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NUTRITIONAL AND STORAGE RESPONSES OF GROUNDNUT SEEDS TO VARIOUS PROCESSING METHODS

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Abstract:
This study evaluated the impact of different processing methods on the nutritional composition and shelf life of groundnut (Arachis hypogaea) seeds. Conducted in the Department of Crop and Soil Science laboratory, the experiment involved five treatments: oil frying, sand frying, oven drying, smoking (with shells), and a raw control, using a completely randomized design (CRD). Proximate analysis showed that processing significantly reduced moisture and ash content while enhancing fat, protein, and carbohydrate levels after 8 hours. During a 24-week storage period, moisture and ash content progressively increased across all treatments, indicating higher susceptibility to microbial spoilage. Carbohydrate content of oil-fried seeds notably increased from 8.91% to 10.53%, reflecting enhanced energy value. Although fat, protein, and carbohydrate contents declined over time in most treatments, oil-fried seeds retained higher nutrient levels at the end of the storage period. Among the methods tested, oil frying was the most effective in preserving nutritional quality and reducing moisture content, which is crucial for extending shelf life. The results suggest that while processing improves the nutritional profile of groundnut seeds, storage duration should be minimized to maintain nutrient stability.

Keywords: *Groundnut, Processing methods, Nutritional quality, Shelf life*

Introduction

Groundnut, a member of the family *Fabaceae* is an annual legume crop originated from South America. It is commonly called pistache in French, mani in Spanish, amondoim in Portuguese, ying zui dou in Chinese, ful suldani in Arabic. The local names of groundnut in the major ethnic groups in Nigeria are epa (Yoruba), okpa (ibo) and ayayaa (Hausa) (Nigam 2014; Olayinka *et al.,* 2013).

The crop is an upright or prostrate plant distributed in the tropical, sub-tropical and warm temperate zones. In Nigeria, it is mainly grown in the northern part of Nigeria (Kano, Kaduna, Taraba, Bauchi, Borno, Adamawa states) (Abalu and Harkness, 1979). Groundnut is primarily cultivated in areas of the world between 40 °N and 40°S, growing 30–50 cm tall and grows best in light sandy loam soil and needs warm weather throughout the growing season but can grow with as little as 350 mm of water and best yields needs at least 500mm (Subrahmanyam *et al.,* 1992). It is the 6th most important source of edible oil and the 3rd most important source of vegetable protein (Nigam, 2014). The biochemical composition of groundnut per 100g edible portion as stated by USDA (2010) constitute moisture (6.5g), carbohydrate (16.1g), lipids (49.2g), protein (25.8g), dietary fibre (8.5g), magnesium (168mg), phosphorus (376mg) and iron (4.6mg).

However, Peanut seeds are eaten raw, boiled or roasted or used in preparation of peanut sauce mixed with onions, garlic, vegetables for vegetarians, for preparation of maafe (meat stew) in Mali, for preparation of nkate nkwan (peanut butter soup) in Ghana, peanut powder is also an important

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ingredient in the spicy coating of kebab in both Nigeria and Ghana; it is used in making biodiesel fuel, laxatives, dye, shampoo, insecticides, glue and explosives. The extracted oil can be used for cooking, for margarine, vegetable ghee, salads, for deep-frying, for shortening in pastries and bread (Prasad *et al.,* 2009). The cake produced from groundnut after extraction of oil can be used as feed supplement for livestock, as fertilizer and for the preparation of kulikuli and donkwa (traditional recipe in Nigeria). Groundnut can also be processed into Yaji (roasted meat pepper), Sisipelebe or Gudigudi, Donkwa, Kunungeda, groundnut chin-chin, kulikuli, roasted groundnut, boiled groundnut and groundnut soup (Obeepa-Yoruba, Nkatieenkuwn-Ibo, Miyanyakuwa-Hausa, Omiisagwe-Benin) (Olayinka *et al.,* 2013). Groundnut has good digestibility in both raw and roasted forms of consumption and the energy value is generally slightly higher in the roasted form than the raw form (Nagaraj, 1988). Ayoola and Adeyeye, (2010) have analyzed the groundnut seeds (raw, sun-dried and roasted) for proximate composition and some nutritionally valuable minerals and found that the roasted groundnut can be considered as a good source of valuable minerals, while the raw groundnut is a good source of protein with high nutrition value.

Consequently, Marotz (2008) stated that shelled peanuts are stored in tightly sealed containers in the refrigerator since excess exposure to heat; humidity or light will cause them to become rancid. Marotz (2008) further stated that unshelled nuts keep longer than shelled nuts. Indeed, groundnut can be processed in various forms for human consumption but information on the effect of different processing methods on the nutritional content and shelf life of the groundnut seeds is scarce, hence the need to bring to light the possible effect of processing on the nutritional content of the seeds and the effect of storage life on the processed seeds.

Materials and Methods

2.1 Experimental site

The experiment was carried out at the laboratory of Crop Science, Faculty of Agriculture, Niger Delta University, Amassoma, Bayelsa State.

2.2 Collection of Experimental materials and seed sorting

Groundnut seeds were procured from the Bayelsa State Agricultural Development (ADP), Yenagoa. The variety used was Samuru-38. The treatments used are Oil fried seeds, Oven treated (fried) seeds, Sand fried seeds, Smoked with seeds inside shell and raw seeds (control).

2.3 Methods of processing the groundnut seeds

2.3.1 Oil Fried method

In this method, 4kg of raw groundnut seeds was weighed into a 10 liter plastic container and 4 liters of boiling water was added into the content. Thereafter, 40g of table salt (NaCl) was sprinkled on the content for improved taste, which was stirred for 20 seconds with a wooden spatula in order to mix the salt thoroughly. After stirring, the content was covered with a lid and allowed to stand for 30 minutes. At the end of this period, the water was drained out and the seeds were transferred into a tray where hands were used to peel off the seed coats from the seeds.

These coatless seeds were then fried in 1 liter of well-refined boiling groundnut oil for 15 minutes and transferred from the boiling oil into a 5mm iron sieve where the oil was allowed to drain out from the seeds. Completely drained seeds were transferred into a tray padded with soft napkin cloth to mop off any oil left on the seeds. Mopping off the oil lasted for 2 minutes after which the seeds were allowed to cool, transferred into a 75cl bottle, and covered with a tight cork for storage.

2.3.2 Sand fried method

In this method, 4kg of raw groundnut seeds were weighed into a 10 liter plastic container and 4 liter of cold water was added into the content and allowed to stand for 20 minutes. At the expiration of this time, the water was poured out and 30g of table salt (NaCl) was sprinkled on the seeds and rubbed in until the seeds absorbed the salt. These seeds so salted were air dried for two hours and fried in 5kg of fine river sand in iron pots for 30 minutes with constant stirring. Properly fried seeds together with the

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sand were removed from the pot, sieved in a 5mm iron sieve, allowed to cool, transferred into a 75cl bottle and covered with a tight cork for storage.

2.3.3 Oven treated methods

This method is similar to that of sand fried; the only difference was that while sand fried used heated sand to fry seeds with local firewood, gas cooker or kerosene stove, oven treated involved placing the salted seeds in the oven ant the temperature regulated to 80^{o}C for 20 minutes. At the end of the regulated time, the seeds were removed, allowed to cool, transferred into a 75cl bottle and covered with a tight cork for storage.

2.3.4 Smoked with seeds inside shell

This method of processing does not involve shelling the seeds. Here, 4kg of unshelled pods were boiled in 6 liters of water for one hour and 60g of table salt was added to the boiling content. After boiling, the pods were sieved out with a 5mm sieve and the water allowed draining off. The pods were placed on a local altar and fire was used to smoke the pods to dryness for 24 hours. Properly dried pods were allowed to cool and kept in tightly covered 75cl bottles for storage.

2.4 Methods of groundnut seed storage

Variously processed seeds and raw seeds were stored in glass bottles of 75cl capacity. Before storage, each bottle was washed thoroughly with detergent and sterilized in the oven at 65^{o}C for 15 minutes. After sterilization, the bottles were allowed to cool before the seeds were stored in them. The processed and unprocessed seeds were tested every 8th week to know the effect of the storage on the proximate composition of the seeds.

2.5 Proximate analysis

Proximate composition of the variously processed and raw groundnut seeds were carried out in triplicates to test the moisture content, fat, crude protein, ash and carbohydrate percentages using AOAC (2012) methods.

2.6 Experimental Design and Statistical techniques

The experimental design used in this research is Complete Randomization Design and the treatments were replicated thrice. Analysis of variance (ANOVA) was used to determine the treatment effects and means were tested using Least Significance Difference (LSD) at 5% level of probability (Wahua, 1999).

Results

The result on the proximate composition of the freshly processed and unprocessed groundnut seeds as shown in Table 1 identified high moisture and ash content in the unprocessed (raw) groundnut seeds than the processed groundnut seeds. For fat content, oil fried seeds had the highest content with a mean value of 55.73% followed by oven fried seeds (52.91%) and the lowest was sand fried seeds (47.05%). Seeds processed with fine sand were high in carbohydrate content but low in fat and protein content when compared with the other processed and unprocessed seed while smoked with seeds in shell was high in protein content but very low in carbohydrate content. Oil fried seeds had high fat content but were very low in moisture and ash content. There was significant difference between the processed (oil fried, oven heated, sand fried, smoked with seeds in shell) and the unprocessed (raw) groundnut seeds in protein, fat, carbohydrate and moisture content but indifference significant in ash content. Smoked with seeds in shell seeds had the highest protein content and the lowest was sand fried seeds.

The duration of storage were found to affect the proximate composition of both the processed and unprocessed groundnut seeds as seen in tables 2, 3, 4. The moisture and ash content increased upon storage while there was reduction of fat, carbohydrate and protein contents of the groundnut seeds but oil fried seeds increased in protein content under storage conditions from 24.55-26.34%. Also, oil fried increased in carbohydrate (CHO) content in sixteenth and twenty fourth weeks of storage period. There was significant increase in moisture content in twenty-fourth weeks from 5.19-5.65% in raw seeds, 2.02-2.78% in oil fried seeds, 3.58-3.93% in sand fried seeds, 4.20-4.51% in smoked with seeds in shell seeds, 3.05-4.54% in oven fried seeds; ash increased from 2.24-2.69% in oil fried seeds, 2.72-3.68% in raw

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seeds,2.68-3.89% in sand fried seeds, 2.40-3.33% in smoked with seeds in shell seeds and 2.60-3.84% in oven fried seeds respectively. However, a reduction was observed in carbohydrate, fat and protein contents of the variously processed and raw seeds.

Table 1: Proximate composition of the variously processed groundnut seeds (8 hours after processing)

Treatment	Properties				
	% Moisture	% Fat	% Ash	% CHO	% Protein
Raw seeds	5.19	47.74	2.72	13.45	24.04
Oil fried seeds	2.02	55.73	2.24	8.91	24.55
Sand fried seeds	3.58	46.59	2.68	13.63	23.25
Smoked seeds	4.20	47.05	2.40	8.49	29.21
Oven Fried Seeds	3.05	52.91	2.60	10.38	23.51
LSD (0.05)	0.18	0.43	0.23	0.25	0.21

Table 2: Proximate composition of the variously processed groundnut seeds (8 weeks after processing)

Treatment	Properties				
	% Moisture	% Fat	% Ash	% CHO	% Protein
Raw seeds	5.22	46.30	3.43	13.41	23.77
Oil fried seeds	2.34	53.11	2.33	8.26	25.48
Sand fried seeds	3.70	46.44	3.33	13.57	22.39
Smoked seeds	4.48	46.72	2.76	8.40	24.35
Oven Fried Seeds	3.51	51.00	3.25	10.40	20.43
LSD (0.05)	0.15	1.48	0.12	0.26	0.29

Table 3: Proximate composition of the variously processed groundnut seeds (16 weeks after processing)

Treatment	Properties				
	% Moisture	% Fat	% Ash	% CHO	% Protein
Raw seeds	5.42	42.85	3.55	13.14	23.09
Oil fried seeds	2.77	49.68	2.39	9.15	25.68
Sand fried seeds	3.77	42.63	3.67	12.60	21.32
Smoked seeds	4.49	46.09	3.18	7.58	23.32
Oven Fried Seeds	4.07	46.77	3.54	8.36	19.45
LSD (0.05)	0.11	0.36	0.10	0.20	0.26

Table 4: Proximate composition of the variously processed groundnut seeds (24 weeks after processing)

Treatment	Properties				
	% Moisture	% Fat	% Ash	% CHO	% Protein

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Raw seeds	5.65	42.59	3.68	12.40	22.24
Oil fried seeds	2.78	50.33	2.69	10.53	26.34
Sand fried seeds	3.93	40.42	3.89	10.45	20.39
Smoked seeds	4.51	43.08	3.33	7.52	23.25
Oven Fried Seeds	4.54	43.60	3.84	7.97	17.70
LSD (0.05)	0.12	0.23	0.12	0.18	0.23

Discussion

Groundnut being a nutritional plant is processed in various forms and stored under different environmental conditions and these methods of processing tends to increase or reduce the storability of the seeds. This research revealed that processing reduced the moisture and ash content of groundnut seeds in 8hrs after processing. Smoked with seeds in shell were high in protein and moisture but low in carbohydrate and this increase in protein content is due to the protection rendered by the shell in the cause of processing but the method of processing (heat) reduced the protein content of oven fried and sand fried seeds. Oven fried method reduced the moisture, ash and carbohydrate content of the seeds but increased the fat content when compared with raw groundnut seeds. Similarly, Sand frying method increase the carbohydrate (CHO) content but reduced ash, moisture, protein and fat percentage of the groundnut seeds. The high moisture content in smoked seeds with shell makes it easily for microbial survival. However, the moisture content of the processed and unprocessed groundnut seeds increased upon storage and this high moisture content aids the survival and growth of microorganisms (Tripathi and Mishra, 2009). The ash content also increased after eight weeks of storage while there was reduction in the protein, fat and carbohydrate levels as storage period progressed. The decrease in fat content was also reported by Amadioha (1998) in potato tubers may be attributed to the lipolytic activities of fungi. Oil fried seeds increased in protein, carbohydrate and fat after 24 weeks of storage and this finding corroborated with Tripathi and Mishra (2009) who reported increase in protein content in red chilli powder stored 30 days and findings from Fagbohun and Faleye (2012a) reported increase in carbohydrate (CHO) after 16 weeks of storage. This increase in protein is due to the proliferation of microorganisms which degrade protein and this may cause rearrangement of nutritional composition of the substrate to amino acids (Cherry, 1983). Sand fried, Oven fried, raw and smoked seeds recorded reduced carbohydrate level and may be attributed to hydrolytic breakdown of carbohydrate to simple sugar. Although, oil fried seeds increased in carbohydrate in sixteenth week and twenty-fourth weeks and this may be as a result of the presence of microorganisms which release metabolites that inhibit the growth of organisms capable of metabolizing carbohydrates (Apinis, 1971; Short and Lacy, 1976). Also, groundnut seeds should not be store for too long to avoid depletion of nutrients because the longer a seed is stored the lower the nutritional content and exposure to microorganism's invasion.

Conclusion

This study revealed that processing methods greatly affect the nutritive content of groundnut seeds as there was decrease in the moisture and ash content of the seeds after undergoing various forms of processing but increase in fat content (oil fried and oven fried seeds), in carbohydrate (sand fried seeds) and protein content (oil fried seeds and smoked seeds with shell). Oil fried method is the best method of processing as it has reasonable amount of fat, carbohydrate and protein but low in moisture content. This low moisture content causes the inability of storage microorganisms from depleting the nutrients of the seeds. Therefore, seeds should not be stored for too long in order to attain the best nutritive value of the seeds either processed or unprocessed.

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