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Effect of Processing Methods on the Proximate and Mineral Compositions in Groundnuts for Consumption

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Authors' contributions

This work was carried out in collaboration among all authors. Author OAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SAO and OMB managed the analyses of the study. Author BOS managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The proximate and some essential mineral compositions of groundnuts processed by different methods for consumption were determined. The parameters were analyzed using standard methods of the Association of Official Analytical Chemists (AOAC, 2005) and Greenfield and Southgate, 2003. From the results obtained, it was found that the proximate compositions (%) of the groundnuts boiled with the pods were – moisture content (18.77 ± 0.02), crude protein (22.93 ± 0.06), crude fat (38.94 ± 0.03), crude fiber (1.75 ± 0.02), ash (3.90 ± 0.04) and carbohydrate (13.73 ± 0.04). Groundnuts roasted with the pods had– moisture content (2.91 ± 0.04), crude protein (29.73 ± 0.08), crude fat (50.11 ± 0.04), crude fiber (4.36 ± 0.03), ash (5.14 ± 0.03) and carbohydrate (7.76 ± 0.05) while those of the groundnuts roasted without pods were – moisture content (2.88± 0.04), crude protein (26.64 ± 0.06), crude fat ss(49.04 ± 0.02), crude fiber (4.26 ± 0.03), ash (4.73 ± 0.02) and the carbohydrate (11.50 ± 0.04). The mineral compositions (in

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(mg/kg) of the groundnut sample boiled with pods were Na (0.23), K (0.67), Ca (0.11), P (0.38), Mg (0.16) and Fe (41.5). Groundnut samples roasted with the pods were Na (0.38), K (0.98), Ca (0.17), P (0.47), Mg (0.27) and Fe (61.2), while the mineral compositions (in (mg/kg) of the groundnut samples roasted without the pods were Na (0.27), K (0.82), Ca (0.16), P (0.42), Mg (0.25) and Fe (53.6). This study revealed that the proximate and the mineral contents in the roasted samples were generally higher than those of the boiled sample except for the moisture and the carbohydrate contents.

Keywords: Groundnuts; boiled; roasted; proximate compositions; mineral contents.

1. INTRODUCTION

Groundnut (*Arachis hypogaea L.*) is a plant belonging to the *Fabaceae* family. It is called by many local names including earthnuts, groundnuts, gobbers, gobber peas, pindas, jack nuts, monkey nuts, pygmy nuts, manila nuts, ground bean and pignuts [1]. Groundnuts are also popularly referred to as peanuts globally. They are the edible seeds of a leguminous plant that grow to maturity in the ground. Cultivated in nearly 100 countries, over 90% of which are developing countries, the groundnut is a food staple and valuable cash crop for millions of households [2].

Groundnut is one of the leading agricultural crops of the world for the production of edible plant oil and protein [3]. They are often enriched with health benefiting nutrients that are beneficial to human health. Groundnut is considered as a vital source of nutrients and calories and for optimum health. Nuts are a good source of oil containing higher unsaturated fatty acids (UFAs) to saturated fatty acids (SFAs) ratio [4].

Groundnuts contain minerals that are primarily associated with strengthening of bones, gums and teeth and play an important role in the normal functioning of the visual cycle, mechanism of blood coagulation [5], immune systems, wound healing [6], normal growth and development during pregnancy, childhood and adolescence [7]. Nutritionally, groundnut seeds are rich due to the presence of oil, protein, niacin, fiber, magnesium, vitamin, manganese, and phosphorus. They also are naturally free from trans-fats and sodium [1,8]. The 'nuts' are high in edible oil content (40-50%) and protein (25%), and also a good source of a variety of essential vitamins and minerals.

Groundnuts can be consumed directly, processed into oil or cake/meal, or further processed into confectionary products or snack food. Every part of the peanut plant is useful in some way: kernels for human consumption, vines as fodder for cattle, and nitrogen fixed from its roots as nutrients for the soil. While valued in most countries primarily for its oil, the ability of groundnuts to improve soil fertility is being increasingly valued in countries like Vietnam, where the plant is being grown to break the rice monoculture, as well as adding to export sales needed to secure income [9].

Groundnut is one of the world's principal oilseed crops. The seed is one of the most dynamic oilseeds as many products have been obtained from it and the seed itself can be directly consumed too. Groundnuts are boiled or roasted and consumed. They are also used in the preparation of groundnut butter. The chief product is the oil which can be used for cooking; the cake left after the oil is extracted, purified and used in supplementary mixes. As they are usually inexpensive, they can be mixed with other kinds of nuts to bring down the cost, while still maintaining flavors and good nutrition. Groundnut has good digestibility in both raw and roasted forms of consumption. The energy value is generally slightly higher in the roasted form than the raw form [1,10].

In fact, within recent years, Ready to Use Therapeutic Food (RUTFs) have been made with a groundnut base and used to treat severe malnutrition in young children. This offers yet another opportunity for groundnut producers to sell their product and also have a positive impact on the life and development of the domestic population [9]. More than half of the world groundnut production is crushed for expulsion of oil, which was diverted mainly as edible oil [11].

Different methods and processes are involved in processing groundnuts for consumption. This study was undertaken to determine the effects of the different methods of processing on the proximate profile and the mineral contents of groundnuts and to advice on which of the methods will be most suitable for processing

groundnut for consumption in order to obtain optimal benefits from the nutritional composition of groundnuts.

2. MATERIALS AND METHODS

2.1 Sample Collection and Preparation

Raw groundnuts used for this study were purchased from ten different local retailers at different sales points in Ibadan city, Nigeria. Three cups of raw groundnuts weighing about 8g per cup were purchased from each point, making a total of 24g per purchase point (and cumulative weight of 240g) of groundnuts. The 240g of groundnuts were poured into a container and were thoroughly mixed to achieve homogeneity. The raw groundnuts were thoroughly washed to remove any possible contaminants and the content was divided into three equal parts for processing. The first portion was boiled with the pods; the second portion was roasted with the pods while the pods of the third portion were removed before roasting. The three portions of the processed groundnuts then formed the samples used for this study.

All analysis done on the samples were carried out in triplicates and the standard deviation of the results was included in the result.

2.1.1 Processing techniques

(a) Groundnuts boiled with pods - The first portion of the divided groundnuts, that is, raw groundnuts with pods weighing about 80g was boiled in distilled water at a temperature of 100°C for 2 hours. After boiling, the water was drained off and the pods were removed leaving only the edible parts which was were mashed with a ceramic pestle and mortar and then stored in an air-tight container at 4–6°C until used.

(b) Groundnuts roasted with pods - The second portion of the divided groundnuts, that is, raw groundnuts with pods weighing about 80g was roasted in a pan with clean sandy soil for about 1 hour 20 minutes. After cooling, the edible parts of the groundnuts were removed from the pods, pounded into a near smooth paste using pestle and mortar and then stored in an air-tight container at 4–6°C until used.

(c) Groundnuts roasted without pods - The third portion of the divided groundnuts, that is, raw groundnuts without pods weighing about 45g was roasted in a pan with clean sandy soil for about 1 hour. After cooling, the groundnuts were pounded into a near smooth paste using pestle and mortar and then stored in an air-tight container at 4–6°C until used.

2.2 Proximate Analysis

The proximate analyses (crude protein, crude fats, crude fiber, and moisture content) were performed on the three sets of processed groundnuts samples; boiled with pods, roasted with pods and roasted without pods. The crude carbohydrate was determined by difference after subtracting the other proximate analysis parameters from 100% as shown below:

> The % Carbohydrate = 100% - (% moisture + % ash + % protein + % crude fibre+ % fat)

The gross food energy was estimated by multiplying the crude protein, crude fat and total carbohydrate by water factors 4, 9 and 4 respectively [12,13].

The analyses were carried out using standard methods [14,15,16].

2.3 Determination of Mineral Elements [14,16]

2.3.1 Determination of Ca, Na and K

Minerals were determined by digesting the ash of the boiled and roasted groundnut samples in 3M Hydrochloric acid.

Calcium, Sodium and Potassium were determined using flame photometer (Model: Corning 410).

2.3.2 Phosphorus determination (Spectrophotometric Method)

Phosphorus was determined by the routine vanado-molybdate colorimetric method.

The percentage phosphorus was calculated using the formula:

$$\%\text{Phosphorus} = \frac{\text{Absorbance x Slope x Dilution factor}}{10000}$$

2.3.3 Determination of Mg and Fe using Buck 210 VGP AAS

Magnesium and Iron were determined using atomic absorption spectrophotometer (Model: Buck VGP 210).

3. RESULTS AND DISCUSSION

The results of the proximate analysis and the mineral contents of groundnuts purchased from ten different sales points within the city of Ibadan and processed in three different ways for consumption: boiled with the pods, roasted with the pods and roasted without the pods are summarized in the Tables 1 and 2.

The moisture contents for the groundnuts boiled with pods, roasted with pods and roasted without pods were 18.77%, 2.91% and 2.88% respectively. The groundnut sample boiled with pod has the highest moisture content which can be attributed to the fact that the sample was boiled in water and must have absorbed large amount of water during the process. The values for groundnuts roasted with and without pods fall within the permissible limit of 10-12% [13,17]. Moisture content plays a very important role in the keeping quality of foods; high moisture can have an adverse effect on their storage stability. [18]. Groundnut seed with 10.1% moisture content at 35°C survived for 12 weeks and the survival period increased up to 120 weeks when the moisture content is reduced to 4.4%. [13,17,19].

Protein is a major nutrient components of different varieties of groundnuts. Protein content of groundnuts is genetically controlled; it is also influenced by nitrogen fertilizer application and agronomic practices [13]. The protein content in the samples analyzed here ranged between 22.93% and 29.73%. The result of this study corroborates the findings of previous studies [1,20]. Another study [21] reported that the crude protein percentage in groundnut varieties ranged between 19.7 and 31.3%. This indicates that groundnut is a good source of protein to the body. [22]. The present study revealed that the two roasted samples contained more protein contents than the boiled sample which supports the assertion of Kamuhu et al. [17] that protein content increased when roasted.

The fat contents determined for the groundnuts boiled with pods, roasted with pods and roasted without pods were 38.94%, 50.11% and 49.04% respectively. These results were similar to the results of Kamuhu et al. [17] who previously reported a range of 47.32% to 49.13%. The high fat contents of the two roasted samples might be attributed to the exposure of the samples to a higher level of heat leading to higher fat to moisture ratio than found in the boiled sample. Fat content in groundnut seeds is important for human diet as it facilitates fat soluble vitamin absorption and also provides high nutrient energy values [1,22].

Table 1. Proximate compositions of groundnuts processed by different methods

Sample Parameter	Groundnut boiled with pod	Groundnut roasted with pod	Groundnut roasted without pod
Moisture (%)	18.77 ± 0.02	2.91 ± 0.04	2.88 ± 0.04
Crude Protein (%)	22.93 ± 0.06	29.73 ± 0.08	26.64 ± 0.06
Crude Fat (%)	38.94 ± 0.03	50.11 ± 0.04	49.04 ± 0.02
Crude Fiber (%)	1.75 ± 0.02	4.36 ± 0.03	4.26 ± 0.03
Ash (%)	3.90 ± 0.04	5.14 ± 0.03	4.73 ± 0.02
Carbohydrate (%)	13.73 ± 0.04	7.76 ± 0.05	11.50 ± 0.04
Dry Matter (%)	81.24 ± 0.02	97.09 ± 0.04	96.17 ±0.04
Gross Energy (Cal/100g)	522.12 ± 0.28	598.11 ± 0.42	587.24 ± 4.00

Table 2. Mineral contents of processed groundnuts processed by different methods

Sample parameter	Groundnut boiled with pod	Groundnut roasted with pod	Groundnut roasted without pod
Na (mg/Kg)	0.23 ± 0.01	0.38 ± 0.02	0.27 ± 0.02
K (mg/Kg)	0.67 ± 0.02	0.98 ± 0.01	0.82 ± 0.03
Ca (mg/Kg)	0.11 ± 0.01	0.17 ± 0.01	0.16 ± 0.02
P (mg/Kg)	0.38 ± 0.02	0.47 ± 0.03	0.42 ± 0.03
Mg (mg/Kg)	0.16 ± 0.01	0.27 ± 0.03	0.25 ± 0.03
Fe (mg/Kg)	41.5 ± 0.14	61.2 ± 0.14	53.6 ± 0.14

The fiber contents of the groundnuts boiled with pods, roasted with pods and roasted without pods were 1.75%, 4.36% and 4.26% respectively. The fiber content was lower in the boiled sample when compared with the roasted samples. This assertion supports the trend initially observed by Ndidi et al. [23]. However, these values were lower than the range of 6.56% to 10.83% reported by Kamuhu et al. [17]. The results of this study imply that roasted groundnuts will be better sources of fiber than boiled groundnuts. Diets low in crude fiber are undesirable and may cause constipation, cancer, and piles [22].

The ash contents of the samples analyzed ranged between 3.90% and 5.14%. This result agrees with the report of Jossyln, [24] which stipulated that total ash contents of groundnut varies between 3.0% and 7.4%. The sample roasted with pods had the highest ash content; the boiled sample had the least while the sample roasted without pods came in between them. This is attributable to processing methods; as dissolution of minerals in water would have happened in the boiled sample and higher volatilization of minerals in the sample roasted without pods than in the sample roasted with pods. High ash content in diets may indicate that they are rich in different mineral elements [1].

The crude carbohydrate contents of the groundnuts boiled with pods, roasted with pods and roasted without pods were 13.73%, 7.76% and 11.50% respectively. Comparatively, these values were lower than the results of Kumar et al. [17] who reported a range of 26.50% to 25.30%. Nevertheless, the results were higher than that obtained by Chowdhury et al. [13] who got a range of 1.218% to 6.275% for carbohydrates in five varieties of groundnut. These results revealed that groundnut boiled with pods contained higher percentage of carbohydrate than the roasted samples. Nevertheless, all the samples analyzed contained appreciable content of carbohydrate which suggests groundnut as a good source of carbohydrate when consumed.

Gross Energy: The results of the groundnut samples analyzed revealed that 100g of groundnuts boiled with pods, roasted with pods and roasted without pods contribute 522.12, 598.11 and 587.24 calories of energies respectively when consumed. This study revealed that roasted samples provide more energy than the boiled sample when consumed.

The analyzed mineral compositions in (mg/kg) for the groundnuts samples were as follows: Samples boiled with pods contained Na (0.23), K (0.67), Ca (0.11), P (0.38), Mg (0.16) and Fe (41.5). Samples roasted with pods contained Na (0.38), K (0.98), Ca (0.17), P (0.47), Mg (0.27) and Fe (61.2), while samples roasted without pods contained Na (0.27), K (0.82), Ca (0.16), P (0.42), Mg (0.25) and Fe (53.6). These results further establish the order of the result of the ash content as discussed above. This study revealed that the samples roasted with pods contained the highest mineral contents closely followed by those roasted without pods while the sample boiled with pods contained the least amount of the minerals analyzed.

4. CONCLUSION

The results of this study revealed that groundnut samples processed by both boiling and roasting contained appreciable amount of nutrients and minerals. It was also established that the sample roasted with pods contained the highest contents of all the parameters considered except moisture and carbohydrate contents which were highest in the sample boiled with the pods, least in the samples roasted with pods, while the sample roasted without pods came in between the two methods of processing. The samples exposed to more heat, that is, the roasted samples contained higher proximate and mineral contents than those exposed to lesser heat by boiling. However, the results established that roasting of groundnuts with the pods is the most nutritionally advantaged method of processing groundnuts.

COMPETING INTERESTS

Authors declare that no competing interests exist.

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