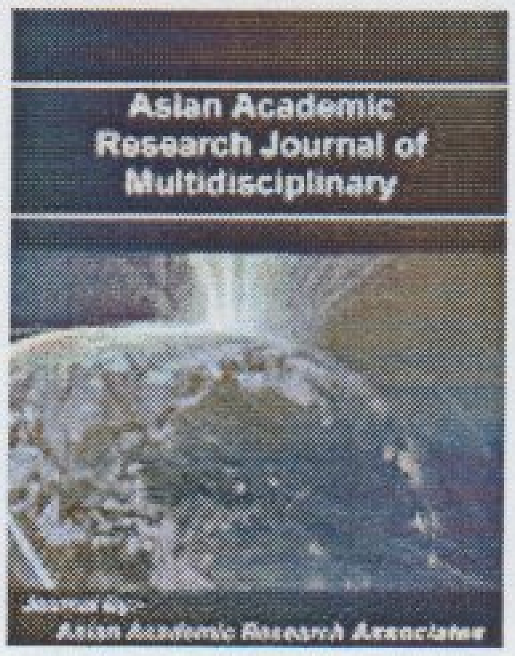
A Peer Reviewed International Journal of Asian Academic Research Associates

AARJMD

ASIAN ACADEMIC RESEARCH JOURNAL OF MULTIDISCIPLINARY



THE EFFECT OF DRYING ON THE NUTRITIONAL PROPERTIES OF GINGER (ZINGIBER OFFICINALE ROSC.)

ORHEVBA B.A*; EGBITA, C.O**

*Department of Agricultural and Bioresources Engineering, Federal University of Technology, PMB 65, Minna, Niger State, Nigeria

**Department of Agricultural and Bioresources Engineering, Federal University of Technology, PMB 65, Minna, Niger State, Nigeria

ABSTRACT

The effects of drying as a processing technique on ginger were investigated with respect to the proximate compositions of the produce. Matured ginger rhizomes (variety UG_1 also known as *Tafin-Giwa*) were collected, graded and sorted into three (3) groups of equal weights with sample codes A, B and C. Sample A was left unprocessed (fresh) while samples B and C were dried using the Oven and Sun drying methods respectively to a specified percentage weight loss of between 90 – 95% after which the three (3) samples were taken to the laboratory and their proximate compositions determined. The Oven-dried process took a total period of 13hours at a regulated temperature of 55^0C and the percentage weight loss was found to be 90.18% while the Sun-drying process took a total period of 5days (12hours per day) at an average ambient temperature of 38.16^{0}C and the percentage weight loss of the rhizomes was 90.95%. The Analysis of the results of proximate compositions showed that the moisture content, lipid content and carbohydrate content of ginger reduced after drying while the ash and protein contents increased. The crude fibre content of fresh ginger increased after Oven drying and reduced after Sun drying. The moisture, lipid and carbohydrate contents of the oven-dried ginger were 7.93%, 10% and 46.74% respectively, which were less than those of the sun-dried ginger with values of 10.83%, 11.33% and 63.03% respectively. On the other hand, the ash content, crude fibre content and crude protein content of the oven-dried ginger were 13.77%, 17.63% and 12.46% respectively and were greater than those of the sun-dried with values of 7.73%, 6.6% and 11.25% respectively. Thus, based on the results obtained in this study , it was concluded that during drying of ginger rhizomes, not only the moisture of the produce was affected but other nutritional parameters were also affected due to the presence of volatile and heat-sensitive compounds in the produce. The oven-drying technique however was a better option for the drying process as it was more effective in removing sufficient moisture and also enhanced some nutritional parameters of the produce; however the sun-drying technique remains a better option for the extraction of ginger oil.

Key words: Oven drying, Sun drying, Ginger, Rhizomes, Nutritional properties

1.1 INTRODUCTION

The spice ginger is obtained from the underground stems or rhizomes of *Zingiber officinale (Rosc.)*, a herbaceous tropical perennial belonging to the family *Zingiberaceae*. The plant *Zingiber officinale* is a monocotyledonous perennial plant although it is cultivated as an annual crop and propagated vegetatively by the cuttings of the fresh rhizomes (Sutherland, 1981). Basically it is cultivated in all the tropical and sub-tropical regions of the world. The whole plant is refreshingly aromatic, but it is the underground rhizome, raw or processed, that is valued as spice. Its medical value is increasingly being recognized. Ginger originated in South-East Asia, probably in India (Burkill, 1966; Purseglove *et al*., 1981). The name itself supports this view. The Sanskrit name '*Singabera*' gave rise to Greek '*Zingiberi*' and later the generic name '*Zingiber*'. Ginger (*Zingiber officinale Rosc.*) belongs to the family *Zingiberaceae* and to the order *Zingiberales*. Nearly half of the world's production comes from India. Other major producers of ginger are Brazil, Jamaica, Nigeria, Thailand, Australia, Fiji, Philippians, Bangladesh and Indonesia (FAO, 2008).

Ginger is mostly consumed as a whole delicacy, spice or herb. It is used as a spice in culinary, beverage, confectionary, pharmaceutical and perfumery industries (Njoku *et al*., 1995). It is an important export crop valued for its powder, oil and oleoresin (NEPC, 1999). It is sometimes called 'root ginger' to distinguish it from other things that share the name 'ginger' (Wikipedia, 2011). Ginger is majorly used or available in five different forms; Fresh (or wet) ginger, Dry ginger, Preserved ginger, Pickled ginger and Crystallised ginger. Primary products of ginger rhizomes for flavouring purposes are fresh ginger, preserved ginger in syrup or brine and the dried ginger. Secondary products are ginger powder, oils and oleoresins from dry ginger. Dried form of ginger is the most traded in European countries. Ginger oil and Oleoresins are also widely traded for its flavouring and medicinal properties. Confectionery ginger which constitutes 3% of the world trade give higher rate of return compared to the fresh or dried rhizomes. Australia, China, Fiji and Thailand are the major processors and exporters of confectionery ginger. India produces ginger in different forms like oils, oleoresins, and fresh ginger in brine, pickles, candies and syrups (Spice Trade, 2011).

There is little or no research on ginger handling and processing hence no known research information on ginger production and processing for the Nigerian farmers. Farmers are therefore handling and processing their ginger using primitive practices inherited from ancient traditions resulting in poorly and unhygienically processed ginger (Maigida and Kudi, 2000). The processing of the Nigerian ginger has not been standardized with the result that microbiological, organoleptic and chemical properties of the products often fall short of importers' specifications. The amount of foreign exchange earned by exporting dry ginger is however very insignificant when compared with the amount spent on importing processed ginger products thereby substantiating the need for industrial processing of the Nigerian ginger within Nigeria (Meadows, 1988). Consequently, Nigerian ginger receives low rating in international markets and hence loss in foreign exchange earnings. The traditional drying methods used by farmers to dry ginger are varied, haphazard and risky, resulting in mould growth, loss of some volatile oil by evaporation and destruction of some heat-sensitive pungent properties (Ebewele and Jimoh, 1981). It is therefore expedient to make room for improvement on the traditional processing and drying methods so as to improve the appearance and general quality of dried ginger. This project is therefore being carried out to determine the effects of 'drying' on the proximate composition of ginger.

1.2 MATERIALS AND METHODS

1.2.1 Materials

Freshly harvested matured ginger rhizomes, specie: UG_1, known locally as *Tafin-Giwa,* were obtained from Abdul Farms at Nok Village in Kafancha LGA of Kaduna State, Nigeria. The Matured fresh ginger rhizomes are shown in Plate 1.1.

Plate 1.1: Matured fresh ginger rhizomes

1.2.2 Methods

After the matured rhizomes (7 - 9 months of growing period) were collected from the farm, they were sorted and transferred to a bath containing warm water and washed thoroughly to remove soil particles, dirts and other contaminants that might have been clogged to them. After washing, the water was completely drained off from the rhizomes.

The cleaned rhizomes were then collected together in a large bowl. Using the electronic weighing balance (Mettler weighing balance, sensitivity = 0.01g, Serial No. H52764), 1000g of the rhizomes was measured and kept in a bowl labelled Sample A. Another 1000g of the rhizomes was measured again using the electronic weighing balance and kept in a bowl labelled Sample B. Finally another 1000g of the rhizomes was measured using the electronic balance into a third bowl labelled Sample C. Sample B was taken for Oven drying (Gallenkamp Oven 300 Plus Series, APP NO: 2062P 19N, CAT No. = OVE 200 210G) while Sample C was taken for Sun drying.

Using a paring knife, the rhizomes in each Sample were split into slices of uniform thickness. Splitting was done lengthwise (longitudinal dissection) and it was ensured that the thickness of the splits were uniform to allow even drying of the entire rhizomes.

Drying

Oven Drying

The rhizomes in sample B were then taken to the electric oven for drying. The slices were arranged on drying racks such that one slice does not climb over another then the racks inserted into the oven. The oven was then regulated at a temperature of 55^0C and the stop watch set to a time lag of 5 hours after which the oven was switched on.

At the end of every 5 hours, the weight of the dried rhizomes was measured using the electrical weighing balance and the percentage loss in weight calculated using the formula:

$$\text{Percentage loss in weight} = \frac{\text{Original Weight} - \text{Weight after Drying}}{\text{Original Weight}} \times 100\%$$

Drying was continued until the percentage loss in weight fell within the range of 90 – 95%. The dried rhizomes at this stage were collected together and kept in a bowl labelled Sample D.

Sun Drying

The prepared rhizomes in Sample C were placed under direct sunlight to dry. They were spread uniformly on a metallic sheet such that they do not touch or climb over one another to allow even drying of the entire rhizomes and then covered with a wire gauss (screen) to prevent incorporation of free moving particles in air that could produce contamination and also to prevent pests. The metallic sheet used was well cleaned and black coated to check against loss of heat energy from the sun. The sheet (containing the rhizomes) with the screen on it was then placed in a sunny location for days to allow drying of the rhizomes.

Using the Temperature/Humidity meter Temperature/Relative Humidity meter (Model No. UT-5525 Temperature measuring accuracy – ±0.2°C, Relative humidity accuracy - ±0.2%), the temperature and relative humidity for each drying day was measured and recorded over a time lag of 6a.m to 6p.m with a range of 3 hours; the average temperature and relative humidity of each day was then calculated as:

$$\text{Average temperature in a day} = \frac{\sum \text{Temperatures measured in that day}}{5}$$

$$\text{Average Relative Humidity in a day} = \frac{\sum \text{Relative Humidity in that day}}{5}$$

The percentage loss in weight was also calculated at the end of drying day as:

$$\text{Percentage loss in weight} = \frac{\text{Original Weight} - \text{Weight after Drying}}{\text{Original Weight}} \times 100\%$$

Drying was continued until the percentage loss in weight fell within the range of 90 – 95%. The dried rhizomes at this stage were collected together and kept in a bowl labelled Sample E.

The mean daily temperature was then computed by calculating the mean of all the average temperatures of the drying days i.e.

$$\text{Mean daily temperature of the entire drying period} = \frac{\sum \text{All daily Temperatures}}{\text{Number of drying days}}$$

Also, the mean daily relative humidity was calculated as the mean of the average relative humidity of the drying days i.e.

$$\text{Mean daily Relative Humidity of the entire drying period} = \frac{\sum \text{All daily R.H}}{\text{Number of dying days}}$$

The mean daily temperature calculated was then recorded as the drying temperature for the biomaterials (ginger rhizomes) and the mean daily relative humidity calculated was then recorded as the relative humidity as at the period of drying.

1.2.3 Experimental Procedures

The proximate composition of the samples A, B and C were determined according to the method described by the Association of Official Analytical Chemists (2000), these were done in three replicates.

1.3 RESULTS AND DISCUSSION

1.3.1 Results

The temperature used in drying the rhizomes in the oven was 55^{0}C. The result of the percentage loss in weight of the ginger rhizomes during the Oven drying procedure is presented in the table below:

Table 4.1: Results Computed from the Oven Drying Method of Processing

Session	Original Weight of Sample (g)	Weight After Drying (g)	Weight loss (g)	%loss in weight
5 Hours	1000	432.1	567.9	56.79
5 Hours		120.5	879.5	87.95
3 Hours		98.2	901.8	90.18

Therefore the total drying time = 13hours and the percentage loss in weight after drying period = 90.18%.

The summary of the results of the daily recorded temperatures and Relative Humidity of the entire sun drying period as well as the percentage loss in weight for each drying day is shown in Tables 4.2.

Table 4.2: Summary of Results for Sun drying Method

Day	Average temp (°C)	Average R.H (%)	Weight After Drying (g)	%loss in weight

1	36.24	43.28	533.4	46.66%
2	36.50	37.48	3 81.8	61.82%
3	36.48	40.60	300.1	69.99%
4	40.92	34.40	159.8	84.02%
5	40.68	37.62	90.5	90.95%
Average	38.16	38.68		

Therefore, the mean daily temperature for the entire 5 days of drying = 38.16^{0}C and the mean daily relative humidity for the entire 5 days of drying = 38.68%. The percentage loss in weight of the rhizomes after the entire drying period = 90.95%.

The results of proximate composition of fresh ginger samples (A), Oven-dried ginger samples (B) and sun dried ginger samples (C) are presented in Tables 4.3 to 4.5.

Table 4.3: Proximate Composition of Fresh Ginger (Sample A)

Nutrients	Composition (%)			Mean (%) ± S.D
	Replicate 1	Replicate 2	Replicate 3	
Moisture	88.8	88.2	88.5	88.5 ± 0.17
Ash	2.5	2.0	2.8	2.43 ± 0.35
Lipids	18	13	16.8	15.93 ± 2.13
Crude Fibre	8.7	8	8.2	8.30 ± 0.29
Crude Protein	9.80	9.0	9.59	9.46 ± 0.34
Carbohydrates	61	68	62.61	63.87 ± 2.99

Table 4.4: Proximate Composition of Oven-dried Ginger (Sample B)

Nutrients	Composition (%)			Mean (%) ± S.D
	Replicate 1	Replicate 2	Replicate 3	

Moisture	9.2	6.4	8.2	7.93 ± 1.16
Ash	13.5	12	15.8	13.77 ± 1.56
Lipids	10	9	11	10 ± 0.82
Crude Fibre	16	18	17.1	17.03 ± 0.82
Crude Protein	12.25	12.59	12.55	12.46 ± 0.15
Carbohydrates	48.25	48.41	43.55	46.74 ± 2.25

Table 4.5: Proximate Composition of Sun-dried Ginger (Sample C)

Nutrients	Composition (%)			Mean (%) ± S.D
	Replicate 1	Replicate 2	Replicate 3	
Moisture	12	9.6	10.9	10.83 ± 0.98
Ash	7	8.5	7.7	7.73 ± 0.61
Lipids	11	11	12	11.33 ± 0.47
Crude Fibre	6.7	6.7	6.4	6.6 ± 0.14
Crude Protein	11.38	11.2	11.18	11.25 ± 0.09
Carbohydrates	63.92	62.6	62.72	63.03 ± 0.60

1.3.2 Discussion of Results

The proximate results obtained showed a drastic drop in the percentage moisture of fresh ginger after drying from 88.5% ± 0.17 to 7.93% ± 1.16 for Oven-dried and 10.83% ± 0.98 for Sun-dried ginger, this explains the reason why raw ginger rhizomes are bulbous, thick and juicy while the dried rhizomes are harder and stringier thus making them easier to handle and store. It was also observed that the dried roots are more pungent in terms of odour than the fresh roots probably due to the fact that moisture has been driven off from the fresh roots. It can be clearly seen that as the roots dry up due to effect of heat, Moisture is not the only parameter that is affected but other nutritive parameters are affected as well; since the 'drying' process is targeted at removing moisture in other to preserve the ginger roots or change its form, a look at the moisture content of each of the two products (7.93% ± 1.16 for the Oven-dried and 10.83% ± 0.98 for the Sun-dried) and comparing them with their respective percentage loss in weight after drying, (90.18%

for Oven-dried and 90.95% for Sun-dried) shows that the other parameters (Ash, Lipid, Crude Fibre, Crude Protein and Carbohydrates) were more affected during the drying process in the Sun-dried case. This is probably due to the fact that the Sun-drying technique is not a controlled system and is subject to humidity (moisture in air) in the drying atmosphere which is another source of moisture to the rhizomes. Thus it can be said that the Oven drying method is better in processing ginger for storage because it reduces more amount of moisture in the produce and thus promoting its shelf life and reducing microbial growth and infestation of the produce.

The ash content of the fresh rhizomes were found to increase after drying from 2.43% ± 0.35 to 13.77% ± 1.56 for Oven-dried (an extravagant increase of about 467%) and 7.73% ± 0.61 for Sun-dried ginger; this goes to show that the organic matter of ginger roots are reduced when they are dried and the mineral content of the dried roots are higher than the fresh ones thus they (dried roots) are better sources for medicinal purposes. It can also be said that the Oven dried ginger contains more inorganic matter than the Sun dried ginger as some amount of the organic matter of the oven dried ginger might have been lost due to the high heating temperature given that they are volatile. Ash residue is generally taken to be a measure of the mineral elements in foodstuff (Gregory, 2008).

Fresh ginger contains volatile oils that constitutes 1 – 3% its weight; this could be the reason why the amount of lipids (ether extract) dropped from 15.93% ± 2.13 to 10% ± 0.82 for Oven-dried and 11.33% ± 0.47 for Sun-dried after drying the fresh ginger roots. During splitting of the roots to increase the rate of drying, these volatile oils are being given off to the atmosphere. The percentage lipid (ether extract) of the Oven dried method was found to be slightly lower than that of the Sun dried method (10% ± 0.82 for Oven dried and 11.33% ± 0.47 for Sun dried). This is probably due to the fact that ginger (which contains high amount of volatile oils) was subjected to a higher temperature in the Oven drying technique (55^0C) compared to that of the Sun drying technique (38.16^0C) therefore more losses would be incurred in the Oven drying technique than the Sun drying technique; in order words, Sun dried ginger contains slightly higher percentage of lipids (oils) than Oven dried ginger.

The percentage Crude Protein of the fresh roots increased from 9.16% ± 0.34 before drying to 12.46% ± 0.15 and 11.25% ± 0.09 after Oven-drying and Sun-drying respectively thus showing that dried ginger is more proteinase than the raw roots.

The Carbohydrate content of ginger roots was found to reduce from 63.87% ± 2.99 for the fresh roots to 46.74% ± 2.25 for the Oven-dried and 63.03% ± 0.60 for the Sun-dried roots. The two drying methods however showed a great difference in comparing each result with that of the fresh roots but overall there was a decrease in each case, while the Sun dried roots tend to reserve much of the sugar content (energy) of the fresh root as carbohydrate content of fresh roots reduced slightly from 63.87% ± 2.99 to 63.03% ± 0.60, the Oven dried roots produced a drastic drop in the carbohydrate content to 46.74% ± 2.25. This shows that the Sun dried roots has a higher calorific value than the Oven dried roots and thus it is a more reliable source of energy however the Oven-dried roots serve as a better option for diabetics.

The Crude Fibre content is the only parameter which showed different variability in comparing the fresh roots with each of the dried roots. It was observed that while there was an increase in the percentage crude fibre of the fresh roots after drying using the Oven drying method from 8.3% ± 0.29 to 17.03% ± 0.82, a drop from 8.3% ± 0.29 to 6.6% ± 0.14 was recorded in the Sun drying technique this shows that the Crude fibre of all dried roots varies with technique of drying. Therefore one cannot specifically say the crude fibre content of dried roots are higher or lower than that of fresh roots but depends on the method of drying used. Research has shown that diets low in fibre are unhealthy and can cause diseases such as diabetes mellitus, obesity and coronary heart disease; ginger is known to be fibrous which is why it is used as a good food supplement and one of the world's most popular spice (Mensah et al., 2009; Bhattacharjee and Sengupta, 2009; Soetan and Aiyelaagbe, 2009). The Oven drying technique was found to increase the crude fibre content of the fresh roots from 8.3% ± 0.29 to 17.03% ± 0.82 while the Sun drying technique was found to reduce the crude fibre content of the fresh roots from 8.3% ± 0.29 to 6.6% ± 0.14. During drying, it was observed that the Sun dried roots shed much of its cork skin than the Oven dried roots; this explains the increase in the fibre content of the Oven dried roots and decrease in the Sun dried roots. This was also evident in the colour of the respective roots; the Oven dried rhizomes were golden brown in colour while the sun dried rhizomes were pale yellow in colour. Therefore it can be said that the Oven drying method increases the fibre content of ginger while the Sun drying method reduces it. The Sun-dried ginger would be better suited for extraction of oil since it lowers the fibre content of the rhizomes whereas in the production of powdered ginger as a spice, the oven-dried ginger is better off.

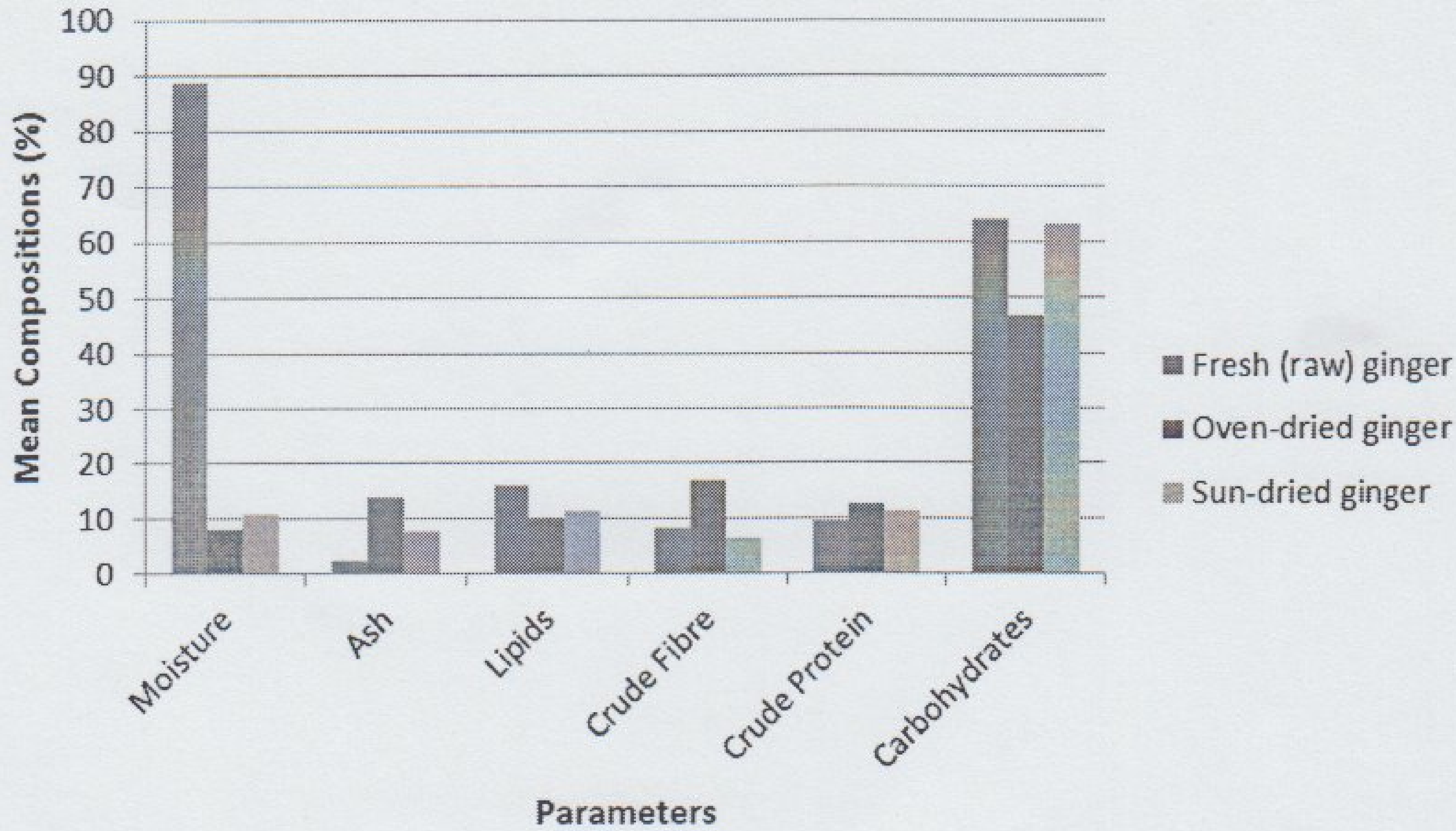


Fig.1: Bar Chart showing the Mean Proximate Compositions of Samples A, B and C.

1.4 Conclusion

This study has shown that the proximate composition of ginger is affected when it is being dried. The high drop in moisture content of fresh ginger when dried shows an increase in quality in terms of durability and usability. Heat treatment of ginger alters its proximate composition due to the fact that most of the chemical constituents of ginger are volatile and as such, are given off when subjected to high temperature or heat. A clear evidence of this is the reduction in the lipid content of ginger as it is dried.The Oven drying technique from the study proved to be more efficient than the Sun drying technique in terms of rate and quantity of moisture reduction, fibre content, mineral content and protein content while the Sun drying method proved to better in terms of the lipid content, carbohydrate content and organic matter content.

1.5 References

Association of Official Analytical Chemist in (2000): Official Methods of Analysis 13th edition, Arlington, USA, Association.

Bhattacharjee S. and Sengupta A. (2009). Spices in cancer Prevention: An overview. Internet J. Nutrition Wellness p.7(1).

Burkill I. H. (1966). A *Dictionary of the Economic Products of the Malay Peninsula, Kuala Lumpur*, Ministry of Agriculture and Co-operatives.

Ebewele R. O. and A. A. Jimoh (1981). Feasibility study of Kaduna State ginger processing industry. *Ahmadu Bello University Chemical Engineering Consultant,* 1-45, 50 –56, 63 – 80

Food and Agricultural Organisation FAO Statistical Database (2008). http://www.fao.org/htm document. Retrieved 01-04-2011.

Gregory I. O. (2008). Food Analysis and Instrumentation; Theory and Practise. Department of Food Science and Technology. Michael Okpara University of Agricultural Umudike Umuahia, Nigeria.

Maigida D. N. and M. T. Kudi (2000). Improving the traditional methods of processing ginger. Rural Women Participation in Agriculture, Kwoi, Kaduna State, 1 - 4.

Meadows A. B. (1988). Ginger processing for food and industry: *Proceedings of first National Ginger Workshop,* Umudike, Nigeria, 34 – 42.

Mensah J. K., Okoli R. I., Turay A. A., Ogie-Odia E. A. (2009). Phytochemical analysis of medicinal plants used for the management of hypertension by *Esan* people of Edo State, Nigeria.

NEPC (1999). Product profile of ginger. Nigerian Export Promotion Council B/K 312, *Kumba St, Wuse, Zone, II,* Abuja, 1-6.

Njoku B. O., E. N. A. Mbanaso and G. N. Asumugha (1995). Ginger production by conventional and tissue culture techniques. *Dolf Madi publishers,* Owerri, 13-14.

Purseglove J. W., Brown E. G., Green C. L. and Robbins S. R. J. (1981). Spices *Vol.2*. Longman Inc. New York.

Soetan K. O. and Aiyelaagbe O. O. (2009). The need for bioactivity-safety evaluation and conservation of Medicinal plants – A review. J. Med. Plant Res. 3(5): 324-328.

Spice trade (2011) http://www.spice-trade.com/ginger.html document. Retrived 01-04-2011.

Sutherland J. A. (1981). Introduction to tropical agriculture. *3rd Edition,* 114-115.