Effects of Pretreatments and Drying Methods on Some Anti-nutrients and Proximate Composition of Peanut (Arachis Hypogaea)

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Abstract - *In this study, the fresh peanuts were dehydrated by microwave hot air drying and conventional hot air oven drying methods. The samples were dried at three different temperatures: 50, 60, and 70°C, with and without the application of pretreatment by soaking in water and in brine. The effect of the pretreatment and drying processes were tested on some of the anti-nutrients (oxalate and tannin), and proximate composition of the peanuts. The average value for oxalate and tannin were 24.58% and 5.27% respectively for the raw samples. Pretreatment and microwave drying was proven to have the highest effect on the anti-nutrients by reducing the oxalate from 24.58% to 2.08% when pretreated in brine and dried at 70°C; and the tannin was also reduced from 5.27% to 3.33% when water soaked and microwave dried at 70°C. This shows that pretreatment by soaking in brine or water reduced the anti-nutritional factor of peanut which in turn influenced the proximate compositions of the peanuts.*

Key Words: Temperature, Pretreatments, Anti-nutrients, Nutrients, Peanut

1. INTRODUCTION

Peanuts (*Arachis hypogaea*), which is also referred to as groundnuts in certain places of the world are edible leguminous seeds. India and Nigeria are the second and third principal producer of peanuts respectively in the whole world, with total production capacity of approximately 6.857 million metric tons and 3.029 million metric tons respectively per year [1]. *Arachis hypogaea (A. hypogaea)* is also regarded as pea from the family (f*abaceae*) of bean/legume. Even though *A. hypogaea* is a leguminous crop; it is commonly considered as oilseeds because of its great oil content. *A. hypogaea* is a rich source of oil, protein and fibers [2]. Aside the production of oil, *A. hypogaea* can be used for peanut butter manufacturing, production of confectioneries and roasted peanuts, manufacturing of Snack products, meat product formulation extenders and for making of soups and desserts. There are so many *A. hypogaea* cultivars presently. Some *A. hypogaea* varieties are favoured over others because their specific usages due to their differences in flavour, percentage oil content, variation in their size and shape, and their ability to resist diseases infection. There are many different cultivars which are used interchangeably however, the most popular cultivars are Spanish, Runner, Virginia and Valencia.

Most *A. hypogaea* sold are done in their shell and are mostly of the Virginia type with some Valencias breed chosen due to their largeness in size and the eye-catching appearance of their shell. Spanish *A. hypogaea* are commonly used for production of candy, salted nuts, and butter. Some Runner varieties are also used to manufacture peanut butter [3]. The consumption of *A. hypogaea* globally are in various forms, principally as traditional cuisine. They are utilised as the comprehensive source of dietary basis for people on tours to various areas like Antarctica, space and trekking. It has notably been the source of elimination of malnutrition amongst the population in many African countries in the recent years [4]. Anti-nutrients are substances found in most food substances which are Poisonous to humans or in some ways limit the nutrient availability to the body. Plants evolve these substances to protect themselves and to prevent them from being eaten. However, if the diet is not varied, some of these toxins build up in the body to harmful levels [5]. Some vitamins in food may be destroyed by anti-nutritional substances. Legume family is one of the most important families in plant kingdom, in which it is a cheap protein source for vegetarian diets [6]. The Presence of anti-nutritional factors, such as flatulence factors, phytic acid and enzyme inhibitor limit the use of leguminous crops in food industry. There are diverse anti-nutrients domiciled in various fragments of *A. hypogaea*, such as peanut hull, skin, seed, kernel, root and cotyledons [7]. The presence of lectins in *A. hypogaea* causes broad interference with absorption of nutrients across intestinal wall. Lectins also known as hemagglutinin, is a plant agglutinin that exerts specific affinity for certain sugar molecules [8]. Ramakrishna et al. [6] reported the presence of trypsin inhibitors inhibiting the activities of protease, such as plasmin, chymotrypsin and trypsin. Pahnwar [9] revealed the presence of phytates, oxalates, tannins, aflatoxin, oligosaccharides and hydrogen cyanide in peanuts and their effects on health. Goitrogens is a naturally occurring compound that is present in groundnut that suppresses the function of thyroid gland [8]. It interferes the uptake of iodine, which in turn causes the enlargement of thyroid gland. The phenomenon is known as "goitre". Salunkhe [8] also found Peanut I in groundnuts. Peanut I is a peanut protein that acts as an allergic factor in inducing peanut allergy in certain individuals. The other anti-nutrients that are present in groundnut include phenolic compounds, flatus agent, bitter flavour compounds and phytate. This study investigates the presence of some anti-nutritional factors like oxalates and tannins in *A. hypogaea* and evaluates the effects of processing techniques on them.

2. MATERIALS AND METHODS

2.1 Collection and Preparation of samples

Shandong peanuts which are characterized by plump grain size, large size, with excellent taste and high nutrition sample was collected from a local vendor in Uyo, Akwa Ibom State. The sample was soaked, dried and subjected to the triplicate treatment.

2.2 Pretreatments

Seeds of unshelled peanuts were soaked in distilled water for 1, 2, and 3 hours at a peanut: water ratio of 1:10 (w/v). After soaking, the water was drained off and the seeds were dried in the hot air oven. Also, raw seeds of unshelled peanuts were brine soaked for 1, 2, and 3 hours at peanut: water ratio of 1:10 (w/v). After soaking, the water was drained off and the seeds were dried in a hot air oven. 500g of the pre-soaked sample was separately subjected to the following processing techniques; microwave drying and oven drying.

2.3 Processing Techniques

(a) Microwave Roasting

Seeds were microwave-roasted for 6 min using a domestic size Moulinex microwave (Geli 1380, type 665; Geli group, Zhuhai City, China). After the treatment, the seeds were dried in a hot air oven and then, grinded with the motar and pestle into granules, put in crucibles and placed in the dessicators for further analysis.

(b) Oven Roasting

Seeds were oven-roasted for 6 min using a domestic size hot air oven. After the treatment, the seeds were dried and then, grinded with the motar and pestle into granules, put in crucibles and placed in the desiccators for further analysis.

2.4 Anti-nutrients Determination

(a) Determination of Tannin

Permanganate Titration

Quantitative estimation of tannin was performed by titrating the extract with standard potassium permanganate solution following the method of AOAC [10]. Briefly 5 ml aliquot of the extract was mixed with 12.5 ml of indigo-carmine solution and 375 ml of distilled water. This mixture was titrated against $KMnO_4$ solution ("Y" mL). As titration preceded the blue colour of the indigo-carmine passes through many shades to a final yellow with a faint pink tint at the rim. It was taken as the end-point. The concentration of tannin was estimated using the following relationship:

1ml of standard $KMnO_4$ solution = 0.595ml of 0.1N Oxalic acid

1 ml of 0.1 N Oxalic acid = 0.0042 g of tannin

Preparation of the Standard Solution of Indigo Carmine

Standard solution of Indigo carmine was prepared as follows: 6g Indigo carmine is dissolved in 500ml of distilled deionized water (dd) by heating, after cooling 50ml of 95 – 97% is added, the solution is diluted to 1L and then filtered. The blank tests by titration of a mixture of 25ml indigo carmine solution and 750ml dd H_2O are carried out.

(b) Oxalate Content Determination

Oxalate content was determined by AOAC (2012) [11] method. Briefly, 1 g of the sample was weighed into 100 mL conical flask. Then, 75 mL of 3mol/L were added and the solution was carefully stirred intermittently with a magnetic stirrer for about 1 h and then filtered using Whatman No.1 filter paper. The sample filtrate (extract, 25 mL) was collected and titrated against hot (80–90°C) 0.1 N solution to the point when a faint pink colour appeared that persisted for at least 30s. The concentration of oxalate in each sample was obtained from the calculation:

1mL 0.1 permanganate = 0.006303 g oxalate

2.5 Proximate analysis

The proximate compositions of the cocoyam sample, namely, moisture, ash crude lipid, protein content, crude fibre, and carbohydrate were determined according to the recommended methods of the AOAC [10].

2.6 Statistical Analysis

All the experiments were made in triplicate and the results were expressed as mean ±SD (standard deviation). The different between means were determined using ANOVA and Turkey's HSD adhoc test in SPSS 20.0

3. RESULTS AND DISCUSSIONS

The effects of pretreatment and processing techniques on the anti-nutrients are presented in tables 1 and 2. The average value for oxalate was 24.58% at room temperature (RT) (see table 1). The results obtained from this research showed a significant effect of the pretreatments on the anti-nutrients. Soaking in water and in brine as pretreatment measures have reduced the percentage of oxalate from 24.58% to 4.83% when soaked with water and to 3.99% when soaked with brine (see table 1), soaking is a domestic treatment that is often used by people to prepare complimentary foods at home. Previous studies by Mubarak [12] and Vijayakumari et al. [13] had shown that soaking significantly reduced phytate, trypsin inhibitor activity (TIA), and tannin contents. Table 2, also showed the effects of pretreatment and processing techniques on the anti-nutrient tannin. The average value for tannin was 5.27% at RT (see table 2). There was significant effect of the pretreatment on the anti-nutrient. Tannin was reduced from 5.27% to 3.92% during water soaking and to 3.75% during brine soaking. There were no significant differences between water soaking and brine soaking (see table 2).

The oxalate content was also seen to significantly reduce when sample drying temperatures was increased from the temperatures of 50 to 70°C, revealing the effects of oven heat on the anti-nutrient. When the sample was water soaked and subjected to the same oven temperatures of 50 to 70°C, the oxalate content reduced to a minimal level of 2.10% at 70°Celsius. However, brine soaked and oven dried values of oxalate content showed significant effect compared with the raw sample as the value reduced to 2.73%.

The microwave drying showed a significant effect on the oxalate content of peanut, the oxalate content decreased with increase in temperature to a minimal level of 5.46% at 70°C. Pretreated and microwaved dried samples showed a significant effect on the oxalate content as presented in the table 1, except for brine soaked and microwaved dried at 50 and 60°C. The least value of oxalate content for pretreated and microwave dried sample was obtained as 2.08% at 70°C.

Table -1: Effects of oven drying and microwave drying of Peanut in Reducing Oxalate

Drying Temperature (⁰C)	Raw (R)		Water Soaking (WS)		Brine Soaking (BS)	
	MD	OD	MD	OD	MD	OD
Room temp. (RT)	24.58 ± 1.26^{A}	24.58 ± 1.26^{A}	4.83 ± 0.36^{B}	4.83 ± 0.36^{B}	3.99 ± 0.36^{B}	3.99 ± 0.36^{B}
50	10.51 ± 0.73^{B}	7.35 ± 0.36^{B}	1.89 ± 0.36^{BC}	3.99 ± 0.36^{B}	3.99 ± 0.36^{B}	2.73 ± 0.73^{BC}
60	8.61 ± 0.36^{C}	4.20 ± 0.36^{C}	3.36 ± 0.73^{C}	3.57 ± 0.36^{B}	3.78 ± 1.89^{B}	2.73 ± 0.36^{BC}
70	5.46 ± 0.36^{D}	4.20 ± 0.36^{C}	2.94 ± 0.36^{C}	2.10 ± 0.73^{C}	2.08 ± 0.93^{B}	2.52 ± 0.63^{C}

Values with different letters within the same row and column show significant differences (P<0.05).

There was no significant effect of heat on tannin content when dried at 50 and 60°C, but, reduced to 3.33% when the temperature was raised to 70°C, indicating that increase in heat could cause a decrease in the anti-nutrient when samples are oven dried. When samples were water soaked and oven dried, the tannin content showed no significant effect; the average value of the tannin content was within the range of the raw sample (Table 2) during oven drying. Even at brine soaking and oven dried at 70 degrees Celsius, there are no significant differences with the raw content of tannin and brine soaked and dried samples as presented in the Table 2.

There was no significant differences between the raw (untreated) sample and the microwave dried content of tannin even as the drying temperatures increased from room temperature to 70°C. Similarly, there was no observable significant differences between the raw (untreated) sample and the oven dried content of tannin at increasing drying temperatures, except at 70°C, where the tannin level significantly reduced to 3.42±0.29% (see table 2). Pretreated microwaved and oven dried samples showed no significant effect on tannin as presented in the table 2, except for brine soaked (BS) and microwaved dried at 70°C (3.50±1.09%). The least value of tannin for pretreated and dried sample was obtained at 70°C as 3.33% when water soaked and microwaved dried at 70°C.

Table -2: Effects of oven drying and microwave drying of Peanut in reducing Tannin

Drying Temperature (⁰C)	Raw (R)		Water Soaking (WS)		Brine Soaking (BS)	
	MD	OD	MD	OD	MD	OD
Room temp. (RT)	5.27 ± 1.39^{A}	5.27 ± 1.39^{A}	3.92 ± 0.24^{B}	3.92 ± 0.14^{B}	3.75 ± 0.43^{AB}	3.75 ± 0.43^{B}
50	4.41 ± 0.38^{A}	5.08 ± 0.38^{A}	3.75 ± 0.25^{B}	5.41 ± 0.29^{A}	4.25 ± 0.43^{AB}	4.66 ± 0.14^{AB}
60	4.17 ± 1.01^{A}	5.06 ± 0.38^{A}	3.42 ± 0.80^{B}	4.91 ± 0.14^{AB}	3.83 ± 0.38^{AB}	4.58 ± 0.14^{AB}
70	3.75 ± 0.25^{A}	3.42 ± 0.29^{B}	3.33 ± 0.14^{B}	4.50 ± 0.75^{AB}	3.50 ± 1.09^{B}	4.41 ± 0.14^{AB}

Values with different letters within the same row and column show significant differences (P<0.05).

Table 2, also shows the effects of pretreatment and processing techniques on the anti-nutrient tannin. The average value for tannin is 5.27 ±1.39 %. There were significant effects of pretreatments on the anti-nutrient tannin. Tannin was reduced to 3.92 ±0.24 % during water soaking and 3.75 ±0.43 % during brine soaking at room temperature. There are no significant differences between water soaking and brine soaking. The effect of processing methods and temperature on the proximate analysis of oven dried peanut is presented in Tables 3a to 3b. Table 3a shows the proximate results for moisture contents, ash contents and fat contents while table 3b shows the proximate results for fibre contents, protein contents and carbohydrate contents.

Table -3a: Effect of Treatment (Oven Drying) at Various Temperatures on the Proximate Analysis of Peanut

	MC (% wb)			Ash (%)			Fat (%)		
TM	Raw	WS-OD	BS-OD	Raw	WS-OD	BS-OD	Raw	WS-OD	BS-OD
RT	5.24 ± 0.12^{A}	4.07 ± 0.06^{B}	3.55 ± 0.15^{B}	2.61 ± 0.05^{B}	4.05 ± 0.05^{A}	2.74 ± 0.04^{A}	48.45 ± 0.39^{B}	47.01 ± 0.56^{B}	35.55 ± 0.49^{C}
50⁰C	4.37 ± 0.04^{A}	4.41 ± 0.03^{B}	3.70 ± 0.01^{B}	2.72 ± 0.04^{B}	2.76 ± 0.03^{B}	2.59 ± 0.02^{A}	45.09 ± 0.11^{C}	46.33 ± 0.09^{C}	35.66 ± 0.15^{C}
60⁰C	3.71 ± 0.01^{B}	4.28 ± 0.04^{B}	3.66 ± 0.06^{B}	2.58 ± 0.03^{B}	2.58 ± 0.02^{B}	2.71 ± 0.02^{A}	34.19 ± 0.14^{D}	46.92 ± 0.08^{BC}	36.87 ± 0.18^{B}
70⁰C	1.04 ± 0.04^{C}	4.10 ± 0.06^{B}	3.64 ± 0.02^{B}	3.13 ± 0.08^{A}	3.96 ± 0.04^{A}	2.49 ± 0.02^{A}	51.76 ± 0.50^{A}	48.04 ± 0.07^{A}	34.48 ± 0.20^{D}

Note: TM = Temperature, RT = room temp, WS-OD = soaked in water and oven dried, soaked in brine solution and oven dried

Table -3b: Effect of Treatment (Oven Drying) at Various Temperatures on the Proximate Analysis of Peanut

	Fibre (%)			Protein (%)			Carbohydrate (%)		
TM	Raw	WS-OD	BS-OD	Raw	WS-OD	BS-OD	Raw	WS-OD	BS-OD
RT	2.71 ± 0.37^{A}	1.96 ± 0.04^{A}	1.91 ± 0.02^{A}	36.77 ± 3.62^{A}	33.91 ± 1.22^{B}	37.37 ± 0.25^{A}	9.45 ± 3.16^{C}	9.00 ± 0.71^{C}	17.37 ± 0.25^{B}
50⁰C	2.27 ± 0.05^{A}	2.13 ± 0.02^{A}	1.83 ± 0.02^{A}	31.69 ± 0.81^{C}	29.90 ± 0.59^{C}	33.26 ± 0.73^{D}	13.87 ± 0.88^{B}	14.47 ± 0.62^{A}	22.96 ± 0.61^{A}
60⁰C	1.81 ± 0.02^{B}	1.97 ± 0.03^{A}	1.92 ± 0.03^{A}	35.53 ± 0.09^{B}	30.06 ± 0.33^{C}	35.91 ± 0.49^{BC}	22.18 ± 0.07^{A}	14.19 ± 0.31^{A}	18.93 ± 0.68^{B}
70⁰C	2.61 ± 0.03^{A}	1.95 ± 0.04^{A}	1.79 ± 0.02^{A}	31.63 ± 1.54^{C}	30.56 ± 0.25^{C}	35.08 ± 0.08^{C}	9.82 ± 1.76^{C}	11.39 ± 0.30^{B}	22.52 ± 0.20^{A}

Values with different letters within the same column show significant differences ($P<0.05$).

The average moisture content of raw peanut was 4.07%; water soaking and brine soaking influenced the moisture content to 5.24% and 3.55% respectively. The ash, fat, fibre, protein and carbohydrate content of raw peanut were obtained as 2.61%, 48.45%, 2.71%, 36.77% and 9.45% respectively. Water soaking showed significant increase in the ash content and decrease in the fat, fibre, protein and carbohydrate content. Brine soaking showed significant increase in the protein content and carbohydrate content as presented in tables 3a and 3b. The least values for protein and fat were observed as 29.90% and 46.33% respectively when samples were water soaked and oven dried at 50℃. Percentage raw Ash and Fat contents 3.13% and 51.76 % respectively were highest when oven dried at 70℃. Oven drying had some significant effects on the proximate composition of peanut.

4. CONCLUSIONS

The results obtained from this research showed a significant effect of the pretreatments on the anti-nutritional factors. Soaking in water and in brine as pretreatment measures have reduced the percentage of oxalate from 24.58% to 4.83% when soaked with water and 3.99% when soaked with brine. Also, the effects of pretreatment and processing techniques on the anti-nutritional factor tannin showed tannin reduction from 5.27% to 3.92% during water soaking and 3.75% during brine soaking. The oxalate content significantly reduce when sample drying temperatures was increased from 50 to 70°C, revealing the effects of oven heat on the anti-nutrient. When the sample was water soaked and subjected to the same oven temperatures of 50 to 70°C, the oxalate content reduced to a minimal level of 2.10% at 70°Celsius. Anti-nutrients was also seen to affect the amount of nutrient available in food and hence, influence the usage of such food raw material. Reducing the anti-nutrients helped to improve on the nutritional content of the food.

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