be as a result of the release of bound mineral by nixtamalization.

Table 3. *Mineral Content of Treated and Untreated Beans Samples.*

	Samples	
Parameters (mg/100g)	**A_1**	**B_1**
Nitrogen	3.43 ± 0.03^a	3.06 ± 0.00^b
Phosphorus	332.53 ± 0.27^b	385.78 ± 3.39^a
Calcium	0.01 ± 0.01^b	4.37 ± 0.19^a
Sodium	62.13 ± 0.09^b	84.50 ± 0.06^a
Potassium	386.10 ± 0.06^b	403.20 ± 0.01^a

Each of the value of the sample on the table is mean ± S.E of three determinations, different letter along the row are significantly different ($p<0.05$)
keys
sample $A_{1::}$ untreated beans
sample B_1: treated beans

Table 4. *Mineral Content of Treated and Untreated Okro Samples.*

Samples		
Parameters (mg/100g)	**A_2**	**B_2**
Nitrogen	0.35 ± 0.03^a	0.42 ± 0.02^a
Phosphorus	22.42 ± 0.06^a	14.11 ± 0.06^b
Calcium	19.26 ± 0.13^b	30.10 ± 0.06^a
Sodium	13.32 ± 0.11^a	11.19 ± 0.01^b
Potassium	202.27 ± 0.30^a	169.03 ± 0.03^b

Each of the value of the sample on the table is mean ± S.E of three determinations, different letter along the row are significantly different ($p<0.05$).
[3]sample $A_{2:}$ untreated, sample B_2: treated.

3.2. Microbial Load of Beans and Okro Samples

Table 5 shows that bacterial count of untreated samples of beans reduces from $2.5x10^5$ to $1.7x10^2$ for treated beans samples and $5.0x10^6$ to $1.2x10^3$ for untreated and treated samples okro samples. A similar trend was observed in their fungi count. According to [1] mycotoxins are reduced with the usage of potash. The drastic reduction in the microbial load in the usage of potash shows that this nixtamal could be used for increasing the shelf life of the food stuff such as beans and okro.

Table 5. *Microbial Load of Treated and Untreated Samples of Beans and Okro.*

	Samples			
Parameters (mg/100g)	**A1**	**B_1**	**A_2**	**B_2**
Bacterial count	2.5×10^5	1.7×10^2	5.0×10^6	1.2×10^2
Coliform count	-	-	3.1×10^2	-
Fungi count	6.9×10^7	1.3×10^2	2.2×10^5	1.0×10^1

Each of the value of the sample on the table is mean of three determinations, [3]sample $A_{1:}$ untreated, sample B_1: treated beans, $A_{2;}$ untreated, $B_{2;}$ treated okro.

4. Conclusion

In conclusion, the findings of this work revealed that potash reduces the mineral content of okro and protein content of beans however; it enhances the mineral content of beans. In view of the result obtained from this study and considering the hazardous aspect of potash treated food. Therefore recommendation is hereby forwarded. The national agency for food and drug administration control (NAFDAC) in Nigeria that is charged with the responsibilities of enforcing all laws, guidelines, policies and compliance should have a standard or permissible concentration of potash that should be allowed for food processing. More research should be carried out on the levels of concentration of potash permissive for various food stuff usage.

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