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Phytochemical Screening and Effect of Temperature on Proximate Analysis and Mineral Composition of *Zingiber officinale* Rosc.

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Authors' contributions

This work was carried out in collaboration between all authors. Author EJA contributed to the experimental design, carried out laboratory work and contributed to the protocol (writing of the manuscript). Authors JAA and PNN carried out laboratory work and contributed to the protocol. Author MAA contributed to the experimental design, performed the statistical analysis and contributed to the protocol. Authors JAOS and UA contributed to the protocol. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: To investigate the phytochemical composition and effect of temperature on the proximate and mineral composition of *Zingiber officinale*.
Study Design: Activity directed phytochemical screening, proximate analysis and mineral composition investigation of *Z. officinale rhizomes* using *in vitro* methods.
Place and Duration of Study: Medicinal Plants Section, Bioresources Development Centre, Ogbomoso, Nigeria between May and November, 2016.
Methodology: Fresh rhizome of *Z. officinale* was milled, extracted with absolute ethanol and screened for phytochemicals. Proximate and mineral analyses were carried out at various temperatures; room temperature (28℃; control), 40, 50 and 60℃.

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Results: Phytochemicals including; alkaloid, tannins, saponins and cardiacglycosides were present in the rhizomes. The results showed significant ($P< 0.05$) decrease in the percentage of crude protein (9.53±0.04) at 60℃ when compared with room temperature; control (9.62±0.04), increase in crude fiber and ash at 40℃ (8.31±0.02 and 6.76±0 .02 respectively) and 60℃ (8.34±0.03 and 6.77±0.02 respectively) when compared with the control (8.28±0.15 and 6.74±0.01 respectively). The results also showed a significant ($P< 0.05$) decrease in the percentage of sodium (0.057±0.001 and 0.061±0.001) at 40 and 60℃ respectively when c ompared with the control (0.064±0.002); potassium (1.65±0.01) at 40℃ when compared with the c ontrol (1.73±0.02); magnesium and calcium at 40℃ (0.197±0.002 and 0.083±0.001 respecti vely) when compared with the control (0.203±0.005 and 0.087±0.001 respectively).
Conclusion: The current study showed that drying at above room temperature does not affect the proximate and mineral composition of *Z. officinale* rhizomes. The presence of nutrients and phytochemicals in *Z. officinale* could be exploited for the overall well-being of man.

Keywords: Ginger; alkaloids; drying; crude fibre; saponins; crude protein.

1. INTRODUCTION

Zingiber officinale (ginger) is the most widely cultivated rhizome of the family zingiberaceae worldwide [1]. *Z. officinale* is referred to differently by the various ethnic groups in Nigeria as Chitta in Hausa, Ata'le in Yoruba and Oso-chikwu in Igbo. It has a distinctive thickened branched rhizome with a brown corky outer layer and a pale yellow center with a spicy lemon-like scent. Rhizomes of *Z. officinale* are considered significant sources of essential nutrients such as mineral elements (calcium, iron, magnesium, sodium and zinc), carbohydrates, fats, vitamins, and extractive oleoresins [2].

Ginger is consumed as a spice all over the world [3] and is used in the treatment of certain medical conditions [4,5]. Reported pharmacological effects of ginger include immunomodulatory, anti-tumorigenic, antioxidant, anti-inflammatory, anti-apoptotic, anti-hyperglycemic, anti-lipidemic, antithrombotic, hypotensive and anti-emetic actions [6,7,8,9,10,11].

Ginger is consumed in different forms- fresh (green) ginger, whole dry ginger and spilt dry ginger. The demand for fresh ginger in the international market is low due to its high moisture content making it susceptible to bacterial attack and postharvest losses [12]. [13] proposed that vegetables are made available and consumed in their dried forms for the purposes of preservation, packaging, transportation, distribution and exportation. To achieve this, they can undergo sun-drying, oven-drying or drying under room temperature.

The effects of the different methods of drying on the proximate and mineral composition, phytochemical properties and sensory qualities of food, fruits and vegetables have been extensively studied [12,14,13]. Several studies conducted on medicinal foods have shown that temperature may have an effect on its proximate and mineral composition [13,15,16,17].

Due to the increased demand for the exportation of Nigerian species of ginger for use in confectionaries, pharmaceutical and cosmetic industries; there is a need to determine drying techniques and temperatures that would not produce a negative effect on both the proximate and mineral composition as well as improve the quality and shelf life of the rhizome.

Hence, this study was done in to assess the phytochemical properties of fresh sample of *Z. officinale*, and determine the proximate as well as the mineral composition of the rhizomes at different temperature.

2. MATERIALS AND METHODS

2.1 Collection of Plant Materials

Fresh rhizomes of *Zingiber officinale* Rosh. were obtained at Sabo market, Ogbomoso, Oyo state, Nigeria (May, 2016). The plant was identified and authenticated at the Botany Department, Obafemi Awolowo University, Ile-Ife, Nigeria. A voucher specimen (Ife-17578) was deposited for *Zingiber officinale* Rosh (Ginger) at the herbarium unit of the Department. The rhizomes were then washed under running tap water and diced into small slices.

2.2 Phytochemical Screening of Extract of *Z. officinale*

Mass of 10 g of fresh rhizomes of *Zingiber officinale* was weighed on the laboratory bench,

cut into pieces and pulverized with an electric blender (Kenwood). The milled plant materials was extracted in 20 ml of absolute ethanol for 72 h at room temperature on a flask shaker and filtered with Whatman No.1 filter paper [18]. The filtrate obtained was screened for the phytochemicals such as alkaloids, tannins, phlobatannins, saponins, flavonoids, cardiac glycosides, steroids, phenols, anthraquinones, chalones, triterpenes, cardenolides and dienolides using standard procedures described by [19,20,21].

2.3 Proximate Analysis of Extract of *Z. officinale*

Proximate analysis was carried out on the rhizomes dried at the various temperatures (40, 50 and 60℃) while the room temperature served as control. Proximate compositions of the pulverized samples were determined as described by [22] ((crude protein (method 988.05), crude fat (method 2003.06), total ash (method 942.05), crude fibre (method 958.06), dry matter and moisture (method 967.08)) and value for carbohydrate was obtained by difference.

2.4 Determination of the Mineral Compositions of *Z. officinale*

Prior to the determination of the mineral elements, the dried rhizomes of *Z. officinale* were first ashed as described by [23]. Percentage sodium and potassium composition were determined according to [22] using the PFP7 Digital Flame Photometer (JENWAY) with filters corresponding to each mineral element. Magnesium, iron and calcium composition of the samples were determined on aliquots of the solutions of the ash by established atomic absorption/emission spectrophotometer (Buck Scientific, US). Phosphorus was determined spectrophotometrically using the Vanado-molybdate (yellow) method 975.16 [22].

2.5 Statistical Analysis

Values were expressed as Mean ± SEM (Standard Error of Mean). Data were subjected to one way analysis of Variance (ANOVA) and level of significance was done using Duncan Multiple Range Test (DMRT) at $P \leq 0.05$ of SPSS version 15.

3. RESULTS

3.1 Phytochemical S of Ethanolic Extract of Fresh *Z. officinale*

The phytochemical screening results showed appreciable amount of alkaloids, tannins, saponin, phenols and cardiac glycoside; moderate amount of phlobatannin, flavonoids and anthraquinones; trace amount of steroids, terpenes and cardenolides; and absence of chalcones (Table 1).

Table 1. Phytochemical screening of ethanolic extract of fresh *Z. officinale*

Phytochemical	Observation
Alkaloids	+++
Tannin	+++
Phlobatannin	++
Saponin	+++
Flavonoids	++
Anthraquinones	++
Steroids	+
Terpenes	+
Cardenolides	+
Phenol	+++
Chalcones	-
Cardiac glycosides	+++

+++ Appreciable amount, ++ Moderate amount, +Trace amount,-Absent

3.2 Proximate Composition Analysis of *Z. officinale*

The proximate composition analysis results showed significant increase (p= ≤) in crude protein contents at 40° and 50℃ (9.83±0.05 and 9.72±0.03 respectively) when compared with the control (9.62±0.04). A significant increase (p= ≤) was also observed in crude fiber and ash at 50℃ (8.36±0.02 and 6.85±0.02 respectively) against the control (8.28±0.15 and 6.74±0.01 respectively). No significant difference (p= ≤) was observed in the percentage of carbohydrate at all the temperatures when compared with the control (Table 2).

3.3 Mineral Composition Analysis of *Z. officinale*

The mineral composition analysis results revealed a significant decreases (p= ≤) in sodium contents at 40° and 60℃ (0.057±0.001 and 0.061±0.001 respectively) as compared with the control (0.064±0.002); potassium content (1.65±0.01) at 40℃ against study control (1.73±0.02); magnesium and calcium contents

Table 2. Proximate composition of *Z. officinale* sample at different temperatures

Temp	Crude protein (%)	Crude fat (%)	Crude fibre (%)	Ash (%)	Minerals (%)	Carbohydrate (%)
Room temp	9.62±0.04	3.24±0.02	8.28±0.15	6.74±0.01	10.19±0.03	62.03±0.01
40℃	9.83±0.05 [c]	3.18±0.01[a]	8.31±0.02[a,b]	6.76±0.02[a]	9.63±0.02[a]	62.32±0.01[c]
50℃	9.72±0.03 [b,c]	3.25±0.01[a]	8.36±0.02[b]	6.85±0.02[b]	9.69±0.02[a,b]	62.15±0.03[b]
60℃	9.53±0.04 [a,b]	3.24±0.04[a]	8.34±0.03[a,b]	6.77±0.02[a]	9.77±0.02[a]	62.27±0.01[c]

Data are presented as mean± SEM; n = 2; Superscripts; a, b and c indicates significantly different from room temperature, 40 and 50℃ at P= ≤ 0.05

Table 3. Mineral composition of *Z. officinale* sample at different temperatures

Temperature	Na (%)	K (%)	Mg (%)	Ca (%)	P (%)	Fe (mg/Kg)
Room temp	0.064±0.002	1.73±0.02	0.203±0.005	0.087±0.001	0.161±0.038	23.05±0.35
40℃	0.057±0.001 [a]	1.65±0.01[a]	0.197±0.002[a]	0.083±0.001[a]	0.120±0.001[a]	22.40±0.10[a]
50℃	0.064±0.001 [c]	1.74±0.01[b]	0.216±0.002[c]	0.094±0.001[c]	0.127±0.001[a]	25.30±0.10[c]
60℃	0.061±0.001[a,b]	1.70±0.01[b]	0.210±0.002[b,c]	0.088±0.001[b]	0.124±0.001[a]	23.80±0.10[b]

Data are presented as mean± SEM; n = 2; Superscripts; a, b and c indicates significantly different from room temperature, 40 and 50℃ at P= ≤ 0.05

(0.197±0.002 and 0.083±0.001 respectively) at 40℃ when compared to the control (0.203±0.005 and 0.087±0.001 respectively). However, a significant increase (p= ≤) was observed in iron content (25.30±0.10) at 50℃ against control (23.05±0.35) (Table 3 above).

4. DISCUSSION

The phytochemical screening of the fresh rhizomes of *Z. officinale* revealed the presence of alkaloids, tannin, saponins, phlobatannins, flavonoids, anthraquinones, steroids, terpenes, cardenolides, phenols and cardiac glycosides although in varying quantities. These results were in agreement with results reported by [24] and [25].

The medicinal properties of the plant ginger cannot be over emphasized due to the presence of high levels of phyto-nutrients as seen in this study. The presence of cardiac glycosides, cardenolides and flavonoids seen in this study are believed to confer cardio-protective effects due to their individual effects on the heart [11, 26]. Cardiac glycosides are known to improve the force of the contraction on a failing heart while flavonoids possessing antioxidant properties ensure healthy cardiac circulation [27,28].

The high amounts of saponins as reported by this study is favorable as high concentrations of these naturally occurring phyto-nutrients have been shown to facilitate the intestinal uptake of other nutrients by enhancing the growth of beneficial gastrointestinal floral and intestinal mucosa cell permeability which probably accounts for its use in the management of incidences of malabsorption and constipation/ bloating [3,29].

Mineral elements detected in the rhizomes of *Zingiber officinale* dried at different temperatures included sodium (Na), potassium (K), magnesium (Mg), calcium (Ca), phosphorous (P) and iron (Fe). The mean mineral values as detected in this study followed the order Fe>Mg>K>P>Ca>Na which differed from the results of previous studies reported by [3] which is probably due to the specie variation and climatic condition compared to that used in the study. An increase in the level of Na, K, Mg, Ca, Fe of *Z. officinale* at 50° was observed. These findings were similar to findings of [12] who reported that food processing techniques such as drying, soaking and cooking would lead to an increase in levels of mineral elements in food due to the destruction of inhibitory anti-nutritional factors.

A significant different in the calcium (Ca) content of samples dried at 50℃ was observed against other drying temperatures. The result for calcium obtained in this investigation was much less than values reported by [28]. The low calcium content of ginger might rule out its use as a calcium supplement in incidences of infant or adult hypocalcemia. The result revealed an increase in amount of iron obtained in samples dried across all temperatures. The iron (Fe) content of room dried samples of *Z. officinale* was similar to the values reported by [13] and [3]. Other mineral components (Mg and K) showed significant differences between samples dried at room temperature and oven dried samples at 50^{o}C

and 60℃ respectively. These observed increases could probably be explained by the increase in total amount of soluble solids that results from decreased moisture content [30].

Results of the proximate analysis of the rhizomes of *Z. officinale* revealed the presence of carbohydrate, moisture, protein, fibre, ash, fat with mean values of CHO (62.19%), moisture (9.82), protein (9.67%), fibre (8.31%), ash (6.78%) and fat (3.23%). A decrease in crude protein values was observed at rhizome drying temperatures of 40, 50 and 60℃, which was similar to reports by [16] and [13] which probably are due to denaturing of the protein. Crude protein values of this study was found to be higher than that obtained from similar studies [3,28] and much lower than values reported for *Talinum triangulare*, sweet potatoes leaves and balsam apples [31]. Hence, it is proper to say that consumption of ginger is not a good substitute for recommended daily allowance for protein.

Results revealed a statistically significant increase in the values of crude fibre and ash in samples dried at room temperature, 40℃ and 50℃ at $p<0.05$. These increases in value with corresponding temperature was in accordance with reports by [16] and [13] but much higher than values reported by [28] and [32] for *Z. officianle.*

The results of this study showed a statistically significant decrease in moisture content of the rhizomes ($P < 0.05$) across drying temperatures. The results obtained were similar to other studies that observed a decrease in moisture with increased drying temperature which ultimately have an overall effect on the shelf life and stability of ginger [12,13].

5. CONCLUSION

In conclusion, it is observed that drying at higher temperatures above room temperature does not have negative effect on the proximate and mineral composition of ginger. Hence rapid reduction in moisture content of ginger is recommended during drying to enhance its quality and shelf life. The presence of phyto-nutrients and minerals in rhizomes of ginger supports its use for the overall mental and physical well-being of man.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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