THE EFFECTS OF STORAGE ON THE NUTRITIONAL QUALITIES OF PEANUT BUTTER

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ABSTRACT

Peanut butter is a popular health and nutritious staple food across the world. After the various stages of production, the peanut butter was package in high density polythene films and glass jars which were then stored for the period of three months to compare best preferred storage medium. Proximate analysis were carried out on the peanut butter samples to quantify some of the nutritional parameters which includes moisture content, fats, protein, ash and fiber, at a regular interval of one month for the storage period of three months. The colour and taste of the peanut butter were some of the method used to assess the stored products, questionnaires were also used to access these and other parameters considered and the results subjected to statistical analysis using the chi-square method. The changes in the nutritional parameters were quantified at a monthly interval throughout the storage period. At the end of the storage period it was noted that the peanut butter sample made with skin stored in high density polythene films had high nutrients retention capacity and showed less change in taste and colour.

Keywords: *Blanching, Colour, Drying, Grinding, Skin, Sorting, Taste, Roast*

INTRODUCTION

The leguminosae family is divided into three subfamilies of Ceasalpinioideae, Mimosoideae and the third and largest being the Papilionoidea. The members of this subfamily are shrubs and herbs which have characteristics flower resembling the flower of sweet peas. The flower gives rise to pods which contain one or several seeds, depending on the species and environmental conditions (Bishop et. al., 1982). Shelled peanuts are generally available in pre-packaged containers as well as bulk bins. Just as with any other food that may purchase in the bulk section, but for the by-products most of them are not found on shelves of store as they are known to have a short storage period thus reducing the shelf life.

To have the maximum freshness of these by-products, good storage media needs to be employed. When purchasing peanuts in bulk or in a packaged container, it is important that there should not be any evidence of moisture or insect damage. Whole peanuts still in their shell are usually available in bags or in the bulk bins.

Peanut is an important industrial and oil seed crop in Nigeria. It is grown both for domestic market and for export. While peanut is grown mainly for oil production and export in high income areas it is grown primarily as food crop in other areas of Nigeria. Popular not only as a source of protein and vegetable oil, peanut is also valued for the food and medicine industry. The domesticated peanuts in Nigeria are amphidiploids or allotetraploid, meaning that they have two

sets of chromosomes of two different species. The wild ancestors of the peanuts were thought to be Arachis duramensis and Arachis ipaensis. A view recently confirmed by direct comparison of peanuts' chromosomes with those of several putative ancestors (Omokanye et. al., 2001; Izge et. al., 2007).

The leaves are opposite pinnate with four leaflets (two opposite pair, no terminal leaflet), each leaflets is between 1 to 7cm in length and up to 3cm in width. After pollination, the fruit develops into a legume of 3 to 7cm in length containing 1 to 4 seeds, which forces its way underground to mature (Wikipedia, 2008). According to peanut butter lovers (2008), the plant grows to a height of 30 to 70cm and spreads 1m. Some others develop to form a bunchy erect growth; others are called runners and they spread over the ground. The plant has deep taproots, with numerous lateral roots, and if properly inoculated many nodules will form. Usually the flowers are self pollinated, the peg, a stalk like structure that is technically referred to as gynophores grows downward into the soil, pushing ovary tip beneath the soil where pods develop.

The primary use of peanut butter is in the home, but large quantities are also used in commercial manufacture of sandwiches, candy, and bakery products. Peanut oil is often used in cooking, because it has a mild flavour and burns at a relatively high temperature. Under the name "Plumpy's nuts" 100g or two small sachets of peanut butter per day are given by World Health Organization as a surviving base to many African children as there is a growing need for the consumption of protein which is gradually becoming scarce in most developing countries (Singh, 1992). Peanut seeds are also used in the manufacture of lactose, milk called peanut milk. Other industrial uses of peanut includes production of Paints, Vanish, Lubrication oil, leather dressings, furniture polish, insecticides, nitro-glycerine soap and cosmetics contain peanut oil and its derivatives and protein portion of the oil is used in manufacture of some textile fibres (Frater, 2009). Sulankhe (1989) reported that peanuts and its derivatives can be used in the manufacture of protein concentrates which are used in production of beverages, ice cream, candy etc.

Over the years in Nigeria, storage of locally prepared peanut butter has been a problem as local producers of this product cannot store them beyond a particular period of time and during this process losing its major nutrients. Thus this study is to access the effects of storage on the nutritional qualities of peanut butter and also proffer the best storage method for this product.
The objectives of this study are to determine the nutritional qualities and to ascertain the effect of storage on the nutritional qualities of peanut butter.

MATERIALS AND METHODS

A 3.8kg of fresh peanuts was immersed in a water container of 12 litre capacity; they were rubbed against each other thoroughly by hands. This process was repeated twice to ensure that all the clod and stuck sands were removed from the peanut shells. The peanuts were placed in a basket to allow water drain off the seeds which was later sundried.

The cleaned fresh peanuts were placed on big circular trays and then placed in an oven dryer (105oC) for a period of 20 hours. This drying process is to remove or reduce the moisture content of the peanuts to about 5%. The peanuts were shelled manually by hand to remove the seeds and carefully sorted to separate the good ones from the bad ones.
Desrosier and Desrosier (2004) said that the roasting process of the good seeds was

carried out using an oven roaster. 0.9kg cleaned, shelled and sorted fresh peanuts were arranged on a large round tray to increase its drying surface area and then placed in the oven (125oC) for 2 hours. The roasted peanuts were placed in an aluminium rice washer and placed on top of a pot of boiling brine solution for 5 minutes to soften the skin. This timing is because if the boiling of the peanuts is less the skin will not soften and if more than then the seeds become too soft for the skin to be removed. The peanuts were divided into two portions; the first portion was left with its skins intact while the skins of the second portion were removed. The kernels of the steamed seeds were then sun dried again to reduce the moisture gained during blanching.

Desrosier and Desrosier. (2004) further stated that the portion of the peanuts without skins were ground by the use of crush mill and collected in a container. 12g of the peanut paste was placed inside the cup of a blender and 8g salt was added. The mixture was blended for about 3 to 4 minutes until desired consistency was reached. 5g of the oil was added during grinding to aid in reaching the desirable consistency and to increase the spread ability of the peanut butter, this procedure was repeated for the second portion (with skin). 0.09kg of the peanut butter was packaged in high density polythene bags (HDPB) and glass jars and each was in turn placed in another polythene films, this was sealed using a sealing machine with air space in them. Another 0.09kg were put in each of the glass jars without covers and stored on a shelf at room temperature and with controllable light. The nutritional qualities of the peanut butter were checked at monthly intervals from the production date.

The Association of Official Analytical Chemistry (AOAC) (1984) was used to determine the moisture content; the soxhlet extraction method was used to determine the fat content while the methods described by Ibitoye (2005) were used to determine the dietary fibre and the total ash contents of the peanut paste. The Kjeldahl extraction method was used to determine the protein content.

The data collected were analysed using the Chisquare method,

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where O is the observed value for each sample and E is the corresponding expected value.

RESULTS AND DISCUSSION

The moisture and fibre contents of the paste prepared from the peanuts with skin (P01) were higher than that prepared without the skins (P02). This difference was due to the varying roasting stages of the peanuts before being made into a paste (Desrosier and Desrosier, 2004). The result of the proximate analysis of the peanut butter immediately after storage for the first one month for the storage period is presented in Table 1.

Table 1 Nutritional Analysis of Peanut Butter Immediately After Production

Sample	Moisture content		Ash		Fibre		Protein		Fats	
	%	G	%	g	%	G	%	g	%	g
P_{01}	2.73	2.46	4.02	3.62	2.14	1.92	22.62	20.13	32.67	29.41
P_{02}	2.98	2.68	4.00	3.60	2.15	1.94	21.67	19.51	38.27	34.42

Where P01 is the peanut butter made with skins and P02 is the peanut butter made without at the initial month of the study.

It was observed from Table 2 that P11 and P12 (with and without skins respectively) are almost of the same nutritional composition, except for the fat contents of P12 which was higher than P11, P13 has less qualities of all the nutrients considered but was higher in moisture content than both P11 and P12. From the results of the proximate analysis, it could be seen that the peanut butter underwent some changes in its composition within the time of storage. P13 was stored in an open glass jar; this ascertained the effects of air on peanut butter and measured the difference with the packed samples which showed less quantity of nutrients than both P11 and P12. The difference in the nutritional qualities of the samples varied P13 showing higher values in moisture and fibre content followed by P12. The protein and ash contents increased to almost 50% of the initial content, thus proving that fermentation took place in the peanut butter during the period of storage (Food Science Central, 2008).

Table 2 Nutritional Parameters of the Peanut Butter after One Month of Storage

Sample	Moisture content		Ash		Fibre		Protein		Fats	
	%	G	%	g	%	G	%	g	%	g
P_{11}	3.71	3.32	7.00	6.30	2.67	2.41	48.61	43.75	35.00	31.50
P_{12}	3.71	3.32	7.00	6.30	2.67	2.41	48.61	43.75	38.67	34.80
P_{13}	5.00	4.50	6.50	5.87	4.00	3.60	42.78	38.50	27.50	24.75

Where P11 is the peanut butter made with skins stored in HDPE, P12 is the peanut butter made without skins stored in HDPE and P13 is the control stored in glass jar at the end of one month. Table 3 shows that P23 was richer in fibre and moisture content, while P21 has higher fats and protein contents thus P12 has a higher nutrient retention capacity. Some changes were observed from the initial nutritional composition of the peanut butter. P12 has a greater strength to withstand rapid fermentation of it constituents, which may be due to the presence of its skin as it contain more antioxidants while P23 has higher transformation of its constituents due to the contact with atmosphere air.

Table 3 Nutritional Parameters of the Peanut Butter after Two Month of Storage Period

Sample	Moisture content		Ash		Fibre		Protein		Fats	
	%	g	%	g	%	G	%	g	%	g
P_{21}	3.91	3.52	4.22	3.80	2.58	2.32	43.11	38.80	43.33	39.00
P_{22}	4.02	3.62	2.36	2.12	1.88	1.70	40.56	36.50	38.67	34.80
P_{23}	5.90	5.31	1.83	1.65	3.33	3.00	38.89	35.50	35.50	31.95

Where P21 is the peanut butter made with skins stored in HDPE, P22 is the peanut butter made without skins stored in HDPE and P23 is the control stored in glass jar at the end of two months. The nutritional content of P31 in Table 4 was higher than P32 with exception to moisture content; this shows that P31 maintained its increase in all the quantified nutrients, while there was decrease in some of the nutrients in P32 and P33. These decreases went below the initial content in some nutrients including ash of P33. Though there were decrease in all the samples but P31 showed minimum of these changes.

The nutritional parameters considered for this study were moisture content, Ash, fibre, protein and fats.

Table 4 Nutritional Parameters of the Peanut Butter after Three Month of Storage period

Sample	Moisture content		Ash		Fibre		Protein		Fats	
	%	g	%	g	%	G	%	g	%	G
P_{31}	3.91	3.52	4.00	3.60	2.42	2.18	42.22	38.00	44.80	40.32
P_{32}	4.21	3.79	2.32	2.09	1.67	1.50	39.44	35.50	36.78	33.10
P_{33}	6.07	5.46	1.80	1.62	3.15	2.84	35.61	32.05	27.50	24.75

Where P31 is the peanut butter made with skins stored in HDPE, P32 is the peanut butter made without skins stored in HDPE and P33 control stored glass jar at the end of the third month.

MOISTURE CONTENT

The peanut butter made without skins (Table 4) recorded about 24.63% increase in moisture content within the first month of storage while, the peanut butter with skins recorded 35.77% increase, which was higher than that produced without skins. The control recorded an increase of 45.33% these increase continued to appreciate with time of storage. After two months of storage, the moisture content of the peanut butter made with skins increased with about 43.09%, without skins recorded 35.07% increase and 98.13% increase of the initial moisture contents of the samples. After three months storage period, almost all the samples recorded increase in moisture content, except for those produced with skins, which recorded no increase during the last month of storage. The peanut butter made without skins had recorded 41.42% increase while the control sample had an increase of 103.73%, even greater than the initial moisture content of the peanut butter.

ASH

Table 4 shows 74.15%, 75.14% and 66.22% as the increase in ash content for peanut butter sample made with skins, without skin and control respectively after one month of storage. At the end of 2 months of storage, the ash content reduced to below the initial content of 7.95%, 10% and 53.14% decrease for samples with skin, without skin and control respectively. The control sample stored in glass jars showed higher degree in the ash content reduction then followed by the sample made without skins.

After three months of storage, the peanut butter sample made with skins recorded an increase of 2.27% of initial content, which showed a decrease when compared with the results from the second month of storage. The sample made without skins and control sample recorded higher degree of decrease in ash content of 40.29 and 50.29% below the initial content respectively. This shows that the peanut butter made with skins has higher retention capacity for ash. This may be due to the presence of antioxidants inherent in the skins (Desrosier and Desrosier, 2004; Wikipeadia, 2008).

DIETARY FIBRE

Tables 1 to 4 above shows the change in dietary fibre content of the peanut butter samples at different storage periods. At the initial state the peanut butter sample made without skins contained higher amount of dietary fibre than that produced with skins. After one month of storage, the control sample had a higher fibre content of 3.6g which recorded 85.77% increase of the initial content of 1.94g. Dietary fibre content of the samples made with and without skins increased to 2.41g and 2.41g which reordered 25.52% and 25.52% respectively. This shows that air content of the peanut butter had highly influenced the fibre transformation in the control sample of the peanut butter. At the end of the second month of storage, the sample made with skins and control sample had an increase in dietary fibre content from 1.92g and 1.94g to 2.32g and 3.00g which represents 20.83% and 54.64% of its initial contents respectively while the peanut butter sample made without skins recorded 12.89% decrease of its initial fibre content. Finally after three months of storage period, the peanut sample recorded increase of 13.54% and 46.39% for sample produced with skin and control which accounted to 3.60g and 2.84g respectively while peanut butter sample produced

without skins recorded a decrease of 22.68% of its initial content. This proves that there were decreases in the entire sample at the end of the third month of the storage period: The increase in the sample made with skins and without skins at the end of third month of storage decreased to 20.83% and 13.54% at the end of second and third months of the storage period. This proves that the content would continue to decrease with increase in time of storage. Also in the case of sample made without skins, the quantity of fibre decreased with time of storage.

PROTEIN

Tables 1 to 4 show the quantity of protein present in the samples. P01, P11, P21 and P31 are the samples of peanut butter produced with skins at initial state, first month, second month and third months of storage periods respectively. These samples showed higher increase in protein content with the time of storage. At the initial state, the sample made with skins had higher values for protein than that made without skins; after one month of storage, the sample made with skins had an increase of 117.38% which was more than the initial amount of protein of the peanut butter, the peanut butter made without the skins had an increase of 124.24% which was also more than twice the initial content and the control sample had 91.26%.

After three months of storage, the samples had the following increase 88.77%, 81.96% and 59.22% for the sample made with skins, without skins and control respectively, the increase amounted to 38.00g, 35.5g and 32.05g respectively. These confirmed that Protein content will continue to reduce with increase in time of storage after the first month of storage.

FATS

Tables 1 to 4 show that the peanut butter had an increase in its fat content. The peanut butter made with skin increased from initial value of 29.41g to 35.00g after the first month of storage which accounts to 19% increase, and after the second month of storage there was another increase to 39.0g which accounts for 32.61% of the initial value, hence at the end of the third month, the value of the increase was 40.32g. this accounts for 37.09% of the initial content while the value of fat content of the peanut butter made without skin were 31.50g, 34.8g, and 33.1g after production, one month, two months and three months of the storage periods respectively, these values account for 10% after one month, another 10% after two months and 4.88% after three months of storage periods. It was observed that the increase was maintained between the first and second months storage period as the value remained the same, while there was decrease after the third month of storage, from 10% to 4.88% of the initial value

In the case of the control sample, the values were 24.75g, 31.95g and 24.75g after the first, second and third months of storage. These figures accounts for 15.85%, of the initial value of fats; after the first month, the fats content recorded an increase of 8.64% of the initial value after the second month of storage and after the third month of storage, the sample recorded another decrease of 10% of its initial composition. These data confirms that the peanut butter with skins, if properly packed and stored under normal conditions has more stable composition of

FATS.

Colour Sensory Evaluation of Peanut Butter. The results for the colour sensory evaluation of peanut butter as observed by the panellists are shown in Tables 5.

Table 5: Colour Evaluation for the Peanut Butter.

S/No	Panellist	O_0		O_1			O_2			O_3		
		1	2	1	2	3	1	2	3	1	2	3
1	1	7	6	6	5	5	6	6	5	5	5	4
2	2	7	7	7	6	5	6	6	4	5	5	5
3	3	6	7	5	6	5	6	5	5	5	5	5
4	4	6	6	5	5	5	5	5	4	4	4	4
5	5	6	6	5	5	4	6	6	5	6	5	4
6	6	7	6	6	5	4	5	6	5	4	4	4
7	7	7	7	6	6	5	5	5	5	5	5	4
8	8	7	7	6	6	5	6	5	6	5	5	5
9	9	7	6	6	5	5	5	5	5	5	5	4
10	10	6	7	5	6	4	5	6	4	4	4	5

Where O0 is the result for the sensory evaluation immediately after production, O1 is after one month of storage period, O2 is after two months of storage period and O3 is after three months of storage period while 1is the sample with skin, 2 is the sample without skins and 3 is the control (which is prepared and preserved using the normal local method).

To determine whether the observed colour score differ significantly from the expected or original colour of the peanut butter the panellists score for the sample after production and during the storage were analyzed statistically using the chi-square statistical package, the results of which are presented in Table 6.

Table 6: Chi-Square Values Colour

Period	x^2 calculated	x^2 table	
		5%	1%
Before storage (with skins)	2.45	16.92	21.67
Before storage (without skins)	2.81		
After 1 month (with skin)	6.05		
After 1 (without skinks)	7.81		
After 1 (control)	12.10		
After 2 months (with skin)	7.81		
After 2 months (without skin)	7.20		
After 2 months (control)	13.61		
After 3 months (with skin)	12.80		
After 3 months (without skin)	13.61		
After 3 months (control)	15.31		

From the results obtained in Table 6, it was hypothesized that there was no significant difference between the colour quality of the freshly produced and stored peanut butter. The calculated chi-square value for peanut butter at initial state (both with and without skins), one month after (with skins without skins and control) and three months after (with skins, without skins and control) were less than the chi-square value 5% and 1% level one could therefore say that observed colour frequencies of the peanut butter during these period, do not differ significantly from the expected frequencies, therefore the hypotheses is accepted at 5% level of error, that the resultant colour at the end of these periods is not significantly different from the freshly produced peanut butter. The calculated chi-square values of the peanut butter after two months (control) and after three months (without skins and control) were higher than the critical value at 5% level, thus rejecting the hypothesis at 5% level. This indicates that there was a significant difference in the resultant colour of the samples after two months (control) and three month (without skins and control) from the freshly produce peanut butter.

Taste Evaluation of Peanut Butter

In order to determine whether the observed taste of the peanut butter differ significantly from the taste, the scores of the samples after production and at an interval of one month throughout the storage period of three months were analyzed statistically and the result presented in Table 7.

Table 7: Chi-square Values for Taste

Period	x^2 calculated	x^2 table	
		5%	0.1%
Before storage (with skins)	1.01	21.67	27.88
Before storage (without skins)	2.11		
After 1 month (with skin)	1.51		
After 1 month (without skins)	3.20		
After 1 month (control)	8.45		
After 2 months (with skin)	4.05		
After 2 months (without skin)	6.61		
After 2 months (control)	15.3		
After 3 months (with skin)	10.51		
After 3 months (without skin)	11.25		
After 3 months (control)	28.80		

Table 7 shows the calculated chi-square values for peanut butter immediately after production (with skins, without skins) one month after (with skins, without skins and control); after two months (with skin, without skins and control) and after three months (with skins and without skins) are less than the chi-square values at 5% and 0.1% level while the control sample was greater than the value of chi-square at 0.1% level after three months. It could be said that there was no significant difference in the frequencies during these period of the observed taste of the peanut butter and that of the expected frequency during these period.

Therefore, the hypothesis is accepted at 0.1% level which indicated that there is no significant difference in the resultant taste of the peanut butter from the freshly produced peanut butter samples.

The calculated chi-square value of the peanut butter after three months of storage is higher than the critical value of 1% level but greater than 27.88 at 0.1% level, the hypothesis is rejected at 10% level, this indicates that there is significant difference in the resultant taste of the peanut butter after the third month of storage from that of freshly produced peanut butter.

CONCLUSIONS

The aim of this study was to produce peanut butter from the improved cultivar of peanuts in Nigeria, access and analyse its nutritional parameters with time of storage and to ascertain its taste and colour within the storage periods of three months. In quantifying these values, the levels of the changes in the quality parameters were determined with time of the storage. From the studies, the results showed that the samples packaged and stored in high-density polythene films gave better results when compared with those stored in open glass jars in terms of nutrient retention capacity and fermentation resistance. Also, the samples packaged and stored in the high-density polythene film gave better colour and taste after the storage periods.

It can thus be concluded that peanut butter can be produced locally without much loss in the nutritional qualities and stored effectively for a period of three months with a record of minimum losses throughout the storage period. If properly packaged and stored peanut butter can stay more than the prescribed period of this project without much change in its colour and taste. Apart from preserving the quality of the product, the sealed storage can also serve as a good packaging material that can easily fit into the marketing system of the peanut butter, because transportation and handling which are often the constraints can be enhanced.

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