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Comparative Analysis of the Nutritional Qualities of Seeds of Shea Nut (*Butyrospermum parkii*) and Cocoa (*Theobroma cacao*)

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Authors' contributions

This work was carried out in collaboration between both authors. Author OOA designed the study, wrote the protocol, and supervised the work. Author AOV performed the physico- chemical and statistical analysis, wrote the first draft of the manuscript, managed the analyses of the study and literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

This research work compares the chemical, nutritional and anti-nutritional compositions of shea nut (*Vitellaria paradoxa*) with cocoa (*Theobroma cacao*), and the effect of roasting on these properties. The ash, crude fibre, fat and carbohydrate contents of the two seeds showed some similarities, while the theobromine content of the sheanut was higher than that of cocoa.
The mineral compositions of the two seeds were very low but the effect of roasting on the mineral content followed the same trend of increasing both the macro and micro elements contents of the samples.
The anti-nutrient compositions of the two seeds were similar, with roasting having an increasing effect on the anti-nutritional factors (phytic acid, oxalate and tannin) when compared with the raw samples. The results revealed that sheanut will be a suitable substitute for cocoa in industrial applications.

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1. INTRODUCTION

The tropical crops under study are cocoa (*Theobroma cacao*) and sheanut (*Butyrospermum parkii)*. Cocoa belongs to the genus *Theobroma* in the family of *Sterculiaceae,* while shea nut belongs to the genus *Butyrospermum* in the family of *Sapotaceae* [1]. The tree crop, cocoa (*Theobroma cacao*) has played an important role in the economies of various regions of the world. Shea nut butter is one of the Africa's most sustainable natural resources and the shea tree is an important source of income; it's the third largest cash crop in Burkina Faso and Ghana, where it's surpassed only by cocoa and coffee [2]. Shea butter has been used for centuries in Africa for its moisturizing and healing properties, where it has been used to protect and condition skin, which have been damaged by the sun and wind [3].

The economic importance of the shea tree cannot be overemphasized, especially in the face of the unstable world market price for cocoa and the need to find suitable substitutes for cocoa in the beverage, confectionery and cocoa butter industries [4]. In order to determine the suitability of sheanut as a substitute for cocoa and as a potential industrial raw material, there is need for comprehensive study of the sheanut seeds.

Thus, this paper compares the chemical, nutritional and anti-nutritional compositions of shea nut (*Butyrospermum parkii*) with cocoa (*Theobroma cacao*) and the effect of roasting on these properties.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

The samples used for this study were raw cocoa nibs, roasted cocoa nibs, raw shea nuts and roasted shea nuts. The dried cocoa beans were obtained from Idanre Town, in Idanre Local Government Area of Ondo State, while the dried shea nuts were obtained from Bida Town, in Bida Local Government Area of Niger State; both states are located in Nigeria. The samples collection and analysis were carried out in 2010. The samples obtained were sun-dried, cleaned thoroughly to remove extraneous materials (stones, pebbles and twigs) and then separated into two portions. One portion was roasted in the oven at 120℃ for 2 hours, while the other portion was used in its raw state. The raw and roasted cocoa beans were shelled to obtain the cocoa nibs. The different samples were pounded separately with a pestle in a clean wooden mortar and thereafter ground with a laboratory Waring blender to obtain suitable particle sizes for laboratory analysis. The ground samples were stored in an air-tight plastic container and kept in the refrigerator, prior to analysis.

2.2 Determination of Proximate and Mineral Composition

The proximate composition was determined by official methods of Analysis of the Association of Official Analytical Chemists [5]. For the minerals, sodium, calcium and potassium contents were determined by Flame Photometer, Jenway PFP 7 model (Bibby Scientific Ltd., Stone, Staffordshire, UK) while phosphorus content of the samples was determined by Colorimetric method using Vanado Molybdate reagent [6]. Mg, Mn, Fe, Cu and Zn minerals were determined after wet digestion with aqua regia using Atomic Absorption Spectrophotometer, Buck 205 model (Buck Scientific, Inc., East Norwalk, CT).

2.3 Theobromine Determination

Theobromine content was determined by the method of [7].

2.4 Determination of Phytic Acid, Oxalate and Tannin

The method of [8] was employed for phytic acid determination; the oxalate content of the samples was determined by the method of [9], while tannin was quantified as described by [10]

3. RESULTS AND DISCUSSION

3.1 Discussion

All the data obtained were subjected to one-way analysis of variance (ANOVA) using the Statistical Package for Social Scientists (SPSS) 15 and the means were separated using the New Duncan's Multiple Range Test.

The chemical composition of the samples under study is shown in Fig. 1. The percentage moisture contents of the raw cocoa nib, roasted

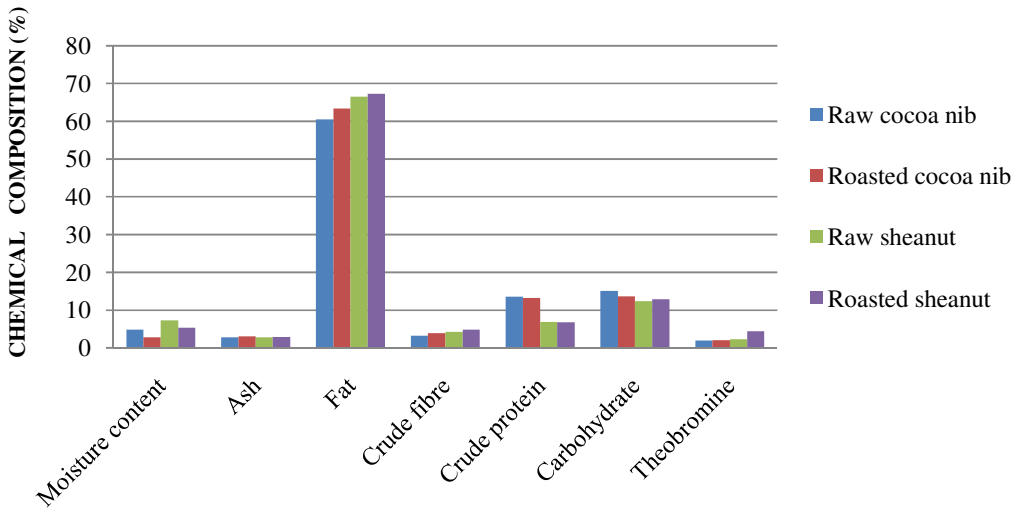

Fig. 1. The chemical composition (%) of samples

cocoa nib, raw sheanut and roasted sheanut are within the 7.5% maximum moisture content recommended by the International Cocoa Organization, Standard Organization of Nigeria and Cocoa Research Institute for commercial cocoa [11,12].

Although, the moisture content of shea nut was higher than that of cocoa nib, the result showed that the moisture content of the roasted samples were generally lower than that of the raw samples. This implies that roasting has a reducing effect on the moisture content of the samples.

The ash content of all the samples is in agreement with the average total ash content of 3.3% specified for cocoa nib by [7]. The importance of ash content is that it gives an amount of mineral elements and inorganic matter present in a food sample. These values for the ash content indicate that all the samples have low inorganic matter. These values for the ash content of the samples are a little bit lower than 3.49 to 3.70% obtained for cocoa nib by [11].

The fat content ranges from 60.44 to 67.23% for the samples. This shows that both cocoa and sheanut can be used as an alternative source of vegetable oil. The values are in agreement with the percentage fat composition of about 60% reported for cocoa and sheanut by previous researchers [11,13,14]. Roasting had a slight increasing effect on the fat content of the samples.

The crude fibre content ranges between 3.26 to 4.88% for the ground samples. These satisfy the maximum crude fibre content of 5.21% specified for commercial cocoa by Pearson, 1976. Roasting also increased the crude fibre content of the samples [6].

The crude protein content ranges from 6.74 to 13.56% for the samples. Protein serves as a source of energy and amino acids required by the body and they also play a part in the organoleptic properties of foods [15].

The recommended daily allowance (RDA) of protein for children ranges from 23.0 – 36.0g and for adult, 44-56g [16]. The mean crude protein values of the samples are too low to be recommended as a protein source for children and adults.

But the crude protein content of cocoa samples compare well with the results 13.56 - 13.94% obtained by [11]. Results showed that roasting reduced the crude protein content of both samples.

The carbohydrate content ranges from 12.36 to 15.09%. This shows that consumption of cocoa and sheanut products will provide reasonable amount of energy for the body and they will also be a good source of feed for livestock [14]. The carbohydrate content of these samples are lower than 21.07- 21.17% reported for cocoa nibs by [11].

The theobromine content of the cocoa samples ranges from 1.98 to 2.11%, while the sheanut samples has between 2.34 to 4.50% theobromine content. According to [17], the theobromine content of cocoa powder may reach up to 10%. Roasting of the samples increased the theobromine content. The stimulating properties of cocoa and chocolate are due to the presence of theobromine and small quantities of caffeine [18,19,20]

Fig. 2 shows the results for the mineral composition of the samples.

All forms of living things require different minerals for their life processes.

All the samples were low in essential mineral elements such as Ca, K, P and Mg. All the samples contain Mn, Fe, Cu and Zn at trace levels.

The observed low essential elements may be due to the presence of the anti- nutritional factors such as phytic acid, oxalate and tannin. It has been reported that the presence of these anti-nutritional factors in foods inhibit the bioavailability of essential minerals [21,22,23,24,25].

Fig. 3 shows the anti-nutrients content of the samples. The anti-nutritional nature of phytic acid lies in its ability to chelate certain important minerals such as calcium, magnesium, iron and zinc in humans and animals, forming mineral-phytic acid complexes [23]. The net result of this is reduced mineral bioavailability in animals or humans consuming diets high in phytic acid [23]. The phytic acid content of these samples was relatively low when compared to phytic acid content of other plants such as legumes [22,27,26]. The charge on oxalate allows it to act as a chelator of various positively charged metal ions such as Ca^{2+}, Fe^{2+} and Mg^{2+}, to deposit crystals of the corresponding oxalates in the body, which irritate the gut and kidneys. Methods to reduce the oxalate content in food are of current interest to scientist [28]. The oxalate content of the examined samples was relatively low when compared to oxalate content of some tropical leafy vegetables [26,29].

According to existing literature, natural tannins are widely distributed in the plant kingdom. They occur in small amounts in most plant tissues [7,18,30]. The percentage composition of natural tannin in cocoa nib is about 5.8% [1].

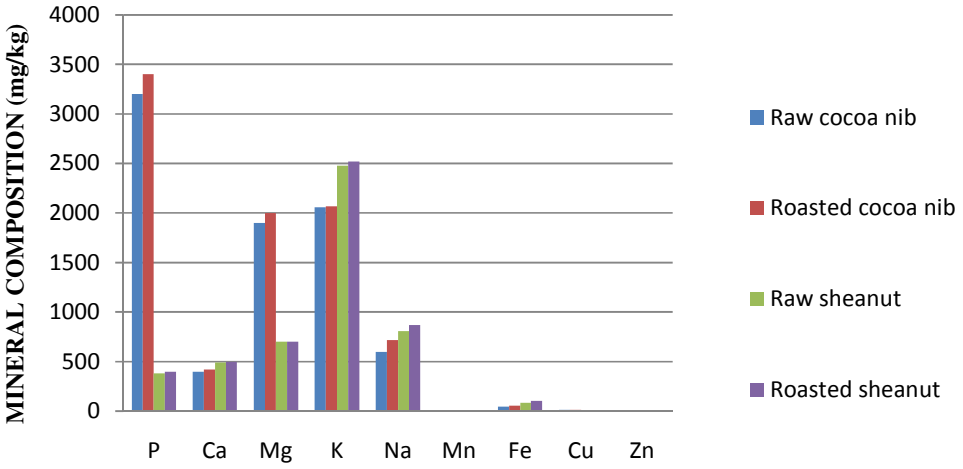

Fig. 2. The mineral composition (mg/kg) of samples

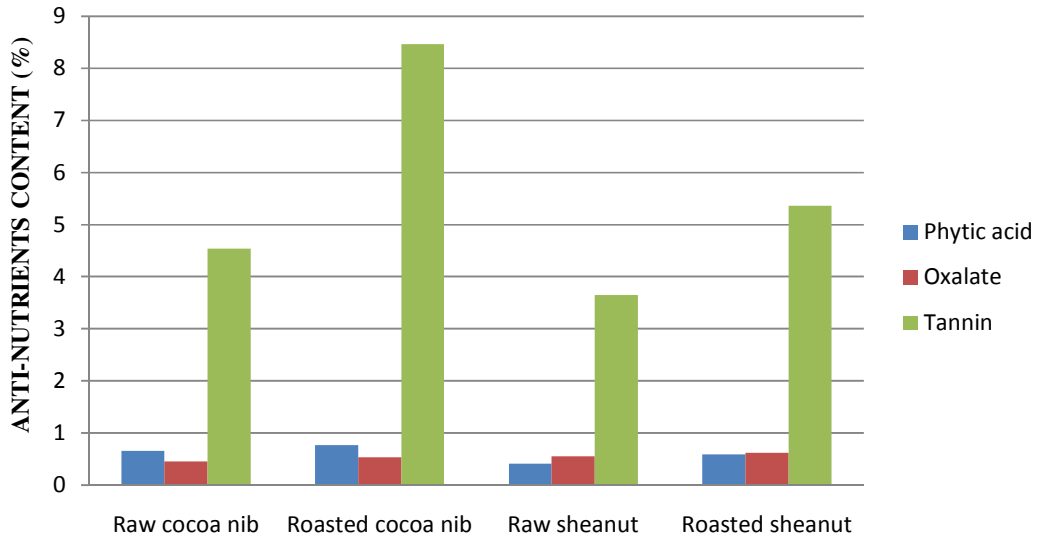

Fig. 3. The antinutrients content of samples

The bitterness and astringency of the cocoa liquor is due to the presence of tannin. Tannic acid has been reported to bind with the proteins of saliva and the mucosal membrane of the mouth during the mastication of food and, consequently inhibit the digestive enzymes of the mouth and bind proline-rich proteins in the saliva [21,22]. Among the anti-nutritional effects attributed to the tannins is a decrease in the digestibility of proteins and carbohydrate as a result of the formation of insoluble enzyme-resistant complexes with tannins. Other anti-nutritional effects of tannins include: damage to the gastrointestinal tract, interference with the absorption of iron and possibly, a carcinogenic effect [31].

It was observed that roasting increased the anti-nutrient contents of the two seeds when compared with the raw samples. According to [29], the variation can largely be attributed to the lower moisture content of the roasted seeds.

However, these results were in agreement with the earlier work of [32] on *Jatropha curcas* where it was reported that concentrations of anti-nutritional factors such as phytate, tannin were either similar or higher in processed seeds.

4. CONCLUSION

This research work compared the chemical, nutritional and anti- nutritional composition of the seeds of cocoa and sheanut, and most importantly the effect of roasting at improving or enhancing the desirable properties.

The results obtained from this research work revealed that sheanut, have similar chemical, nutritional and anti-nutritional compositions as cocoa. The results also revealed that roasting significantly reduced moisture and crude protein contents of the seeds, while roasting significantly increased the minerals, ash, crude fibre, fat, theobromine, phytic acid, oxalate and tannin contents of the seeds.

It can be conveniently concluded that sheanut and its products will be a suitable substitutes for cocoa and its products in the beverage, confectionery, chocolate and other industries where cocoa is being widely used. As a result, sheanut can serve the same household and industrial purposes as cocoa.

This research was conducted for one year only, and further research is needed to see the effects of environments in each year on these chemical composition components.

COMPETING INTERESTS

Authors declare that there are no competing interests.

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