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EFFECT OF ROASTING ON MINERAL CONSTITUENTS OF JACKBEAN (*Canavalia ensiformis*) FLOUR

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ABSTRACT

The effect of roasting on mineral constituents of Jackbean flour was examined. Jackbean was procured from International Institute of Tropical Agriculture (IITA), (Genetic Resources Unit) Ibadan, Oyo State Nigeria. The seeds were sorted and roasted at 160 ^{0}C for 10, 20, 30, 40 and 50 mins. The roasted and unprocessed (control) bean were then milled into flour and thereafter investigated for mineral content to assess the effect of roasting on the samples. The data generated were statistically analyzed using SAS 2.0 and SPSS 20.0 packages. The results showed that roasting at 160 ^{0}C for 20 mins produced flour sample with improved minerals in terms of Na (11.08 mg/kg), Fe (1.68mg/kg), Mn (0.74mg/kg), Cu (0.77 mg/kg), Zn (1.95 mg/kg). Roasting

Introduction:

Jackbean botanically classified as *Canavalia ensiformis*, known as "Sese nla" in Yoruba which is among tropical legumes that does well in Nigeria (Okonkwo and Udedibie, 1991, Odedeji, *et al*., 2019). Jackbean marginalized in most evolving countries of the world Nigeria inclusive. This has massively affected the utilization and cultivation of this legume despite its nutritional and mineral potentials. Those cultivating the seed in Nigeria plant it as ornamental plant and the

at 160 ^{0}C for 40, 30 and 10 mins resulted in highest value for Mg, K and Ca: 81.00 mg/kg, 215.26 mg/kg, 60.10 mg/kg respectively. The Na:K values for all the roasted samples were less than one. Roasting thus had positive effect on the mineral constituents of jackbean during its processing.

Keywords: Mineral, constituents, jackbean, roasting

Crop is believed by some people to be snake expellant (Odedeji, *et al*., 2019). The crop has potential in new product development and human consumption, but its attendant prolonged processing period, and tough testa have affected the mineral constituents of the flour (Akande *et al*., 2013). Food products quality produced from legume flour samples generally affect the functional and pasting properties as influenced by the processing conditions that are employed (Ezeocha and Onwuka, 2010).

Legumes have some associated challenges which include anti-nutritional factors, prolonged period of processing, and tough seed coat. These are more pronounced in underutilized legume, especially in Jackbean and have affected the mineral and nutritional compositions of the crop (Arise *et al.,* 2022).

In order to reduce these peculiar problems with legumes, different pre-processing techniques have been employed to enhance the processing, nutritional quality, sensory acceptability, reduction in the oligosaccharides and other anti-nutritional factors in them. These have been found to advance the nutrient compositions and mineral constituents of the food crops. Some of the commonly used pre-processing methods included soaking, boiling at high temperatures (in water, alkaline or acidic solutions), fermentation, autoclaving, dehulling, microwaving, steam blanching sprouting and roasting (Arise *et al.,* 2022; Skulinova *et al.,* 2002).

Roasting of leguminous seeds has been documented by researchers to improve the protein, mineral and other nutritional contents and reduces the anti-nutritional compositions (Odedeji *et al.,* 2018; Mahando, 2004; Harper and Zandi, 2008 and Srilakshmi, 2008). Plant proteins are major sources of human's nutrition because animal protein are costly for the poor

(Owuamanam *et al*., 2014). In a study of mineral elements status in ten different kinds of legumes, they were relatively high in calcium, iron, magnesium, phosphorus and potassium, and low in sodium (Dave *et al*., 2008).

Food processing operations not only improves flavour and palatability of foods but also increase the bioavailability of nutrients by inactivating some anti-nutritional factors and growth inhibitors (Carmelia *et al.,* 2007). Studies had revealed that pre-treatments such as sprouting, soaking/fermentation, autoclaving, blanching or roasting could improve the quality of seeds and grain products (Ade- Omowaye *et al.,* 2003*;* Kirbaslar and Erkmen, 2003 and Carmelia *et al.,* 2007).

Documented works on the beans centered majorly on its potential in animal feed formulations (Anyanwu *et al*., 2011). There is a gap in the effect of roasting on the mineral constituents of Jackbean cultivated in developing countries such as Nigeria, which is the basis for its marginalization (Ikegwu *et al.,* 2010, Odedeji *et al.,* 2019). This study therefore assessed the effect of roasting on the mineral constituents of Jackbean flour.

Materials and Methods

Source of Planting Material and Experimental Location

The seeds of Jackbean (*Canavalia ensiformis*) with Accession Number: TCe4 were obtained from the Genetic Resources Unit of International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State Nigeria. The seeds were planted at the experimental farm of Osun State Polytechnic, Iree. Analytical Grade chemicals and equipment were obtained from the Departments of Food Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State and Food Technology, Osun State Polytechnic, Iree, Osun State, Nigeria.

Preparation of the beans

The pods of Jackbean were harvested after maturity (four months) and sundried. The seeds were shelled and were thereafter winnowed to remove chaff.

Flour Production from Raw and Treated Jackbean

Jackbean seeds were thoroughly cleaned and sorted to remove defective ones. The seeds were thereafter graded according to their sizes. The cleaned seeds were soaked in warm water to soften the hull and ease its removal. The hulls were removed by repeated working between the palms and were removed leaving behind dehulled seeds. The dehulled seeds were thereafter drained and dried to reduce the moisture content and facilitate grinding into flour (Odedeji *et al*., 2018).

Roasting

Odedeji *et al.* (2018) method was adopted for roasting of the dehulled Jackbean seeds. Two hundred grammes (200 g) of the beans were roasted inside a universal hot air- regulated oven at 160 ^{o}C for 10, 20, 30, 40 and 50 mins after cleaning and sorting operation. The beans were allowed to cool before milling into flour.

Effect of Pre-processing Methods on Mineral Composition of Jackbean Flour

Five grammes (5g) of the sample was weighed for ashing. The ashing was done in a muffle furnace at 500 ^{o}C and was allowed to cool to room temperature. The ashed sample was digested in the digestion flask with 1N HCl at 90 ^{o}C for 5 mins. The content was properly mixed before being transferred into a 100 ml volumetric flask and made up to mark with IN HCl. The content was then be filtered and kept in a polyethylene bottle. The mineral elements in the digest were characterized using Atomic Absorption Spectrophotometer (AAS).

Results and Discussion

Effect of Roasting on Mineral Constituents of Jackbean Flour

The result of the effect of roasting on mineral constituents of jackbean flour is presented in Table 1.0. Sodium in Jackbean flour roasted at 160 ^{o}C for 20 mins compared to all other roasting times recorded higher significant effect ($P<0.05$) and a mean value of 11.08 ± 0.08 (mg/kg). It was observed that there was no significant difference for samples R_1 and R_4 for this element with mean values of 5.43 $\pm$ 0.16 and 5.39 $\pm$ 0.08 (mg/kg) respectively, which represented the lowest value. The value recorded for sodium was lower than 20.74 reported for Okra seed flour (Adelakun, 2009). Sodium represents the principal cation of extracellular fluid that maintains the osmotic pressure of the fluid and activities of some enzymes such as amylase. The body needs of sodium are not great. Intakes of 1.1 – 3.3 g sodium or 2.8 – 8.3 g Na per day is considered safe and adequate for healthy adults by the Food and Nutrition Board (2011). Excess sodium in the diet contributes to hypertension in genetically prone individuals (World Health Organization, 2005).

Potassium recorded higher significant effect for jackbean flour produced from roasted Jackbean seed at 160 ^{0}C for 30 mins and a mean value of 215.26 $\pm$ 0.10 (mg/kg). There was steady increment in potassium as roasting time increases from 148.03 $\pm$ 0.06 in sample R_1 to 215.26 $\pm$ 0.10 in sample roasted for 30 mins after which there was a sharp reduction to 114.63 $\pm$ 0.10 (mg/kg) in sample R_4. All the samples were rich in potassium and higher than 20.42 recorded for Okra seed flour (Adelakun, 2009). Potassium levels influence multiple physiological processes, including resting cellular – neuronal, muscular and cardiac tissue, hormone secretion and action,

vascular tone, systemic blood pressure control, gastrointestinal motility, acid-base homeostatis, glucose and insulin metabolism, minerals corticoid action, renal concentrating ability and fluid and electrolyte balance (Linus and Wingo, 2014). The higher content of potassium of the samples revealed that the samples are nutritionally significant and indispensable (D`Elia *et al*., 2011).

The Sodium: Potassium ratio was found to be lower than one in all the samples. This had been reported by Alinnor and Oze, (2011) to lower blood pressure. A diet rich in potassium helps to offset some of sodium's harmful effect on blood pressure (D`Elia *et al*., 2011).

Similar significant effect ($P<0.05$) was recorded for samples R_2 and R_5 with mean values of 1.68 $\pm$ 0.29 and 1.40 $\pm$ 0.01 (mg/kg) compared with other roasting times and the raw sample for Iron while samples R_1 and R_3 showed similar but lower significant effect for Iron with mean values of 1.04 $\pm$ 0.06 and 1.01 $\pm$ 0.57 respectively. There was increase in this element as the roasting time increased from 0.17 $\pm$ 0.01 in R_0 to 1.40 $\pm$ 0.01 in R_5 with the exception of R_4 (0.33 $\pm$ 0.02). The body requires about 1.5 – 2.2 mg/day of Iron (Belitz *et al*., 2010). Iron is a constituent of both heamoglobin and myoglobin pigments as well as some enzymes (Adeleke, 2014). Highest content of iron was recorded for sample R_2 (1.68 $\pm$ 0.29) (mg/kg).

Higher significant effect ($P < 0.05$) was recorded by samples R_1 and R_2 though with varied means of 0.61$\pm$0.01 and 0.74$\pm$0.01 in term of manganese compared with other roasting times and the untreated sample. There was steady reduction in manganese over the roasting time from 0.61 in R_1 to 0.38 $\pm$ 0.02 in R_4 with the exception of R_2. The values recorded for the samples for this element were lower compared with 393.98 reported by Adelakun, (2009) for okra seed flour. Manganese is an essential trace mineral that functions as the prosthetic group in a number of enzymes. Growth failure, skeletal abnormalities and impaired reproductive function had been reported to be caused by manganese deficiency. Abnormal insulin metabolism and glucose tolerance are the important effects attributed to manganese deficiency (Agte *et al.,* 2005).

The results of the analysis showed that lead is present in the sample in low level compared to other elements. However, as the roasting time increases, lead value was increasing slightly from 0.09 $\pm$ 0.01 in R_1 to 0.16 $\pm$ 0.05 in R_5. Sample R_5 showed higher significant effect ($P<0.05$) while other samples including the untreated sample showed no significant difference with mean values ranging from 0.08 $\pm$ 0.02 to 0.10 $\pm$ 0.01. The level of lead as recorded for sample R_5 was within the general limit of lead consumption (0.2–10 mg/l) as reported by Ronald and Ronald (1999). Lead is a mineral of no nutritional interest, since it is not known to have any function in the body. It is toxic and its effects are cumulative in nature. Acute lead poisoning usually manifests itself in gastrointestinal effects (Belitz *et al*., 2010).

Higher significant effect (P<0.05) and mean of 0.77 $\pm$ 0.02 was recorded for copper in sample R_2 while sample R_1 and R_0 showed similar significant effect mean values of 0.50 $\pm$ 0.02 and 0.58 $\pm$ 0.02 respectively. Similar significant effect with lower means of 0.40 $\pm$ 0.01 and 0.42 $\pm$ 0.01 were presented by samples R_3 and R_4. The values recorded for copper were lower than 0.41 ppm as reported for bambara groundnut due to effect of processing by Abdulsalami and Sheriff, (2010). Copper is vital element in the formation of oxido-reductase enzyme and help in the catalyses of iron II to iron III. This is an important reaction because it is only in this form that protein can be transported to the liver (Bender, 2006)

The result of analysis revealed higher significant (P<0.05) effect on zinc for sample R_2 with mean of 1.95 $\pm$ 0.03 compared to other samples and the raw sample. There was reduction in the zinc content from 1.65 $\pm$ 0.03 in R_0 to 0.87 $\pm$ 0.04 in R_4 as the roasting time increased except for sample R_2. Zinc deficiency in animal causes serious disorder because it is a component of a number of enzymes (Abdulsalami and Sheriff, 2010). Sample R_1 showed higher significant effect (P < 0.05) for Calcium with a mean value of 60.10 $\pm$ 0.10 compared to other samples. This was followed by sample R_2 with a mean value of 55.12 $\pm$ 0.10. The least value of 20.13 $\pm$ 0.06 was recorded by sample R_0. Calcium helps to build and maintain strong bones and healthy communication between the brain and various parts of the body. People whose calcium intake is inadequate before the age of 20 - 25, have a considerably higher risk later on in life of developing brittle bone disease or osteoporosis, because calcium is drawn from the bones as a reserve (Nordquist, 2015).

The results obtained showed that Magnesium (Mg) is the next significant element apart from Potassium in the sample. The raw sample showed higher significant (P< 0.05) effect and mean value of 104.87 $\pm$ 0.11 (mg/kg) for magnesium. Sample R_4 displayed the highest mean of 81.00 $\pm$ 0.06 among the pre-processed samples. Similar mean of 78.10 $\pm$ 0.01 and significant effect was recorded by samples R_3 and R_5 for this element. The recommended dietary allowance by Food and Nutrition Board (2011) for adults was 240 – 420 mg/day, while infants and children between 0 - 8 years need 30 – 130 mg/day of magnesium. Deficiency of magnesium can cause heart arrhythmia and electrolyte disturbances (Bender, 2006). The combination of calcium and magnesium is needed in the mineralization of bone (Adelakun, 2009). The sodium : potassium ratio for all the samples including the raw sample were lower than one which indicated that the samples will support low blood pressure as was reported by Alinnor and Oze, (2011) on chemical evaluation of the nutritive value of *Pentaclethra macrophylla* benth (African oil bean). There was fluctuation in the mineral constituents of the treated sample which supported the findings of Adeoye and Oyetayo, (2021)

Table 1.0: Effect of roasting on mineral constituents of jackbean flour

Parameters (mg/ kg)	Ro	R_1	R_2	R_3	R_4	R_5
Na	8.90 ± 0.02^c	5.43 ± 0.16^d	11.08 ± 0.08^a	10.19 ± 0.10^b	5.39 ± 0.08^d	9.01 ± 0.02^c
K	152.10 ± 0.10^c	148.03 ± 0.06^d	206.27 ± 0.05^b	215.26 ± 0.10^a	114.63 ± 0.10^e	149.63 ± 0.64^{dc}
Fe	0.17 ± 0.01^d	1.04 ± 0.06^a	1.68 ± 0.29^a	1.01 ± 0.57^a	0.33 ± 0.02^b	1.40 ± 0.01^a
Mn	0.73 ± 0.04^a	0.61 ± 0.01^b	0.74 ± 0.01^a	0.70 ± 0.05^a	0.38 ± 0.02^c	0.58 ± 0.03^b
Pb	0.08 ± 0.02^b	0.09 ± 0.01^b	0.10 ± 0.01^b	0.09 ± 0.01^b	0.09 ± 0.01^b	0.16 ± 0.05^a
Cu	0.58 ± 0.02^b	0.50 ± 0.02^b	0.77 ± 0.02^a	0.40 ± 0.01^d	0.42 ± 0.01^d	0.55 ± 0.01^c
Zn	1.65 ± 0.03^b	1.31 ± 0.02^c	1.95 ± 0.03^a	0.90 ± 0.01^d	0.87 ± 0.04^d	1.35 ± 0.03^c
Ca	20.13 ± 0.06^e	60.10 ± 0.10^a	55.12 ± 0.10^b	20.32 ± 0.32^e	30.30 ± 0.30^c	20.73 ± 0.06^d
Mg	104.87 ± 0.11^a	72.11 ± 0.11^e	73.52 ± 0.02^d	78.10 ± 0.09^c	81.00 ± 0.06^b	78.10 ± 0.01^c
P	0.00 ± 0.00^a	0.00 ± 0.00^a	0.00 ± 0.00^a	0.00 ± 0.00^a	0.00 ± 0.00^a	0.00 ± 0.00^a
Na:K	0.06	0.04	0.05	0.05	0.05	0.06

Values are means of triplicate determinations. Means with the same superscript are not significantly different ($p \leq 0.05$) along the column

Ro = Raw (Untreated jackbean flour)

R_1 = Roasted jackbean flour at 160 °C for 10 mins

R_2 = Roasted jackbean flour at 160 °C for 20 mins

R_3 = Roasted jackbean flour at 160 °C for 30 mins

R_4 = Roasted jackbean flour at 160 °C for 40 mins

R_5 = Roasted jackbean flour at 160 °C for 50 mins

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Conclusion

Roasting as a pre-processing method is recommended for improved mineral constituents most especially sodium, potassium, iron, zinc, calcium magnesium. The sodium: potassium (Na:K) values of the treated samples of less than one is an indication of the possibility of lowering consumers blood pressure which is of great clinical advantage. Roasting at 160^{0}C for 20 mins resulted in improved samples in mineral compared to other roasting times. The findings of this work revealed that roasting had positive effect on the mineral constituents of jackbean flour.

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