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# Evaluation of the Effects of Processing on the Mineral Contents of Maize (*Zea mays*) and Groundnut (*Arachis hypogaea*)

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**Abstract:** Mineral contents of raw and processed (boiled, dried, roasted and fried) maize (*Zea mays*) and groundnut (*Arachis hypogaea*) were determined by Atomic Absorption Spectrophotometric (AAS) method. The results showed that both raw maize and groundnut recorded the highest values for all the minerals analyzed. The lowest values for all minerals (Na, K, Ca, Fe, Zn and Mn) were recorded for boiled groundnut, whereas boiled maize recorded the lowest K, Fe and Mn values of 0.013, 0.236 and 0.008mgkg$^{-1}$, respectively. The observed trend in percentage loss in the analyzed mineral contents for processed groundnut was boiled > fried > dried; while for processed maize the observed trend was boiled > roasted > dried with respect to only Mn, Zn and K.

**Key words:** Processed maize and groundnut · Mineral content · Percentage loss in mineral content

## INTRODUCTION

The consumption rate of maize, especially boiled and roasted maize, has been on the increase particularly in the Southern part of Nigeria during every annual maize harvest season which is usually between the months of April and September. This trend may not be unconnected with the low income level of many people in developing countries such as ours; which has affected our eating habits without any consideration given to nutritional benefits derivable from some consumed food materials.

Chemical composition, after processing for consumption, is an important aspect of edible seeds and fruits. It is affected by the physical structure of the kernel, genetic and environmental factors, processing and other links in the food chain [1, 2]. The nutritional value of a processed food is rarely better than that of the raw food material, although there are some beneficial effects of processing (e.g. the destruction of trypsin inhibitor in legumes and the liberation of bound niacin in cereals). During processing, nutrients are lost because they are leached by water at some stage in the processing [3]. Trace elements and enzymes may also catalyze the destruction of the nutrients. Loss of nutrients may occur at any or all of the following steps between garden and gullet: harvesting, handling and transport; preparation and processing; storage and distribution [4].

Foods from plants and animals contain nutrients in varying amounts and they are unequally sensitive to temperature, light, oxygen and leaching. Consequently, the nutrient loss resulting from processing varies according to the type of food, the length of time that processing takes and the particular nutrient [3]. Most cereals have been reported to be low in essential minerals such as calcium, potassium, iron and zinc; and blending with legumes rich in proteins and amino acids has been reported by [5-7]. Different methods of processing, such as boiling, cooking, roasting and sprouting, have been reported to have effects on the nutritional quality of Kersting's groundnut seed flours [8]. The chemical compositions of groundnut seeds have been evaluated in relation to amino acid and fatty acid compositions [9]. Earlier study has reported that weaning foods based on cereals (maize) are deficient in lysine and tryptophan, thus making their protein quality poorer compared to those from animals [10]. Improved vitamin content in germinated sorghum and maize [11], increased amino acid and vitamins in fermented blends of cereals and soyabeans have also been documented by [12]. This study reports the mineral contents of groundnut *(Arachis hypogaea)* and maize *(Zea mays)* subjected to different processing methods.

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## MATERIALS AND METHODS

**Collection of Sample:** White maize *(Zea mays)* was harvested from a local farm at Ndele village in Rivers State in the month of July and freshly harvested groundnut *(Arachis hypogaea)* was purchased at the Mile One market in Port Harcourt at the same period. These samples were immediately carried in black polyethene bags to the laboratory for use in the study.

**Processing and Preparation of Sample**

**Raw Sample:** Raw maize kernels (300g) and groundnut seeds (300g) each were oven-dried at about 80°C for two hours prior to grinding and digestion.

**Boiled Sample:** Three hundred gram (300g) each of the fresh groundnut seeds and maize kernels was respectively boiled in distilled water at 100°C in aluminum pot for 30min after which they were drained and oven-dried at 80°C.

**Sun-Dried Sample:** Three hundred gram (300g) each of the fresh groundnut seeds and maize kernels were respectively sun-dried for 6hrs after which they were oven-dried at 80°C.

**Roasted Maize Sample:** Freshly harvested maize after removing the husks was roasted on local firewood. Three hundred gram (300g) of the roasted maize kernels after removing from the cobs was oven-dried at 80°C.

**Fried Groundnut Sample:** Fresh groundnut seeds, after removing the shells, were soaked in distilled water for 1 hr and later allowed to dry at room temperature for 2 hrs. Frying of the groundnut seeds was carried out with some quantity of garri to prevent burning during frying using kerosene stove. Three hundred gram (300g) of the fried groundnut seeds was oven-dried at 80°C.

At the end of processing, all the samples were prepared by grinding using an electric blender and sieved with 200µm mesh to obtain powdered samples prior to digestion and analysis.

**Digestion and Analysis:** Five gram (5g) each of the powdered samples was transferred into a Kjeldahl flask. To this was added 10ml of dilute $HNO_3$, $H_2SO_4$ and HCl. The flask with its contents was immersed in a 250ml electro-thermal heating mantle under a regulated temperature until the mixture was slowly digested to near dryness. The residue in the flask was dissolved in 100ml distilled water, filtered and stored in glass container. The mineral contents of the samples were determined using thermo-elemental Atomic Absorption Spectrophotometer (AAS) [13]. Results are reported in mg/kg.

## RESULTS AND DISCUSSION

The mineral contents of raw and differently processed maize kernels and groundnut seeds are presented in Table 1. Boiled groundnut recorded the lowest sodium (Na), potassium (K), calcium (Ca), iron (Fe), zinc (Zn) and manganese (Mn) contents among the differently processed groundnut samples. Boiled maize recorded the lowest K, Fe and Mn values of 0.013, 0.236 and 0.008 mg $kg^{-1}$, respectively among the different maize samples. The concentration of Mn, which is an important antioxidant mineral in the human body, associated with boiled groundnut was below detectable limit of AAS. Sodium to potassium ratio calculated for all the samples showed that boiled groundnut had the highest Na/K of 2.00 while the lowest value of 0.083 was recorded for roasted maize (Table 1). The ratio of sodium to potassium in the body is of great concern for prevention of high blood pressure. Na/K ratio less than one is recommended [8]. The very high ratio of sodium to potassium, 2.00 for boiled groundnut (Table 1) could likely promote high blood pressure.

Table 1: Mineral contents ($mgkg^{-1}$) of raw and processed maize kernels and groundnut seeds.

| | Maize samples | | | | Groundnut samples | | | |
|---|---|---|---|---|---|---|---|---|
| Minerals | Raw | Dried | Roasted | Boiled | Raw | Dried | Fried | Boiled |
| Sodium, Na | 0.061 | 0.031 | 0.002 | 0.006 | 0.066 | 0.034 | 0.012 | 0.004 |
| Potassium, K | 0.106 | 0.088 | 0.023 | 0.013 | 0.096 | 0.061 | 0.031 | 0.002 |
| Calcium, Ca | 0.046 | 0.012 | 0.009 | 0.020 | 0.029 | 0.015 | 0.006 | 0.002 |
| Iron, Fe | 2.316 | 1.112 | 0.512 | 0.236 | 2.172 | 1.011 | 0.069 | 0.034 |
| Zinc, Zn | 0.840 | 0.311 | 0.051 | 0.034 | 1.321 | 0.157 | 0.078 | 0.029 |
| Manganese, Mn | 0.068 | 0.040 | 0.013 | 0.008 | 0.061 | 0.021 | 0.006 | BDL |
| Na/K | 0.575 | 0.352 | 0.083 | 0.462 | 0.688 | 0.557 | 0.387 | 2.00 |

BDL= Below detection limit of 0.001.

Table 2: Percentage loss in mineral contents of processed maize and groundnut

| | Mineral loss (%) | | | | | |
|---|---|---|---|---|---|---|
| | Maize samples | | | Groundnut samples | | |
| Minerals | Dried | Roasted | Boiled | Dried | Fried | Boiled |
| Sodium, Na | 49.18 | 96.72 | 90.16 | 48.48 | 81.81 | 93.93 |
| Potassium, K | 16.98 | 78.30 | 87.74 | 36.46 | 67.71 | 97.92 |
| Calcium, Ca | 73.91 | 80.43 | 56.52 | 48.28 | 79.31 | 93.70 |
| Iron, Fe | 51.98 | 11.53 | 89.81 | 53.45 | 96.82 | 98.43 |
| Zinc, Zn | 62.98 | 93.93 | 95.95 | 88.12 | 94.10 | 97.80 |
| Manganese, Mn | 41.18 | 80.88 | 88.24 | 67.21 | 90.16 | 98.36 |

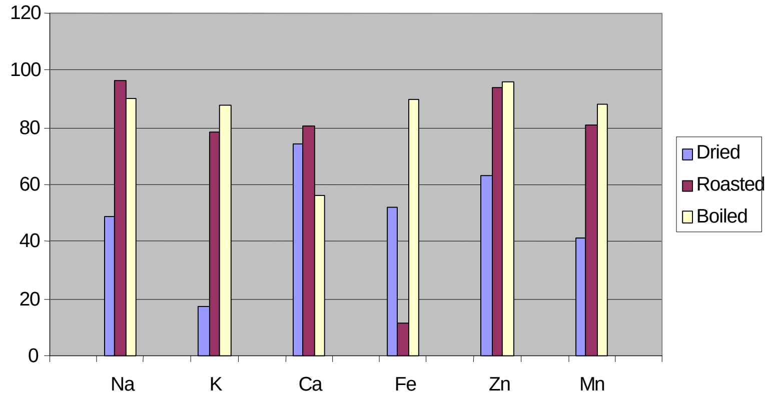


Fig. 1: Variation in mineral loss (%) in processed maize kernels.

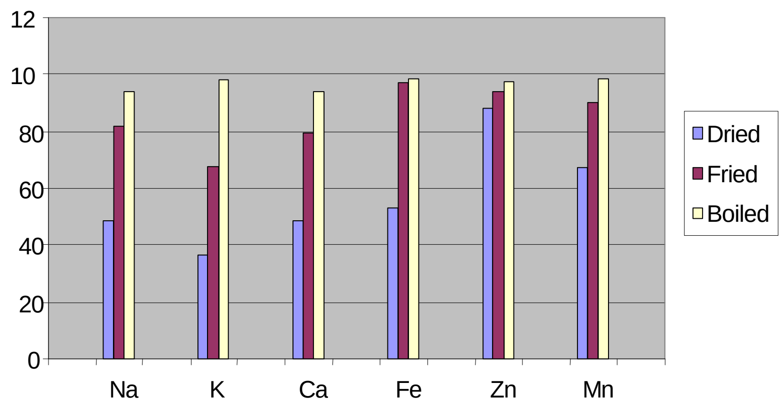


Fig. 2: Variation in mineral loss (%) in processed groundnut seeds

The percentage loss in mineral contents resulting from different methods of processing raw maize kernels and groundnut seeds is presented in Table 2. Mineral loss (%) resulting from different processing methods is calculated from the formula:

$$\text{Mineral loss (\%)} = 100 \times (A - B)/A$$

Where A = value of mineral for the raw sample; B = value of mineral for processed sample.

Among the maize samples, the highest percentage loss of 96.72% was recorded for Na while the lowest value of 11.53% was recorded for Fe in roasted maize (Table 2). The variations in the percentage loss in minerals as a result of different processing methods for maize kernels and groundnut seeds are shown in Fig. 1 and 2, respectively. Pronounced effects of boiling were observed on the contents of K, Fe and Mn only (Figure 1) for maize kernels.

The results showed that the different processing methods had diminishing effects on the mineral composition of maize kernels and groundnut seeds; with the effect of boiling being more pronounced on the composition of Na, K, Ca, Zn and Mn (Fig. 2) in groundnut seeds. Iron contents which ranged from 0.236-2.316 mgkg$^{-1}$ for maize samples and 0.034-2.172 mgkg$^{-1}$ for groundnut samples were very low compared to values reported for bambara groundnut-maize flour blend [7] and some green leafy vegetables [14, 15]. Iron is an essential trace element for haemoglobin formation, normal functioning of the central nervous system and in the oxidation of carbohydrates, proteins and fats. Calcium in association with phosphorous is essential for growth and maintenance of strong bones especially in infants. The calcium contents in both raw and processed maize and groundnut samples analysed (Table 1) are very low compared to values reported for bambara groundnut-maize flour blend [7] and some green leafy vegetables consumed in Nigeria [15, 16].

The percentage loss in analysed minerals (Na, K, Ca, Zn, Fe and Mn) calculated from the results in Table 1 for differently processed groundnut seeds showed the trend: boiled > fried > dried. The noticeable trend of percentage loss in mineral contents of processed maize kernels was: boiled > roasted > dried with respect to only Mn, Zn and K. These results to a large extent support earlier report on the effect of heat, soaking and cooking on trace elements [8, 17]. However, the trend in reduction in the amounts of sodium, calcium and iron as a result of different methods of processing maize kernels was irregular; probably as a result of the different chemical behaviour of the insoluble forms of these elements to the different pretreatment conditions.

The general increase in percentage loss in all the minerals analysed for both maize and groundnut with boiling could be attributed to increased tendency for leaching of the minerals from the germ and endosperm of cereals and legumes, respectively, during boiling. And this tendency appears to be more pronounced for boiled groundnut.

## CONCLUSION

This study has shown that boiling, roasting, frying and drying have varying effects on the mineral compositions of maize kernels and groundnut seeds. Reduction in the concentrations of the minerals analysed in this work was more pronounced for boiled samples, especially boiled groundnut seeds. Thus, boiled groundnut seeds may not contain reasonable concentrations of minerals for nutritional benefits.

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