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Effects of Processing Techniques on the Microbial Quality, Nutritional and Mineral Composition of Black-eyed Bean (*Vigna unguiculata)*

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Black eye pea (*Vigna unguiculata*), because of its preferred taste and nutritional value is one of the commonly eaten beans in Nigeria.
Aim: The effect of processing techniques like soaking, dehulling and drying on microbial quality, nutritional and mineral composition of black-eyed bean was studied.
Study Design: One cup of black-eyed beans was divided into two portions. One portion was manually selected, soaked, dehulled and sundried. The other portion received no treatment. Both portions were ground and sieved.
Methodology: One gram of each sieved sample was serially diluted and enumerated of bacteria using standard microbiological procedures. Proximate and mineral compositions were determined by standard analytical procedures.
Results: The presence of *Staphylococcus*, *Klebsiella*, *Bacillus*, *Enterobacter* and *Salmonella* species were observed in both samples. Species of *Lactobacillus* and *E. coli* were found in treated

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and untreated sample, respectively. The protein, ash and moisture contents of the treated sample were higher compared to the untreated sample while that of carbohydrate, fibre and fat were lower in the treated sample. Analysis of zinc and iron revealed higher values in the treated sample than in the untreated sample. In contrast, the concentration of magnesium was slightly lower in the treated sample.

Conclusion: Processing of raw food items such as beans by soaking, dehulling, drying, etc. before cooking confer quality, nutritional and health benefits on the final edible food products.

Keywords: Microbial quality; black-eyed bean; processing techniques; proximate composition; minerals.

1. INTRODUCTION

Many varieties of food legumes (pulses) are found throughout the world. They provide humans with plant proteins with reduced production costs, easier processing and have, higher prospect of boosting energy efficiency than obtained from animal proteins. Food legumes are among the foods recognized and recommended for consumption for the noble purposes of neutralizing acids in the body system [1]. Beans are often grown as cash crop by small scale farmers and used as a major food legume in many parts of Nigeria, where they are consumed in different types of traditional dishes [2] because of their taste and nutrients composition.

Cowpea, *Vigna unguiculata* (L.) with vernacular names such as black eye pea, field pea, southern pea, crowder pea, etc. is commonly cultivated as a nutritious and highly palatable food source [3]. The seed is reported to contain 24% crude protein, 53% carbohydrates, and 2% fat [4]. Varieties may be short and bushy, prostrate, or tall and vine-like. Canopy heights can be 2–3 feet, depending on the variety [3]. Beans are extensively grown in the northern part of Nigeria. Among the legumes, cowpea is a major staple food, the most extensively grown, distributed and traded food crop consumed because of its considerable nutritional and health value to man and livestock. The amino acids in cowpea complement those of cereals. Their mineral contents e.g. calcium and iron are higher than that of other protein sources like meat, fish and egg. The iron content is equivalent to that of milk, which makes beans very useful in blood cholesterol reduction [5]. Cowpea has been cultivated and domesticated in Africa for centuries. It is now grown worldwide, especially in the tropics. It is better adapted to sandy soils and droughty conditions. The largest producers are Nigeria, Niger, Brazil, Haiti, India, Myanmar, Sri Lanka, Australia and the United States [6]. Cowpea carries out symbiotic nitrogen fixation, where it fixes atmospheric nitrogen through symbiosis with bacteria which inhabit root nodules. The bacteria exchange nitrogen for plants saccharides. Bean is a good food source. It mixes well with other recipes [7] or items including rice, yam, etc. The most familiar type of cowpea is black eye pea.

Many food raw materials go through many procedures before they are finally available as edible food products. These procedures in food processing, are commonly referred to as unit operations and include: cleaning, concentrating, heating and cooling, drying, mixing, separating etc. [8]. This study was undertaken to assess and provide information on the effect of operations or pre-treatments like soaking, dehulling and drying on the microbiological quality, nutritional and mineral composition of black eye pea scientifically referred to as *Vigna unguiculata*.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of Samples

Black eye-beans were purchased from Ukam Market in Mkpat Enin Local Government Area of Akwa Ibom State, Nigeria. The seeds were manually sorted to get rid of extraneous materials and then divided into two parts. One part was soaked in water for 12 hours, dehulled and sun-dried for 9 hours. It was ground into flour using a manual grinder and then sieved. The other part was grinded without soaking, dehulling nor sun-drying. Both samples were analysed for bacterial quality, nutrient and mineral composition using standard microbiological and analytical procedures, respectively.

2.2 Enumeration of Bacteria

One gram of each flour sample was weighed into respective test tubes containing 9 mL of sterile water. Test tubes were shaken to disperse the sample into solution. Five-fold dilutions were made and from each test tube a 0.1 mL aliquot from the 10^{-4} dilution was transferred to respective sterile petri dishes containing prepared nutrient agar medium. The same procedure was repeated on MacConkey agar plates. The inoculum was spread over the media using a sterile glass rod. The inoculated plates were incubated at 37°C for 24 h and the bacterial load of 30-300 colonies in each plate was determined by counting and multiplying by the dilution factor. The result was expressed in colony forming units per gram of black eyed-beans.

2.3 Purification of Isolates and their Identification

The morphological characteristics of all colonies were noted and each colony was sub-cultured on fresh nutrient agar medium for purity. Cell types were determined by their Gram reaction. Each bacterial culture was characterized and identified using the methods described by Cowan [9] and Cruikhank et al. [10].

2.4 Analyses of Nutrients and Minerals Content of Black Eyed-Beans

Analyses for the moisture, fat, crude fibre, protein, carbohydrate as well as the ash content and the mineral composition of the *black eyed-beans.* flour samples were carried out using the methods of Association of Official Analytical Chemist [11] and the Atomic Absorption Spectrophotometer (AAS) as described in the manual, respectively. The samples were digested before analyzing for minerals as follows: One gram (1 g) of each sample was dissolved in 20 ml of $HN0_3$ per 5 ml perchloric acid. This was made up to 100 ml in a volumetric flask. The digest was filtered through a filter paper and was made up with deionised water. The desired mineral in each digested sample was determined in AAS.

3. RESULTS AND DISCUSSION

3.1 Results

Microbial analyses of *black eyed-beans* revealed bacterial species of health importance (Table 1). Preliminary treatments of the food item provide observable changes in it nutrients and minerals levels (Fig. 1).

3.2 Discussion

Black eyed-beans are one of the basic components of a vegetable diet. Romero-Arenas et al. [12] established that they represent a powerful source of elements needed for human nutrition. Microbial analysis of the beans samples (Table 1) revealed 1.9×10^6 of total heterotrophic bacteria and 2.8×10^6 of total coliform for treated beans, and 2.13×10^6 of total heterotrophic bacteria and 5.3×10^6 of total coliform for the untreated beans. The table also reveals a higher microbial load in the untreated sample flour. *Staphylococcus* sp., *Klebsiella* sp., *Bacillus* sp., *Enterobacter* sp., and *Salmonella* sp. were isolated from both beans flours as seen in the table. In addition, species of *Lactobacillus* and *E. coli* were found in the treated and untreated beans, respectively. The presence of conventional indicator bacteria, *E. coli* and *Klebsiella* sp. (faecal coliforms) in this study, indicate the possible presence of enteric pathogens in the tested samples: *Salmonella* for example, is a clinically important bacterium. *Lactobacillus* species outnumbered the rest of the organisms in the samples. *Staphylococcus* sp. and *Klebsiella* sp. were higher in composition in the untreated sample. Isolation of species of *Bacillus*, Lactic acid bacteria, and *Staphylococcus* from the samples as observed in this study, have also been observed in other studies [13–16]. The concentrations of certain important nutrients and minerals were also examined in the samples. These included moisture, ash, fibre, fat, protein, carbohydrate, zinc, iron and magnesium. The treated bean samples revealed higher protein (25.85%), ash (0.93%) and moisture (16.31%) content than the untreated beans (Fig. 1). Ajayi [15] stated the capability of *Bacillus* spp. together with some lactic acid bacteria spp. in increasing the protein and fat contents of samples. In this study, the protein content was higher in the treated samples from which *Bacillus* sp. and *Lactobacillus* sp. were isolated. Oburuoga et al. [17] also reported increased protein content in treated (dehulled) mung bean flour. Apparently, the soaking, dehulling and drying as well as the presence of *Bacillus* species and lactic acid–producing bacteria increased protein content of the treated black-eyed bean in this study. This group of organisms is known for their probiotic potentials and the use of such organisms as starter cultures

Table 1. Microbiological quality of treated and untreated black-eyed bean

Samples	Treated beans	Untreated beans
Total Heterotrophic Bacteria	1.9×10^6	2.13×10^6
Total Coliform	2.8×10^6	5.3×10^6
Microorganisms identified	*Klebsiella* sp.	*Escherichia coli*
	Bacillus sp.	*Salmonella* sp.
	Enterobacter sp.	*Bacillus* sp.
	Salmonella sp.	*Staphylococcus* sp.
	Lactobacillus sp.	*Enterobacter.* sp.
	Staphylococcus sp.	*Klebsiella* sp.

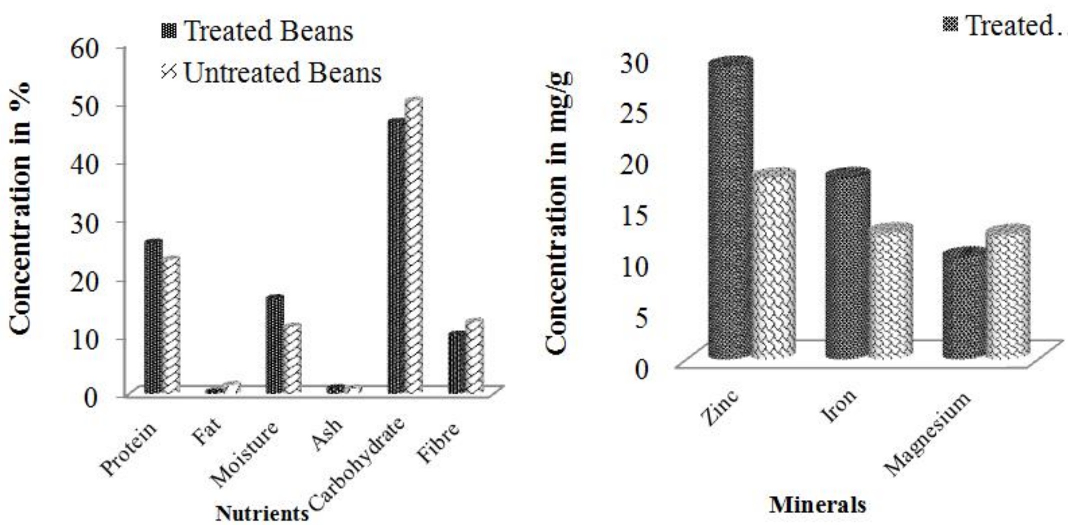

Fig. 1. Levels of nutrients and minerals in the black-eyed bean samples

may be quite desirable in food fermentation processes. The increase in moisture content following the bean seed treatments is attributed to the soaking process. The low moisture content in the untreated bean is a factor that helps to prolong the shelf life as well as the nutrients content of the beans. Onyeike et al. [18], observed that higher moisture content could lead to food spoilage as moisture is required for microbial growth and action.

Fat, carbohydrate and fibre contents were, however, reduced in the treated beans seeds. This agrees with the report by Abusin et al. [19] and Onwuliri and Obu [20], that, there is a significant reduction in the composition of some parameters as a result of soaking. In this study (Fig. 1), fat was reduced to 0.3% from 1.5%; carbohydrate reduced to 46.54% from 50.18% and fibre reduced to 10.09% from 12.29%. Analysis of minerals, in Fig. 1, revealed 17.78 mg/g of zinc, 12.41 mg/g of iron and 12.26 mg/g of magnesium in the untreated bean seeds sample. In the treated sample, 28.72 mg/g of zinc, 17.82 mg/g of iron and 10.05 mg/g of magnesium were obtained. The results showed higher zinc and iron values from the treated sample. The magnesium content was reduced in the treated sample. This reduction indicates the effect of fermentation (soaking) on legumes. The concentration of magnesium was the least among the analysed minerals. Among other benefits, zinc helps to prevent disease and also fights infections. Iron, whose major portion is found in haemoglobin, by its role in the red blood cell production, provides life-giving oxygen to organ systems. Ape et al. [21] reported that magnesium is important in calcium metabolism in bones, involved in prevention of circulatory diseases, regulation of blood pressure and insulin release. Its deficiency reduces cell formation and osteoblasts formation of bones. The reduction in the magnesium content in this study is attributed to soaking, where the mineral must have leached into the water.

4. CONCLUSION

Staphylococcus sp., *Klebsiella* sp., *Bacillus* sp., *Enterobacter* sp. and *Salmonella* sp. were associated with both treated and untreated bean (*Vigna unguiculata)* flours. Species of *Lactobacillus* and *E. coli* were found only in the treated and untreated flour respectively. The protein, ash and moisture contents in the beans increased following soaking, dehulling and sun-drying compared to carbohydrate, fibre and fat, which were reduced in the same sample. Zinc and iron values increased in the treated sample, while magnesium decreased. Preliminary treatments of raw food materials before consumption positively alter the microbial, proximate and mineral composition of the final edible food products. Thus, this study recommends that such treatments as those employed in this study be encouraged and implemented during food production for their associated quality, nutritional and health benefits.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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