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Original article

Effects of Processing Methods on Proximate Composition of Groundnut Seed (*Arachis hypogea* L.) During Storage Period

Obembe Olusola Michael
e-mail: obembemike01@yahoo.com
Department of Plant Science and Biotechnology, Ekiti State University, Ado Ekiti, Nigeria.

Abstract
The experiment was conducted in the laboratory to know the effects of different processing methods on the proximate composition of groundnut (*Arachis hypogaea*) during the period of storage. Four processing methods (oven-drying, smoke drying, sand frying and ash frying) were adopted while the raw groundnut seeds served as the control. Proximate analysis revealed a significant difference in the moisture content of the processed and unprocessed seeds during the storage period and there was a decrease in the moisture content upon the storage. There was a progressive increase in percentage carbohydrate, crude protein and crude fat throughout the period. However, there was no significant difference between crude fat and crude protein in sand fried and ash fried groundnut seeds in the 18th week of storage. In the same vein, there was no significant difference in carbohydrate and crude fat in sand fried and ash fried seeds in the 24th week of storage. A progressive decrease in the ash content was also recorded during the storage period. The smoked seeds revealed a low moisture content and highest protein content by the 24th week of storage. The best processing method is smoke drying because it contains the highest quantity of protein and lowest moisture, which is capable of preventing food spoilage, by the 24th week of storage.
Keywords: *Arachis hypogaea*, proximate, processed, unprocessed, sand-frying, ash-frying, oven-drying and smoke drying.

Introduction

Food processing is the treatment given to raw foodstuffs to prevent the growth of bacteria and fungi or other microorganisms as well as retarding the oxidation of fat that cause rancidity, thus promoting longer shelf life. As shown in an earlier study (Hotz and Gibson, 2007; Nzewi and Egbuonu, 2011), the processing treatments given to foodstuffs increase the nutritional quantity and are effective in eliminating the anti-nutritional

factors in them and thus the need for human and animal consumption.

According to Odeyemi and Daramola (2000), Food storage is the process in which both cooked and raw food materials are stored in appropriate conditions for future use without entry or multiplication of pests and microorganisms. The ultimate role of storage technology is to devise methods by which deterioration of stored foods is restricted as much as possible during the period between harvest and end-use. According to Weiss (1983), this requires a thorough understanding of the structure, composition, biochemistry and physiology of the commodity as storage technologists will be mainly concerned with the slowing down of the rate of metabolism without abnormal events.

Groundnut (*Arachis hypogaea* L.) is a leguminous crop and a member of the family Fabaceae. As shown in an earlier study (Anyasor, 2009), groundnut is an annual crop originating from South America. It is a herbaceous plant of which there are different varieties such as Boro light, Boro red, Mokwa, Kampala, Guta and Ela, According to Olayinka *et al.* (2013) and Nigam (2014), it is locally called Epa in Yoruba, Ayayaa in Hausa and Okpa in Ibo. As shown in an earlier study (Bansal *et al.*, 1993) and Campos-monodragon *et al*. (2009), groundnut is now grown worldwide in the tropical and temperate regions primarily as an oilseed crop. China, USA and India are the main producers of groundnut to the rest of the world. It is originally considered to be food for animals and hence it is used as food for slaves. According to Singh and Singh (1991), it has now become an important source of protein for humans and animals in many developing countries of the world.

According to Atasie *et al.* (2009), the nutritional value is high as the groundnut is affordable and serves as a good source of oil and protein. As shown in an earlier study (Asibu, 2008), groundnut is a rich source of fat ranging from 36 to 54 %. According to Jennette (2003), it is an energy-rich food, providing a valuable supply of vitamins, mineral salts and dietary fibre. As shown in an earlier study (Prasad *et al*., 2009), the extracted oil can be used for cooking, for margarine, vegetable ghee, salad for deep-frying, for shortening in pastries and bread, The cake produced from groundnut after the extraction of the oil can be used as a feed supplement for live-stocks, as fertilizer and for preparation of kuli kuli and donkwa in Nigeria. Groundnut can also be processed into yaji (roasted meat pepper), Sisipelebe or Gudigudi, groundnut chin-chin, kulikuli, roaste groundnut, boiled groundnut and groundnut soup (Obeepa-yoruba Nkatieenkuwn-Ibo, Miyanyakuwa-Hausa, Omiisagwe-Benin) (Olayinka *et al.*, 2013). According to Alper and mattes (2003), the US food and drug administration reported in the year 2003 that scientific evidence suggests that eating 1.5 Ounces (43g) per day of most nuts (including peanuts), as part of a diet low in saturated fat and cholesterol, may reduce the risk of heart diseases. This present study aimed at verifying the effects of processing methods on proximate constituents of groundnut seeds during the storage period.

Materials and Methods

Experimental site

The research work was carried out in the Plant Science and Biotechnology Laboratory, Ekiti State University, Ado Ekiti, Ekiti State Nigeria.

Collection and processing of groundnut seeds

Matured pods of groundnut were bought at Oba market, Ado Ekiti, Ekiti State, Nigeria. The pods were split opened to remove the seeds, which were subsequently packed into a polythene bag and taken to the Laboratory. The seeds were packed into a plastic container filled with boiled water and allowed to stand for 30 minutes. The seeds were thereafter removed from the water and seed coats were removed. Thereafter, the seeds were air-dried for 3 hours and were divided into five portions out of which four portions were subjected to the different processing methods. The seeds were stored for a period of 24 weeks

during which nutritional analysis was carried out every 6 week interval.

Drying methods

Oven drying method

Ten grams (10 g) of the first portion of the seeds was oven-dried at 60°C for 40 minutes. At end of 40 minutes, the seeds were removed and allowed to cool for a period of 6 h. The cooled seeds were transferred into a conical flask and covered in split cork for storage.

Smoking method

Exactly 10 g of the second portion of the groundnut seeds were air-dried for a period of 24 h. The seeds were placed on a local clay pot and a slow-burning fire was used to smoke it until properly dried. The smoked seeds were spread on a metal tray to facilitate cooling. The cooled seeds were transferred into a conical flask, covered with split cork for storage.

Sand frying method

Ten grams of the third portion was subjected to frying in 6 g of fine sand in a frying pan for 25 minutes with constant stirring. The seeds were allowed to cool. Thereafter, the seeds were separated from the sand, using a 5mm iron sieve. The cooled seeds were transferred into a conical flask and covered in split cork for storage.

Ash frying method

Ten grams (10 g) of the fourth portion was fried in 6 g of ash for 20 minutes with constant stirring. The seeds were allowed to cool for a period of 6 h after which the seeds were separated from the ash, using a 3 mm sieve. The cooled seeds were transferred into a conical flask and covered split cork for storage

Raw seeds

The fifth portion (control) was not subjected to any treatment. They were transferred into a conical flask and covered with split cork for storage.

Period of storage

The groundnut seeds were stored for a period of 24 weeks during which proximate analysis was conducted at 6 weeks interval to know the effect of storage on the proximate composition of the seeds.

Proximate analysis

The proximate analysis was carried out in triplicates using AOAC (2012) method.

Data Analysis

The experimental results were analysed by one-way analysis of variance (ANOVA) and the means were separated by Tukey`s multiple range test.

Results

Proximate composition of groundnut seeds 5 h after processing

Table 1 showed the proximate constituents of the processed and unprocessed groundnut seeds 5 h after processing. Moisture was highest (5.16 %) in the unprocessed (raw) seeds, followed by smoked (3.88 %). There were no significant differences in percentage moisture content in oven-fried, sand fried, and ash fried ground nut seeds. The percentage of crude fat was highest (49.27 %) in ash fried groundnut seeds, followed by the oven-dried, then smoked dried, raw and sand fried groundnut seeds. The percentage ash was highest (3.11 %) in raw groundnut seeds, followed by oven-dried, smoked and sand fried seeds with 2.72 %, 2.54 % and 2.12 % respectively. There was no significant difference between the smoked and ash fried groundnut seeds. Percentage carbohydrate was highest in the fresh sample, followed by sand fried, ash fried, oven-dried and smoked seeds with 16.35 %, 14.51 %, 13.90 %, 11.80 % and 9.74 % respectively. The percentage of crude fibre was highest in the sand fried sample, followed by ash fried, oven Fried, smoked and raw sample with 7.89 %, 5.47 %, 4.28 %, 3.57 % and 3.10 % respectively

Proximate composition of processed and unprocessed groundnut seeds by the 6th week Storage period.

Table 2 revealed the proximate constituents of the processed and unprocessed groundnut seeds by the six week storage period. The raw (unprocessed) seeds had the highest moisture (5. 12 %), followed by smoked seeds (4.24 %), oven-dried, sand fried and ash fried seeds with

3.58 %, 3.42 % and 3.15 % respectively. There was no significant difference in the moisture contents of oven-dried, sand fried and ash fried seeds. Ash content was highest in raw groundnut seeds (3.02 %), followed by oven-fried seeds (2.40 %), smoked seeds, sand fried and ash fried seeds with 2.30 %, 2.04 % and 2.10 % respectively. There was no significant difference in the ash content of oven-fried, smoked, sand-fried and ash seeds. Carbohydrate content was highest in raw groundnut seeds (16.40 %), followed by ash fried and sand fried (15.28% and 15.24 %) with no significant difference, and then oven-dried and smoke-dried respectively.

The highest crude protein was recorded in smoke-dried seeds (34.50 %), followed by raw seeds (27.12 %) and ash fried, sand fried and oven-dried seeds respectively. Fibre content was highest in oven-dried and sand fried seeds (7.75 % and 7.32 %) with no significant difference.

Proximate composition of processed and unprocessed groundnut seeds during 12th weeks storage period.

Table 3 showed the proximate constituents of the processed and unprocessed groundnut seeds by the 12th week storage period. Moisture content was highest (4.94 %) in raw groundnut seeds, followed by oven-dried, sand fried and smoked seeds (3.17 %, 3.12 % and 3.05 %) respectively, with no significant difference. The highest fat content was recorded in oven-dried and smoke-dried seeds (48.23 % and 48.11 %), with no significant difference, followed by raw and ash fried seeds. Ash was highest (2.22 %) in raw seeds, followed by oven-dried, while sand fried had the least (1.64 %). Carbohydrate was highest in raw groundnut seeds (16.40 %), followed by ash fried (15.52 %) and sand fried (15.25 %) seeds. There was no significant difference between the carbohydrate content of ash fried and sand fried seeds. The highest protein content was recorded in smoked seeds (27.92 %), followed by raw seeds (27.92 %). Significant differences exist among the crude fibre content.

Proximate composition of processed and unprocessed groundnut seeds by the 18th week storage period.

Table 4 showed the proximate constituents of the processed and unprocessed groundnut seeds by the 18 weeks storage period. The highest moisture (4.94 %) was recorded in raw seeds, followed by smoked dried, oven-fried and sand fried seeds with 3.92 %, 3.13 %and 3.11 % respectively. There was no significant difference between oven-dried, sand fried and smoked dried seeds. Crude fat was highest in oven-dried (49.53 %), followed by ash fried (48.50 %), sand-fried (48.30 %), smoke-dried seeds (48.18 %) and raw seeds (47.82 %) respectively. Ash content was highest (1.98 %) in oven fried and raw seeds (1.89 %) followed by sand fried and ash fried seeds with 1.43 % and 1.37 % respectively and with no significant difference. The raw seeds have the highest (16.75 %) carbohydrate, followed by ash fried (16.87 %) and sand fried (16.31 %), followed by oven fried (13.92 %) and smoked seeds (11.52 %). There was no significant difference between the carbohydrate in raw, and ash fried and sand fried seeds. Crude protein was highest (34.10 %) in smoke-dried seeds, followed by raw (28.19 %), ash fried (26.82 %) and oven-dried (24.75 %) seeds. The highest (6.91 %) crude fibre was recorded in oven-dried seeds, followed by sand fried (4.95 %), while the least (1.2 %) crude fibre was recorded in the raw and smoked seeds.

Table 1: Proximate composition of processed groundnut seeds after 5 h of processing.

Treatment	Parameter					
	% Moisture	% crude Fat	% ash	% Carbohydrate	% crude protein	% crude Fiber
Raw Seed	5.16±0.20a	46.22±1.10c	3.11±0.04a	16.35±0.83a	26.06±0.84b	3.10±0.13d
Oven Fried seed	3.88±0.61c	47.60±1.23b	2.72±0.02b	11.80±0.56d	23.72±0.78e	4.28±0.30c
Smoked Seed	4.44±0.12b	47.48±0.81b	2.54±0.12c`	9.74±0.65e	33.23±1.23a	3.57±0.08e
Sand fried Seed	3.80±0.55c	46.90±1.33c	2.12±0.31d	14.51±0.71b	24.78±1.01d	7.89±0.76a
Ash Fried Seed	3.73±0.32c	49.27±1.11a	2.42±0.03c	13.90±0.64c	25.21±0.93c	5.47±0.06b

Each value is the mean of 4 replicates. Means in each column followed by the same alphabet are not significantly different (p>0.05) by Tukey's test

Table 2: Proximate composition of processed groundnut seeds after 6 weeks of processing.

Treatment	Parameter					
	% Moisture	% crude Fat	% ash	% Carbohydrate	% crude protein	% crude Fiber
Raw Seed	5.12±0.31a	45.35±1.18c	3.02±0.12a	16.40±0.78a	27.12±0.82b	2.79±0.33c
Oven fried seed	3.58±0.06c	48.37±2.11a	2.40±0.14b	12.10±0.96c	23.85±0.99e	7.75±0.29a
Smoked Seed	4.24±0.07b	47.32±1.52b	2.30±0.36c	10.50±0.67d	34.50±1.03a	2.14±0.30c
Sand fried Seed	3.42±0.11c	44.80±1.43d	2.04±0.62c	15.24±0.54b	24.14±0.63d	7.32±0.09a
Ash Fried Seed	3.15±0.03c	48.20±1.86a	2.10±0.45c	15.28±0.66b	26.10±0.49c	5.17±0.53b

Each value is the mean of 4 replicates. Means in each column followed by the same alphabet are not significantly different (p>0.05) by Tukey's test

Table 3: Proximate composition of processed groundnut seeds after 12 weeks of processing.

Treatment	Parameter					
	% Moisture	% crude Fat	% ash	% Carbohydrate	% crude protein	% crude Fiber
Raw Seed	5.10±0.44a	46.32±1.33b	2.22±0.23a	16.44±0.77a	27.92±1.22b	1.68±0.34e
Oven fried seed	3.17±0.56b	48.23±1.23a	2.13±0.43b	13.59±0.65c	24.45±1.10d	6.43±0.37b
Smoked Seed	3.05±0.37b	48.11±1.50a	2.15±0.34b	11.12±0.50d	34.98±1.14a	2.59±0.23d
Sand fried Seed	3.12±0.07b	45.43±1.88c	1.64±0.14c	15.24±0.43b	25.36±1.12b	9.21±0.63a
Ash Fried Seed	2.98±0.77c	46.23±2.11b	1.82±0.32d	15.32±0.61b	26.42±0.91c	5.23±0.32c

Each value is the mean of 4 replicates. Means in each column followed by the same alphabet are not significantly different (p>0.05) by Tukey's test

Table 4: Proximate composition of processed groundnut seeds after 18 weeks of processing.

Treatment	Parameter					
	% Moisture	% crude Fat	% ash	% Carbohydrate	% crude protein	% crude Fibre
Raw Seed	4.94±0.23a	47.82±i.22c	1.89±0.24a	16.95±0.82a	28.19±0.93b	1.21±0.34c
Oven fried seed	3.13±0.53b	49.53±1.21b	1.98±0.15a	13.92±0.47c	24.75±0.79e	6.91±0.38a
Smoked Seed	3.92±0.65b	48.18±1.15b	1.94±0.23a	11.52±0.68d	34.10±1.21a	1.34±0.41c
Sand fried Seed	3.11±0.15b	48.30±1.23d	1.43±0.34b	16.31±0.91a	25.90±1.12d	4.95±0.49b
Ash Fried Seed	2.83±0.33c	48.50±1.04b	1.37±0.34b	16.87±0.71a	26.82±1.06c	3.61±0.71c

Each value is the mean of 4 replicates. Means in each column followed by the same alphabet are not significantly different (p>0.05) by Tukey's test

Table 5: Proximate composition of processed groundnut seeds after 24 weeks of processing

Treatment	Parameter					
	% Moisture	% crude Fat	% ash	% Carbohydrate	% crude protein	% crude Fibre
Raw Seed	3.61±0.40a	48.08±1.34b	1.72±0.15a	17.78±0.53a	28.79±1.23b	1.64±0.52d
Oven fried seed	3.03±0.23b	49.94±1.08a	1.28±0.20b	14.22±0.44b	24.80±1.14d	6.92±0.48a
Smoked Seed	2.10±0.18c	48.85±1.12b	1.02±0.31b	11.85±0.48c	35.28±1.21a	1.64±0.51d
Sand fried Seed	3.04±0.34b	46.72±1.24c	1.10±0.28b	17.74±0.64a	26.50±1.08c	4.92±0.72c
Ash Fried Seed	2.75±0.32d	46.62±1.13c	1.12±0.14b	17.41±0.51a	26.98±1.13c	5.12s±0.69b

Each value is the mean of 4 replicates. Means in each column followed by the same alphabet are not significantly different (p>0.05) by Tukey's test.

Proximate composition of processed and unprocessed groundnut seeds by the 24th week storage period.

Table 5 showed the proximate constituents of processed and unprocessed groundnut seeds by the 24th week storage period. Moisture was highest (3.61 %) in raw seeds seed, followed by sand fried, oven-dried, ash fried, and smoked seeds (3.04 % and 3.03 %, 2.75 % and 2.10 %) respectively. There was no significant difference between moisture content in oven-dried and sand fried seeds and smoked and ash fried seeds. The highest (49.94 %) crude fat was recorded in oven-dried seeds, followed by smoked, raw, sand-fried and ash fried seeds with 48.85 %, 48.08 %, 46.72 % and 46.62 % respectively. There was no significant difference between the crude fat in sand fried and ash fried seed. Ash was highest (1.72 %) in raw seeds. There was no significant difference in the ash content of other processing methods. Carbohydrate was highest (17.78 %) in raw seeds. There was no significant difference between the carbohydrate content in raw, sand fried and ash fried seeds. Smoked

seeds have the least carbohydrate content. Crude protein was highest(28.79 %) in smoked seeds, followed by raw (35.28 %). The least crude protein was recorded in oven-dried seeds.

Discussion

This present research focused on the effects of processing methods on the storage of groundnut seeds. Chemical changes occur in food when stored. According to Odeyemi and Daramola (2000), the physical and chemical properties of a food commodity determine primarily the quality attribute of the food in storage and that the properties are displayed as a measure of quality.

It was observed that the different processing methods and the period of storage affected the proximate constituents of groundnut seeds. The results obtained on moisture and ash contents are similar to the one obtained by Tobin *et al.* (2018), in which processing reduced the moisture and ash contents in ground seeds. As shown in the earlier study (Ayoola *et al.,* 2012), the low moisture content in the processed groundnut seeds makes the shelf life longer and thus, prevent rancidity of the oil, The high ash content in the raw seed showed that it contains more mineral nutrients than the processed ones.

The different processing methods led to an increase in the carbohydrate, crude fat and crude protein content for the period of 24 weeks of storage. The moisture content of both the processed and unprocessed seeds decreased upon the period of storage and low moisture content hampers the survival of spoilage organisms, according to (Tripathi and Mishra, 2009). Hence, the processing methods and period of storage had caused a reduction in the moisture and therefore prevented spoilage. This shows that groundnut seeds should undergo some period of drying in order to prevent too much moisture and hence prevent the growth of fungi and bacteria which are capable of causing spoilage. The high crude protein in the smoked seeds can be attributed to the proliferation of microorganisms that degrade the protein and this may cause the re-arrangement of the nutritional composition of the substrate to the amino acid, as shown in the earlier study (Cherry, 1983). According to Ayoola *et al*. (2012), the crude fibre content increased during the period of storage. The crude fibre was found to be more in the processed groundnut seeds. The presence of crude fibre indicates its ability to aid digestibility in humans,

Conclusion

The roles of the different processing methods cannot be overemphasized because they all caused a reduction in the moisture content, hence preventing the spoilage of the seeds. They also play vital roles in retaining the nutrient composition of the seeds. Smoke drying is the best processing method because the smoke-dried groundnut seeds, apart from having the lowest moisture, still contain the highest quantity of protein.

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