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Drying Methods Impact on Physiochemical Properties of Sliced Ginger (*Zingiberofficinale*)

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ABSTRACT
Ginger is a fresh dried root member which has been cultivated for long time ago. Thousands of prescriptions in medicine are combination of herbs and almost all such prescriptions use ginger to stimulate appetite and calm the stomach during digestion. Effect of drying methods on some physiochemical properties of sliced ginger was investigated. Fresh ginger rhizomes without any physical defects was obtained from Mile 12 market in Kosofe local government area of Lagos State, Nigeria were washed, air-dried and sliced using a vegetable slicer. The initial moisture content of the ginger was determined. Thirty (30) sliced samples were divided into two parts, one part was water blanched at 80^oC for 5 minutes and the other part was un-blanched. All the samples were subjected to sun drying (at 29^oC), oven drying (at 105^oC) and cabinet drying (at 50, 60 and 70^oC). The dried samples were pulverized and sieved to obtain the ginger powder. Proximate analysis was carried out on the ginger powder. Results obtained showed that the gingerol, moisture, crude protein, crude fibre fat, Ash and carbohydrate contents of the samples (blanched and un-blanched) investigated was between (19.30-22.30)%, (9.46-11.35)%, (9.00-13.32)%, (7.97-10.31)%, (4.90-10.11)%, (2.98-4.95) %, and (43.02-66.06) % respectively. The cabinet dried (at 70^oC) blanched sample had the highest gingerol and crude fibre contents values while the cabinet dried (at 60^oC) blanched sample had the highest Ash and carbohydrate contents values. The un-blanched cabinet dried (at 70^oC) sample had the least moisture content while the highest crude protein content was obtained from the un-blanched oven dried sample. The oven dried blanched sample recorded the highest fat content. Results from the statistical analysis using the calculated spearman's correlation show that there are relationships between methods of drying, pre-treatments and the nutritional composition. A significant correlation ($p<0.01$) was found between the methods of drying and the nutritional compositions investigated. The crude fibre, fat and carbohydrate had significant ($p<0.05$) effect under blanched condition while Ash, moisture and protein contents had no significant ($p>0.05$) effect under blanched condition. The moisture, Ash, protein contents had significant ($p<0.05$) effect under un-blanched condition while crude fibre, fat and carbohydrate contents had no significant ($p>0.05$) effect under un-blanched condition. The study revealed that the cabinet drying method retained most of the nutritional compositions of ginger. The cabinet drying method is the best of all the methods of drying investigated.

KEY WORDS: Physiochemical properties, Ginger rhizome ,Oven, cabinet, Drying method

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I. INTRODUCTION

Ginger is a fresh dried root member of ginger family, which has been cultivated for thousands of years in India and China,it reached the west more than two hundred years ago. Thousands of prescriptions in medicine are combination of herbs and almost all such prescriptions use ginger to stimulate appetite and calm the stomach during digestion (Altman and Marcussen, 2001). Ginger has a slender stem, the first stems are lengthier and bear beautiful and fragrant flowers, which are greenish yellow and streaked with purple down the sides. The seeds of the ginger appear in the rare fruiting body. The underground stem of ginger is the most familiar part of the plant and it is extensively used for commercial as well as domestic purposes. The irregular shapes and sizes of the underground section of the stem is the most important part of the herb. The plant stores food reserves in its underground stem. The rhizomes are yellow in colour range is one ginger variety, which has a characteristic blue ring, lying in circles inside the freshly interior; this is one of the most prized variety of ginger (Balunas and Kinghorn, 2005). Spices containing ginger which may be conveniently added into soups, grilled meat and any kind of cheese, vegetables, fruit salad, rice pilaf, muffins or cakeswith the purpose of easing digestion. Spices with ginger are preferred mostly due to their aphrodisiac effect (Tanira, 2008).Ginger is primarily used to treat nausea, but it is also used as an anti-inflammatory, pain remedy, a warming remedy and a cholesterol-lowering herb. Randomized controlled trials support its use in preventing nausea. Case studies suggest usefulness in treating migraines and inflammatory arthritis, but no

randomized trials have been reported. It is reported that ginger inhibits this virus infection and thereby prevents cancer. Ginger is among the healthiest spices loaded with nutritional and bio-active compounds full of benefits for the body and brain (Joe, 2016). It has been established that drying of agricultural produce is of great economic importance all over the world especially in Nigeria where most of the crops and grains harvested are lost to rodents, insects, fungal and microbial attack during storage (Okafor and Okafor, 2007).In order to improve its storability and shelf life. The produce is subjected to drying, a method of preserving food produce from deterioration. However, there are limited studies on the effect of drying methods on the physiochemical properties of ginger. Hence, this research focuses on the determination of suitable method and temperature to dry ginger without altering or destroying its physiochemical properties.

II. MATERIALS AND METHODS

2.1Experimental

Experiment weas carried out to determine the effects of drying methods on ginger rhizomes. The drying method investigated in this study were sun drying, oven drying and cabinet drying. Some physiochemical properties of the dried ginger powder were also determined. The laboratory analysis was carried out in the microbiology laboratory at Lagos State University of Science and Technology Ikorodu, Lagos Nigeria.

The materials and equipment used in the study were ginger rhizome, digital weighing balance, sieve, commercial blender, stainless trays, vegetable slicer, vernier caliper, cabinet drier, oven drier and thermometer.

The fresh ginger rhizomes used were obtained from Mile 12 market in Kosofe, Lagos State, Nigeria without any physical defects. The ginger rhizomes were thoroughly washed to remove adhering debris, thereafter the samples in bulk were sliced using vegetable slicer into 16mm diameter at 5.65mm thicknesses using digital vernier caliper (Hossain and Horque, 2008).10g of the sliced ginger was weighed accurately using Digital weighing balance (Model:EK5350) and were dried in an air oven at 105^0C for 4 hours using AOAC (2003) method of determining moisture content. The aluminum dish containing the samples were removed from the oven and transferred into a desiccator for cooling. The loss in weight was noted and the initial moisture content was calculated using Equation (1) as reported by Olayanju (2003a).

$$\% \, MC_{wb} = \frac{W_2 - W_3}{W_2 - W_1} \times 100 \qquad (1)$$

MC_{wb}= moisture content wet basis
W_1 = weight of can
W_2 = weight of can + moist product
W_3 = weight of can + dried product

Thirty sliced samples of 100g each were divided into two parts, one part contains fifteen samples was water blanched at a temperature of 80^0C for 5-munites (Leal *et al.*, 2006) and the other fifteen sliced samples were not blanched prior to drying processes. All the samples were then subjected to open sun, oven drying (at 105^0C for 4hours) and cabinet drying (at 50^0C, 60^0C and 70^0C).

Six samples (three blanched and three non-blanched) were dried by spreading out the slices on a stainless tray from 9a.m to 4p.m for 3 days for sun dring. The process of weighing during drying was repeated at intervals of 60-minutes until constant weights were obtained. The average weights for both blanched and non-blanched sun dried samples were then determined.

A static-tray type cabinet dryer developed at the Agricultural and Bio-Environmental Engineering Department, Lagos State University of Science and Technology Ikorodu, Lagos Nigeria. was used in this study. The dryer temperature was varied (50^0C, 60°C and 70^0C)(Jayashree*et al.*,2014), this was achieved by means of the temperature regulator on the dryer. Eighteen samples were used in the study (Nine blanched and Nine non-blanched samples). The samples were replicated thrice for each of the drying temperatures. The samples were then dried to constant weight after weighing at intervals of 15, 20 and 25-minutes.

An air oven dryer at the microbiology laboratory of Lagos State University of Science and Technology Ikorodu, Lagos Nigeria.was used for this study. The dryer was fixed at temperature of105^0C. This was done by means of the temperature regulator on the dryer.Six samples were used in this method (three blanched and three non-blanched samples). The samples were then oven dried using AOAC. (2003) standard at temperature of 105^0C for 4-hours until a constant weight was obtained.

2.2Quality Parameter Determination

After all the samples were subjected to different drying methods (sun, oven and cabinet), the samples were pulverized into particles and then sieved to obtain fine particles (powder). Laboratory analysis was carried out on the dried samples

2.2.1Determination of Total Ash Content

Empty crucible was weighed using an analytical balance and the weight recorded. 1g of the samples was weighed into the crucible and was ash in the furnace at 500^0C for 5-6 hours (AOAC, 1996). The crucible containing the sample was later transferred into the desiccators to cool at room temperature. Calculation of the Ash content was based on equation 2

$$\textbf{\% Ash} = \frac{weight\ of\ ash + crucible\ - weight\ of\ empty\ \ crucible}{weight\ of\ ashed\ sample} \times 100 \qquad (2)$$

2.2.2 Determination of Protein

According to kjeldahl using block digestion and steam, the materials used are digestion block, digestion tubes, kjeldahl distillation unit, automatic titration and reagents are H_2O_4, Copper catalyst, 40% NaOH solution, receiver solution, distilled water, 0.1N HCl, 0.1g methyl red indicator was dissolved in 100ml 95% methanol and 0.1g bromocresol green indicator was also dissolved in 100ml methanol. Thereafter 4% boric acid solution was prepared by dissolving 400g of the powder in about 5 – 6L very hot distilled water, the solution was allowed to cool at room temperature and 100ml ofbromecreosol green and 70ml of methyl red solution were added and diluted with 10L de-ionized water the mixture was carefully mixed.The % Protein content and Gram Nitrogen per Liter are as mathematically expressed in Equations 3 and 4 below.

Calculation

$$\textbf{\% Protein} = \frac{(T - B \times N \times 14.007 \times 100)}{W1\ (\text{mg})} \times \text{F} \qquad (3)$$

$$\textbf{gN/L} = \frac{(T - B) \times N \times 14.007}{Volume\ \ sample\ (ml)} \qquad (4)$$

W_1 = Sample weight (mg)
T = Titration volume of sample (ml)
B = Titration volume of blank (ml)
N = Normality of acid to 4 decimal places
F = Conversion factor for nitrogen to protein = 6.25 for food & feeds
gN/l = Gram Nitrogen per Liter

2.2.3 Determination of Crude Fibre

The materials and reagent used are Analytical balance, fritted crucibles, air ventilated oven capable of operating at 105 ± 2^0C and above, desiccators, grinding equipment, fibertec hot extraction unit, fibertec cold extraction unit, hot plate, wash bottle, muffle or incineration furnace 525 ± 15^0C,Acetone (technical grade), 1.25% H_2S0_4 solution and 1.25% NaOH solution. The crucibles were Pre dry fritted at 130^0C for 30 minutes then placed on balance and tare (adjusted) to simplify filtration, 1g of well-prepared sample was weighed into the crucible containing the celite. 1.25% H_2SO_4 was prepared and heated on hot platefibertec hot extraction unit,150ml of preheated 1.25% $H_2SO_4$was added into each column and 2 – 4 drops of n – Octanol to prevent foaming and turn on 'Heater' control fully clockwise. The boiling time was measured from the time when the solution has reached the boiling point (30minutes) at the elapse of 30 minutes (end of extraction) the heater was turned off. The crucibles were positioned in the fibertec cold extraction unit and close valves. 25ml acetone was added to each crucible at room temperature until the acetone has evaporated,Samples were ashed in the crucibles for 3 hours at 525^0C, cooled at room temperature in a desiccator and was accurately weighed to 0.1mg.The crude fibre was determined using equation 5 below.

Calculation

$$\text{\% Crude Fiber} = \frac{W2 - (W3 + C)}{W1} \times 100 \qquad (5)$$

W_1 = Sample weight (g)
W_2 = Crucible + residue weight after drying (g)
W_3 = Crucible + residue weight after aching (g)
C = Blank

2.2.4Determination of Crude Fat

The materials used include soxhlet extractor, thimbles and hexane. 5.00g of well blended sample was weighed into the thimbles (for liquid samples, 5g was weighed into thimbles containing 1g of celite or fine white sand followed by drying in the oven to get rid of the moisture in the sample since soxhlet does not tolerate samples containing moisture above 20%. The celite/sand absorbs the water in the sample) and cotton wool was placed on the sample inside the thimble to prevent pouring out of the sample during extraction. The round

bottom flask was dried in the oven at 60 degree celsius and the initialweight of the empty flask was measured and recorded. 80ml of hexane was poured into the flask, the thimble containing sample was also fitted/placed into the extractor. The heating mantle was switched on and water was set running through the condenser for cooling, the extraction was allowed to continue its reflux for 2hrs after which it was discontinued. The flask was then dried again in the oven to eliminate all hexane present. The amount (% crude fat or oil) present in the sample was calculated by subtracting the weight of the empty flask from the final weight (AOAC, 2008).

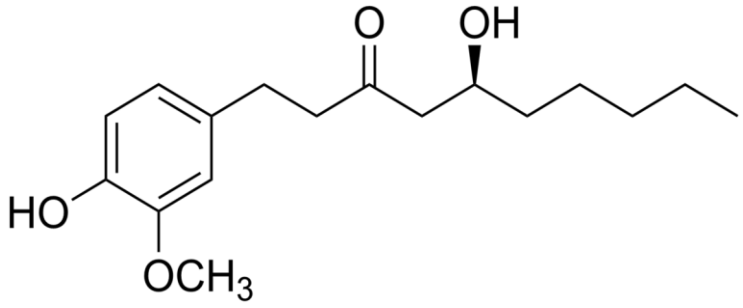
$$\text{Crude fat} = \frac{weig\,ht\ of\ fat}{weig\,ht\ of\ sample} \times 100 \quad (6)$$

2.2.5 Determination of Carbohydrate

The carbohydrate content was estimated by subtracting the sum of percentage of moisture, ash, fat, fibre, and protein contents from 100% according to AOAC. (1990).

2.2.6 Determination ofGingerol

A reverse phase stability indicating HPLC method was used to separate 6-gingerol on a reverse phase C18 (250×4.6mm) column with a mobile phase containing methanol; 0.05% phosphoric acid in water (60:40, v/v)at 280nm using UV-visible detector. The flow rate was kept as 1mL/min. [6]-Gingerol is the active ingredient constituent of ginger which gives chills pepper and black pepper. Formula;$C_{17}H_{26}O_4$



(Source: Mills, 2000).

III. RESULT AND DISCUSSION

The experimental data were analyzed using the analysis of variance (ANOVA). Differences between mean values was established using Spearman correlation coefficient test at a level of 5% of probability

The result of the experiments conducted is as presented in Tables 1. Table 2 shows the result of the proximate analysis and Table 3 shows the Analysis of variance performed on the data obtained from the experiments

Table 1: Gingerol Analysis of Sliced Ginger Dried using Different Drying Method.

Drying Method	Ginger	Gingerol (%)	
	Fresh	18.00	
Oven	105^0C (Blanch)	19.30	
	105^0C (Non- Blanch)		18.68
Sun	(Blanch)	19.55	
	(Non-Blanch)		17.78
Cabinet	50^0C (Blanch)	18.00	
	50^0C (Non-Blanch)		17.25
	60^0C (Blanch)		22.30
	60^0C (Non-Blanch)		21.00
	70^0C (Blanch)		19.00
	70^0C (Non- Blanch)		18.40

Table 2: Proximate Composition of Ginger Powder using Sun, Oven and Cabinet Drying with Fresh Ginger Rhizome Proximate.

Methods	Power Temperature	Moisture Content (%)	Crude Protein (%)	Crude Fibre (%)	Crude Fat (%)	Total Ash (%)	Carbohydrate (%)
Fresh	Natural	34.10	8.65	7.70	8.80	7.45	58.62
Sun	Ambient (blanched)	11.35	9.37	8.93	5.64	3.04	43.02
	Ambient (un-blanched)	10.20	10.51	7.97	4.90	2.98	53.05
Oven	105^{O}C (blanched)	10.00	9.85	9.96	11.56	3.72	52.77
	105^{O}C (un-blanched)	9.73	13.32	8.88	11.14	3.11	51.90
Cabinet	50^{O}C (blanched)	10.00	10.25	8.89	9.91	4.12	63.05
	50^{O}C (un-blanched)	9.46	9.81	8.30	9.50	3.98	62.55
	60^{O}C (blanched)	9.70	9.00	9.46	10.11	4.95	66.06
	60^{O}C (un-blanched)	10.31	9.35	9.85	9.89	4.54	65.54
	70^{O}C (blanched)	9.80	11.26	10.31	8.82	4.45	64.14
	70^{O}C (un-blanched)	9.30	10.61	10.04	8.57	4.05	63.10

Table 3: Spearman's P Correlation Coefficient between Methods of Drying, Pretreatment and Nutritional Composition of Powdered Ginger

	Moisture Content	Ash Content	Crude Fibre	Protein Content	Fat Content	Carbohydrate Content
Method Of Drying	0.9843 (P<0.01)	0.8720 (P<0.01)	0.7532 (P<0.01)	0.6204 (P<0.01)	0.6631 (P<0.01)	0.7935 (P<0.01)
Blanch	0.0762 (P>0.05)	0.0641 (P>0.05)	0.0456 (P<0.05)	0.0562 (P>0.05)	0.0384 (P<0.05)	0.0456 (P<0.05)
Unblanched	0.0335 (P<0.05)	0.0432 (P<0.05)	0.0684 (P>0.05)	0.0293 (P<0.05)	0.0615 (P>0.05)	0.0735 (P>0.05)

*,** Correlation is significant at the ($p<0.05$) and ($p<0.01$)

Sliced ginger rhizomes were grouped into two. One group was blanched and the other group was not blanched. The two groups were both subjected to sun, oven and cabinet drying methods, fresh ginger slices were used as the control. The gingerol contents (an active ingredient in ginger) of both fresh and dried (blanched and unblanched) samples were investigated. The result of the analysis is shown in Table 1.

Proximate analysis was carried out on both the fresh and dried ginger sample, the results was as presented in Table 2. The gingerol content of the samples (blanched and unblanched) investigated was between (9.30-11.35)%. The blanched cabinet dried at 70^0C sample had the highest gingerol value while the unblanched cabinet dried at 50^0C sample had the least gingerol content. Also from the result the gingerol was more prominent in the blanched cabinet dried at 70^0C sample compared with fresh sample. This implies that the drying method and pre-treatment (blanching) has significant influence on the gingerol yield of ginger rhizome.

Sliced ginger rhizomes were dried from an initial moisture content of 34.0 % (wb). Results of the proximate analysis shown in Table 2 indicated that the varying heating temperatures the samples were subjected to during drying significantly affected the value of moisture content obtained in the study. The moisture content of the sun dried sample was 10.20% and 11.35% under unblanched and blanched conditions respectively while the moisture content of the oven dried at 105^0C samples was 10.00% and 9.73% respectively under blanched and unblanched condition. The moisture content of the cabinet dried at 50^0C ginger powder was 10.00% and 9.46% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C ginger powder had moisture content of 9.70% and 10.31% under blanched and unblanched conditions. The moisture content of the cabinet dried at 70^0C sample was 9.80% and 9.30% under blanched and unblanched conditions respectively. The cabinet dried at 70^0C unblanched sample had the least moisture content.

The moisture content of the unblanched cabinet dried at 70^0C sample was significantly different ($p< 0.05$) from the moisture content of the raw (fresh) sample. The cabinet drier was more effective in removing

moisture compared to other drying methods. The differences in the moisture content were because of different drying methods and the pre-treatments given to the samples prior to drying. Therefore it is an indication that the shelf life of the product would be extended and that deterioration due to microbial growth would be limited (Patel and Srinivasan, 2004; Ajayi*et al.*,2017).

The crude protein content of the sun dried sample was 9.37% and 10.51% under blanched and unblanched conditions respectively while the crude protein content of the oven dried at 105^0C sample under blanched and unblanched conditions was 9.85% and 13.32% respectively. The crude protein content of the cabinet dried at 50^0C ginger powder was 10.25% and 9.81% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C ginger powder had crude protein content of 9.00% and 9.35% under blanched and unblanched conditions. The crude protein content of the cabinet dried at 70^0C sample was 11.26% and 10.61% under blanched and unblanched conditions respectively. The oven dried at 105^0C unblanched sample had the highest crude protein content.Crude protein content for raw (fresh) ginger was significantly different ($p< 0.05$) compared to dried sample. The values of the protein content of all drying methods investigated was between (9.00-13.32)% with the oven dried unblanched sample having the highest protein content (13.32%), but this value is higher than the value of 11.4% microwave oven drying method reported by Ajayi*et al.* (2017).

The crude fibre content of the sun dried sample was 8.93% and 7.97% under blanched and unblanched conditions respectively while the crude fibre content of the oven dried samples under blanched and unblanched conditions was 9.96% and 8.88% respectively. The crude fibre content of the cabinet dried at 50^0C ginger powder was 8.89% and 8.30% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C ginger powder had crude fibre content of 9.46% and 9.85% under blanched and unblanched conditions. The crude fibre content of the cabinet dried at 70^0C sample was 10.31% and 10.04% under blanched and unblanched conditions respectively. The cabinet dried at 70^0C blanched sample had the highest crude fibre content.Therefore the value of the crude fibre content of the dried sample ranged between (8.30-10.31)%, these value is quite higher than the (5.0-5.1)% value reported by Ajayi*et al.* (2017). The cabinet dried at 70^0C blanched sample had the highest crude fibre content (10.31%) compared to the raw ginger (7.70%) and other drying methods.

The crude fat content of the sun dried sample was 5.64% and 4.90% under blanched and unblanched conditions respectively while the crude fat content of the oven dried at 105^0C samples under blanched and unblanched conditions was 11.56% and 11.14% respectively. The crude fat content of the cabinet dried at 50^0C ginger powder was 9.91% and 9.50% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C ginger powder had crude fat content of 10.11% and 9.89% under blanched and unblanched conditions. The crude fat content of the cabinet dried at 70^0C sample was 8.82% and 8.57% under blanched and unblanched conditions respectively. The oven dried at 105^0C blanched sample had the highest crude fat content compared to fresh and other drying methods.

The Ash content of the sun dried sample was 3.04% and 2.98% under blanched and unblanched conditions respectively while the Ash content of the oven dried at 105^0C samples under blanched and unblanched conditions was 3.72% and 3.11% respectively. The Ash content of the cabinet dried at 50^0C ginger powder was 4.12% and 3.98% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C ginger powder had Ash content of 4.95% and 4.54% under blanched and unblanched conditions. The Ash content of the cabinet dried at 70^0C sample was 4.45% and 4.05% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C blanched sample had the highest Ash content. These values corresponds with 4.1%, 4.6%, 4.5% and 4.3% for microwave oven, solar box, sun oven plus solar box and conventional oven reported by Ajayi*et al.* (2017). Therefore dried ginger could be a potential source of minerals.

The carbohydrate content of the cabinet dried at 50^0C ginger powder was 63.05% and 62.55% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C ginger powder had carbohydrate content of 66.06% and 65.54% under blanched and unblanched conditions. The carbohydrate content of the cabinet dried at 70^0C sample was 64.14% and 63.00% under blanched and unblanched conditions respectively. The cabinet dried at 60^0C blanched sample had the highest carbohydrate content.

The result shows high carbohydrate content of ginger and according to Otunla*et al.* (2010), ginger can be ranked as carbohydrate rich spice. From this study it can be deduced that the cabinet dried at 70^0C blanched sample had the highest carbohydrate content (66.06%) compared to other drying methods.

Calculated spearman correlation coefficient results show that there are relationships between methods of drying, pre-treatment and the nutritional composition of the sliced dried ginger. Table 4.3 shows the result of the analysis carried out. A significant correlation ($p< 0.01$) was found between methods of drying and the nutritional composition investigated.

The crude fibre, fat and carbohydrate contents had significant ($p< 0.05$) effect under blanched condition while Ash, moisture and protein contents had no significant ($p> 0.05$) effect under blanched condition. The moisture, Ash, protein contents had significant ($p< 0.05$) effect under unblanchedcondition while crude fibre, fat and carbohydrate contents had no significant ($p> 0.05$) effect under unblanched condition.

IV. Conclusion

The following conclusions were drawn from the study;

i. The effects of drying methods on crude fibre, crude protein, total ash content, moisture, carbohydrate and gingerol content of sliced ginger rhizomes under blanched and un-blanched conditions was investigated.
ii. The drying methods and pre-treatment (blanching) greatly affected the gingerol content of the ginger slices. The cabinet dried at 70^{o}C blanched ginger slices had the highest gingerol content compared to the value obtained from other drying methods investigated.
iii. The cabinet dried at 70^{o}C unblanched sample had the least moisture content (9.30%), oven dried unblanched sample had the highest protein content (13.32%).
iv. The highest carbohydrate content was recorded by the cabinet dried at 60^{0}C blanched ginger powder. According to Otunla*et al.* (2010) the high carbohydrate content of ginger ranked it as a carbohydrate rich spice.
v. The crude fibre value obtained in the study ranged between (8.30-10.31)% with the cabinet dried at 70^{o}C blanched ginger powder having the highest crude fibre content.
vi. The fat content of the oven dried ginger powder was the highest (11.56%) while the range of value of Ash content obtained in the study corresponds with that reported by Ajayi*et al.*(2017).
vii. The results from the statistical analysis using the calculated spearman's correlation show that there are relationships between methods of drying, pre-treatments and the nutritional composition. A significant correlation ($p<0.01$) was found between the methods of drying and the nutritional compositions investigated. The crude fibre, fat and carbohydrate had significant ($p<0.05$) effect under blanched condition while Ash, moisture and protein contents had no significant ($p>0.05$) effect under blanched condition. The moisture, Ash, protein contents had significant ($p<0.05$) effect under unblanched condition while crude fibre, fat and carbohydrate contents had no significant ($p>0.05$) effect under unblanched condition.

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