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Effect of selected oven drying temperatures on the quality of Tiger Nut (*Cyperus Esculentus*) and Ginger Nut (*Zingiber Officinale*)

Abdulaziz Nuhu Jibril*, Abubakar Aliyu Ishaq

Department of Agricultural & Environmental Engineering, Bayero University, Kano, Nigeria

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ABSTRACT

The present study was to evaluate the effect of selected drying temperatures on the quality of tiger nut (*Cyperus Esculentus*) and ginger (*Zingiber Officinale*). The temperatures used were 25, 50, and 75°C for 4 hours. The quality composition determined were moisture content, crude protein, crude fiber, crude fat, ash content, and carbohydrate. From the results, the tiger nut parameters that show significant difference at the three drying temperatures 25, 50, and 75°C with their mean values were moisture content 0.05, 0.20, and 1.05%, crude protein 8.75, 6.56, and 5.47%, and crude fat 10.28, 14.60 and 12.65%. For ginger nuts were moisture content was 1.25, 2.15, and 2.60%, and crude protein was 15.31, 14.22, and 17.50%. While the parameters that show no significant difference at the three drying temperatures 25, 50, and 75°C with their mean values were crude fiber 1.26, 1.27, and 1.28%, ash content 2.95, 3.95, and 4.90%, and carbohydrate 76.75, 74.62, and 75.72. For gingers were ash content 8.7, 6.50, and 7.35%, crude fat 8.72, 10.43 and 9.20%, crude fiber 1.42, 1.23 and 1.28%, and carbohydrate 65.84, 67.63, and 64.67. Drying temperatures are crucial in affecting food internal structure, composition and widely practiced as a method of preserving agricultural products because of its ease and affordability.

1. Introduction

Ginger nut "*Zingiber Officinale Rose*" is a tropical species native to South East Asia. It is a part of the *Zingiberaceae* family. The useful part of this plant is subterranean rhizomes. In tropical countries, fresh ginger root is usually consumed as a spice, and dried ginger is used internationally as a medicinal plant. Typically, dried ginger is used as seasoning or medicine. Export quality requirements as a medicinal herb needed careful cutting into parts, well dried, and proper storage [1].

Nigeria is ranked first in the world in terms of the percentage of total hectares of ginger under cultivation but its yield production is small, resulting in it being the fifth producer and the third dried ginger exporter after India and China [2].

Gingernut has an estimated composition of 3 to 6% fatty oil, 9% protein, 60 to 70% starch, 3 to 8% fiber, 8% ash, 12% water, and 2-3 % volatile oil [3]. Gingernut is marketed internationally in the form of three primary products: fresh (i.e. in its green state), preserved, and dry ginger, its oil and oleoresins are also used in many foodstuffs, soft drinks, and beverages [4].

Tiger nut "*Cyperus Esculentus Lativum*" is an underused *Cyperaceae* family tuber developing rather spherical rhizomes from the tuber base [5]. It is a tuber that grows freely and is widely consumed in Nigeria, other parts of West Africa, East Africa, parts of Europe particularly Spain, and the Arab Peninsula. Tiger nut milk was known as a medicinal drink because it was highly energetic and diuretic, rich in minerals, mainly phosphorus and potassium, as well as vitamins C and E [6]. It is basically eaten raw and had received very limited value addition or product development. The tubers contain significant amounts of protein, fat, minerals, fibre, ash, and vitamins that can increase our diets nutritional quality. Alternatively,

* *Corresponding author*. Tel.: +2348066660770
E-mail address: anjibril.age@buk.edu.ng
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tigernut tubers may be used to treat flatulence, indigestion, diarrheal, dysentery and excessive thirst [7].

In Nigeria tiger nuts are a traditional food that can be eaten in different forms. They can be eaten raw as a healthy snack or made into an all-natural, tasty, milky drink known as "*Kunnu Aya (Tiger Nut Milk)*" that serves as a healthy drink or a lactose-free alternative to dairy milk. This cropmilk is also suitable for people with gluten intolerance and those suffering from allergies to the nut [8].

The demand for dry ginger nut and tiger nut in the local and international markets is becoming greater. This implies that more attention should be given to improved drying and storage of these crops to enhance their economic value and increase their shelf life. Drying of ginger nuts and tiger nuts, like other agricultural products, is hygroscopic and is hence affected by environmental conditions such as temperature and relative humidity [9].

The effect of drying temperature is necessary when processing and preserving agricultural products by simple methods like sun drying, salting, smoking, pickling, and advanced methods like canning, dehydration, freezing, and freeze-drying. The objective of this study was to investigate the effect of oven drying temperature 25, 50 and 75 ^{0}C on proximate composition such as moisture content, fiber content, fat content, protein content, total carbohydrates, and ash content for gingernut (*Cyperus Esculentus*) and tiger nut (*Zingiber Officinale*) which will serve as useful information for the prediction of the nutritional composition of these products.

2. Materials and Methods

2.1 Sample preparation

Gingernut (*Zingiber Officinale*) and tiger nut (*Cyperus Esculentus*) were obtained from 'Yan- Kaba Market, Kano State, Nigeria. The fresh ginger nut and tiger nut were thoroughly cleaned with water and wiped with absorbent paper to remove the residual water on the surface. The samples were sliced and divided into three equal portions and the three portions were oven-dried using an electric oven at temperatures of 25, 50, and 75 °C. Thereafter, the proximate analysis of the samples was performed and the quality and nutritional composition were determined which include ; moisture content, fiber content, fat content, protein content, total carbohydrates, and ash content.

Fig 1. (a) fresh tiger nut; (b) dried tiger nut.

Fig 2. (a) fresh ginger nut; (b) dried ginger nut.

2.2 Proximate analysis of the samples

The analyses were carried out at the Faculty of Agricultural Science Laboratory, Bayero University Kano, Nigeria. All the parameters of proximate analysis composition were carried out in triplicate using the Official Methods of Analysis by the Association of Official and Analytical Chemist [10].

2.2.1 Determination of moisture content

2g of the fresh samples of the ginger nut and tiger nut each in triplicates were dried at the 110±5^{0}C in the oven for 4 hours. The moisture content was calculated using the following formulae

$$Moisture\ Content\ (db) = \frac{W_2 - W_3}{W_2 - W_1}\ x\ 100\% \quad (1)$$

Where;

W_1 = Weight of empty container (g), W_2 = Weight of container + Sample before drying (g), W_3 = Weight of container + Sample after drying (g)

2.2.2 Determination of protein content

0.2g each of ginger and tiger nut were weighted accurately and digested with 15ml concentrated sulfuric acid ($H_2\ SO_4$) in the presence of Kjeldahl catalysts. The flask was heated gently in an inclined position till the light blue color solution was obtained. Then the flask was heated on a high flame for 3 hours. Then the digestion mixture was cooled at room temperature. The digest was washed into the distillation flask with distilled water. The nitrogen from the protein in the sample was converted to ammonium sulphate that reacted with 10ml of 2% boric acid 15ml of 40% NaOH to give a slight pink color derivative. The percentage of the crude protein was calculated by [10].

$$Protein\ Content = \frac{(A-B)\times Nacid\ \times F\times 6.25}{Weight\ of\ sample} x100 \quad (2)$$

Where;

A= ml of acid used for titrate sample, B= ml of acid used for titrate blank sample (0), N= normality of acid, F= factor 14.007

2.2.3 Determination of fat content

The fat content was conducted using the Soxhlet method. 2g of each ginger nut and tiger nut samples were weighed and wrapped with a filter paper and placed in a thimble. The thimble was covered with cotton wool and placed in the extraction column that was connected to a condenser (Soxhlet assembly). 250ml of petroleum ether (60 – 80^{0}C) was used to extract the lipid as described by [10].

$$Fat\ Content = \frac{F_2 - F_3}{Weight\ of\ sample}\ x\ 100\% \quad (3)$$

Where;

F_2 = Weight of filter paper and sample before extraction (g), F_3 = Weight of filter paper and sample after extraction (g)

2.2.4 Determination of fibre content

0.5g of ginger nut and tiger nut samples each in the triplicate and digests with 200 ml of 1.25% sulphuric acid by gentle boiling for half an hour. The residue had been washed with distilled water until acid-free. Using 200ml of 1.25% sodium hydroxide to boil the residue again for half an hour, it was filtered and washed several times with distilled water until it was alkaline-free. It was then rinsed with 10 percent Hcl and ethanol twice. It was subsequently rinsed three times with petroleum ether. The residue was put in a crucible and dried at 105°C in an oven overnight. After cooling in a desiccator, it was ignited in a muffle furnace at 550°C for 4 hours to obtain the weight of the ash as described by [10].

$$Fibre\ Content = lost\ in\ weight\ after\ incineration\ x\ 100\% \quad (4)$$

2.2.5 Determination of ash content

The total ash content of a substance is the percentage of inorganic components remaining after the organic matter has been burnt. 2g each of ginger nut and tiger nut samples in the triplicate was placed in a crucible and burnt in a muffle furnace at 550°C for 6 hours. It was then cooled in a desiccator and weighed at room temperature to get the weight of the ash determined by (AOAC, 1998).

$$Ash\ Content = \frac{Weight\ of\ ash}{Weight\ of\ original\ food}\ x\ 100\% \quad (5)$$

2.2.6 Determination of carbohydrate

The carbohydrate content was determined by subtracting from 100 the summed-up percentage composition of moisture, fat, lipid, fiber and ash content [11].

$$\%Carbohydrate = 100 - \begin{pmatrix} \%protein + \%moisture + \%fat + \%lipid + \\ \%ash + \%fiber \end{pmatrix} \quad (6)$$

3. Results and Discussion

The proximate composition consists of moisture content, crude protein, crude fat, crude fiber, ash content, and carbohydrates. The results were for the nutritional composition of ginger nut and tiger nut under the three different drying temperatures which include 25, 50, and 75°C are shown in Table 1, and Table 2 shows the least significant differences in the quality of ginger nut and tiger nut. The results were analyzed using Analysis of Variance (ANOVA).

Table 1: Effect of Selected Oven Drying Temperatures on Quality of Ginger Nut and Tiger Nut (ANOVA)

Nutritional Component (%)	Selected Oven Drying Temperatures (^{o}C)						F-Values		Pr>F	
	25		50		75					
	Gingernut	Tiger nut	Gingernut	Tiger nut	Gingernut	Tiger Nut	Gingernut	Tiger Nut	Gingernut	Tiger Nut
Moisture content	2.60	1.05	2.15	0.20	1..25	0.05	1840.50**	780.54**	0.001	0.001
Crude protein	15.31	8.75	14.22	6.56	17.50	5.47	73.29**	89.35**	0.007	0.005
Crude fiber	1.42	1.27	1.23	1.27	1.28	1.28	0.85^{ns}	0.00^{ns}	0.494	0.999
Crude fat	8.72	10.28	10.43	14.60	9.20	12.63	4.76^{ns}	29.70*	0.088	0.004
Ash content	8.70	2.95	6.50	2.95	7.35	4.90	3.59^{ns}	5.66^{ns}	0.128	0.068
Carbohydrate	65.84	76.75	67.63	74.62	64.67	75.72	0.45^{ns}	0.28^{ns}	0.668	0.769

** Highly significant at 1% level
* Significant at 1% level
ns Not significant

The result in table 1 showed that the drying temperature has a significant effect on the moisture content and crude protein with an increase in temperature for both ginger nut and tiger nut. This is in line with the [12, 13] findings who

reported a decrease in moisture content with increasing temperature while the crude fat was affected significantly for tiger nut. However, the drying temperature has no significant effect on crude fiber, ash content, and carbohydrate on both Gingernut and Tiger nut. The study showed that replications have no significant effect on the quality of this product which means that there is minimum experimental error.

Table 2: Least Significant Difference in Quality of Ginger Nut and Tiger Nut (LSD)

Nutritional Component (%)	**Selected Oven Drying Temperatures (°C)**					
	25		**50**		**75**	
	Gingernut	Tiger nut	Gingernut	Tiger nut	Gingernut	Tiger Nut
Moisture content	1.25333^{c}	0.5200^{b}	2.15333^{b}	1.05333^{a}	2.63333^{a}	0.21333^{c}
Crude protein	15.3100^{b}	8.750^{a}	14.2167^{b}	6.5667^{b}	17.5033^{a}	5.4567^{b}
Crude fiber	1.4220^{ns}	1.2723^{ns}	1.2780^{ns}	1.2680^{ns}	1.2267^{ns}	1.2823^{ns}
Crude fat	8.7200^{ns}	10.2833^{b}	10.433^{ns}	14.6033^{a}	9.1700^{ns}	12.6300^{a}
Ash content	8.7000^{ns}	2.9500^{ns}	6.5000^{ns}	2.9500^{ns}	7.3500^{ns}	4.9000^{ns}
Carbohydrate	65.840^{ns}	76.750^{ns}	67.630^{ns}	74.620^{ns}	64.670^{ns}	75.723^{ns}

The results in the present study showed that moisture content of ginger nut was found highest at 25°C, followed by 50°C and the least was found to be at 75°C while similar trend in the tiger nut was found Crude protein for ginger nut was found to be very high at 75°C were 50°C and 25°C showed the result obtained was similar, the crude protein of tiger nut was found to be highest at 25°C followed by 50°C and 75°C which are found to be similar. No significant difference was found to be in crude fat for ginger nut but tiger nut showed the highest at 25°C, followed by 50°C and 75°C which are found to be similar. The result showed that there is no significant different on crude fibre, ash content and carbohydrate for both ginger nut and tiger nut.

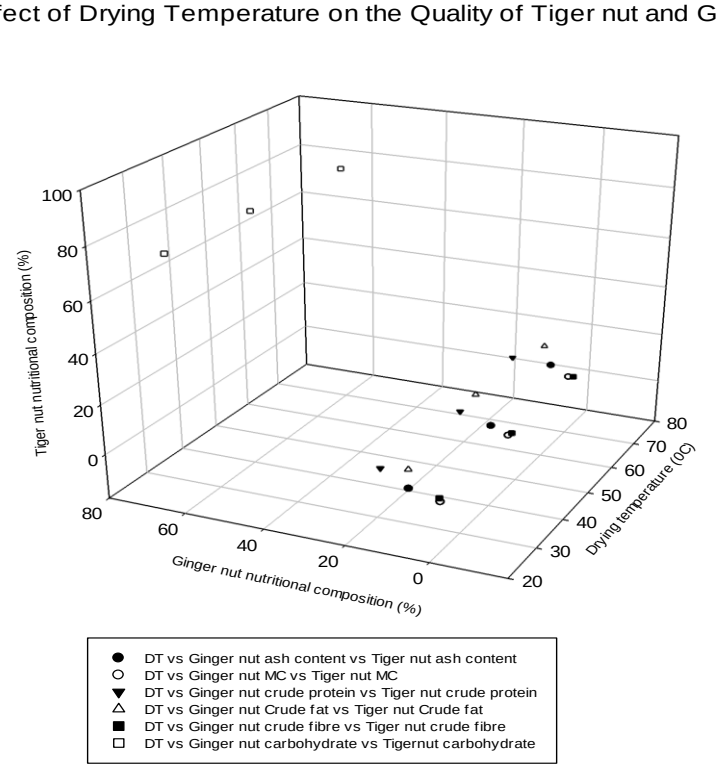

Fig 3: Effect of Drying Temperature on Quality of Ginger Nut and Tiger Nut

The effect of drying temperature on the quality of tiger nut and ginger was shown in figure 1. The average values for moisture content obtained at three drying temperatures for ginger nut and tiger nut were found to be 2.60%, 2.15%, 1.25%, and 1.05%, 0.20%, 0.05% respectively. Moisture content is significant because it is one of the determinants of the shelf-life of processed foods; it exists in the form of bound, adsorbed, or free water in the food. The free water is easily lost on drying unlike the bound and adsorbed water that appear to be associated with proteins present [14]. An increase in moisture content because of an increase in temperature may be due to the lower processing temperature.

The average values for crude protein obtained at three drying temperatures for ginger nut and tiger nut were found to be 15.31%, 14.22%, 17.50% and 10.28% 14.60% and 12.63% respectively. According to [15], the decrease in crude protein content due to drying could be attributed to the leaching of nutrients into the cooking water and could also result from the denaturation of proteins. The progressive increase in protein may be due to progressive loss of moisture with increased drying time. The figure 1 show that ginger nut has the highest crude protein content 17.50 % at oven drying temperature of 75 ^{0}C, the food samples may be graded as oil-rich based on the values obtained for the crude fat.

The average values for crude fat obtained at three drying temperatures for ginger nut and tiger nut were found to be 8.72%, 10.43%, 9.17%, and 10.28% 14.60%, 12.63% respectively. The figure 1 shows that tiger nut has the highest crude fat content 14.60 % at oven drying temperature of 50 ^{0}C.

The average values for ash content obtained at three drying temperatures for ginger nut and tiger nut were found to be 8.70%, 6.50%, 7.35%, and 2.95%, 2.95%, 4.90% respectively. The ash content is a measure of the total amount of non-combustible inorganic minerals [16]. The average values for the crude fiber obtained at three drying temperatures for ginger nut and tiger nut were found to be 1.25%, 2.15%, 2.63%, and 1.27% 1.26%, 1.28% respectively. Crude fiber is the sum of indigestible sugars in a food sample that has the physiological function of adding bulk to stool, thereby contributing to preserving internal distensions for regular peristaltic movement [17].

The average values for carbohydrates obtained at three drying temperatures for ginger nut and tiger nut were found to be 65.84%, 67.63%, 64.67%, and 76.75%, 74.62%, 75.72% respectively. Carbohydrate is the primary energy source for the brain and is essential for the maintenance of glycemic homeostasis and for the integrity and function of the gastrointestinal and was presented in figure 1 that tiger nut has the highest composition of carbohydrate 76.75 % at oven drying temperature of 25 ^{0}C. The moisture content shows an increase in moisture contents with an increase in drying temperature; crude protein was found to decrease with increasing temperature while crude fat, crude fibre, ash content, and carbohydrate show a linear path as no significant with increase in temperature.

4. Conclusion

In this study, the effect of selected oven drying temperatures on the quality of gingernut *(Zingiber Officinale*) and tiger nut *(Cyperus Esculentus*) were evaluated. The proximate composition tested for were moisture content, ash content, crude fibre, crude protein, crude fat, and carbohydrate. The results obtained for moisture content, ash content, crude fibre, crude protein, crude fat, and carbohydrate obtained at three drying temperatures for ginger nut were found to be (2.60%, 2.15%, 1.25%), (8.70%, 6.50%, 7.35%), (1.25%, 2.15%, 2.63%), (15.31%, 14.22%, 17.50%), (8.72%, 10.43%, 9.17%) and (65.84%, 67.63%, 64.67%) respectively. However, the results obtained for moisture content, ash content, crude fibre, crude protein, crude fat, and carbohydrate obtained at three drying temperatures for tiger nut were found to be (1.05%, 0.20%, 0.05%), (2.95%, 2.95%, 4.90%), (1.27% 1.26%, 1.28%), (10.28% 14.60%, 12.63%), (10.28% 14.60%, 12.63%) and (76.75%, 74.62%, 75.72%) respectively. The showed that selected oven drying temperatures have no significant difference on the crude fibre, ash content, and carbohydrate for both ginger nut and tiger nut, while crude fat was found not significantly affected by the drying temperatures on the ginger nut.

Conflict of Interest

We the author of this paper declare that there is no conflict of Interest.

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