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Evaluation of Phytochemical, Mineral, and Nutrient Content of Ginger (*Zingiber Officianale*) in Mubi

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Abstract

The main objective of this study was to evaluate the phytochemicals, vitamins, proximate and nutrient contents of *Zingiber officinale* (ginger). Fresh rhizomes of ginger were obtained, shade dried until all the water molecules evaporated. The rhizomes were ground using pestle and mortar into a very fine powder and kept in an airtight container. Seven solvents were used to determine the suitable solvent to evaluate the phytochemical constituents. The result revealed the presence of resins in chloroform and ethanol, glycoside in acetone, chloroform, ethyl acetone, and ethanol. Whereas steroids and saponins occurred in aqueous and acetone; flavonoids only in aqueous extract, tannins was absent in all the solvents used. The proximate analysis showed that ginger has high fibre and carbohydrate contents, a moderate amount of moisture, and rich in Calcium (878.89±0.03) and Carotenoid (655±0.09). It's composed of good nutritive vitamins and mineral elements to maintain good health. *Zingiber officinale* is, therefore, considered a potential source of medicinal herb, used for health and diet management.

Keywords: phytochemicals; rhizome; ethanol; vitamin; shade

Introduction

Ginger, (*Zingiber officinale Roscoe, Zingiberaceae*) is one of the most important cash crop and principal spice of India (Bartley and Jacobs, 2000). Ginger is believed to be native of South East Asia and originated in the Indo-China region where it has been used in food and medicines for over 5000 years (Adanlawo and Dairo, 2007). It is widely used around the world in food as a spice both in fresh and dried form which adds flavour to the meal, creating a fresh, spicy pungent taste (Jayashree *et al.*, 2011).

The leaves are linear and the flowers are yellowish-green, oblong and ensheathed in a few scarious bracts. It is a well-known herb and is widely used as a spice all over the world (Bartley and Jacobs, 2000) and medical treatment for certain ailments in traditional medicine (Zhang *et al.*, 2009). Ginger contains several phytochemical compounds which have biological activities such as antioxidation, antimicrobial and other pharmacological effects (Zhao *et al.*, 2011).

Ginger was introduced to Nigeria in 1927. The plant is now cultivated in different parts of Nigeria, though the major producing areas include Kaduna, Nassarawa, Sokoto, Zamfara, Akwa Ibom, Oyo, Abia and Lagos states although southern Kaduna remain the largest producers of fresh ginger in Nigeria in Kachia, Jabba, Jama'a and Kagarko Local Government Areas (KADP, 2000, KADP, 2004; Bernard, 2008). The varieties produced in Nigeria are 'Taffin giwa' and 'Yatsun biri which is higher in monoterpene and oil, giving a more pungent aroma and pungency (KADP, 2000; Chukwu and Emehuite, 2003). Nigeria ranked first in terms of the percentage of total hectares of ginger under cultivation but her contribution to total world output is too low compared to other countries in West Africa. This can be attributed to the fact that most of the production is undertaken by smallholder and traditional farmers with rudimentary production techniques and low yields. Besides, the smallholder farmers are constrained by many problems like the farmers do not see it as a business enterprise, therefore are not adequately focused on profit-maximizing motive (Federal Ministry of Agriculture, 1993 in Goni and Baba 2007).

In addition to its food usage, ginger root has been found aiding in lowering the cholesterol level, pain

relief from arthritis, digestive issue, expectorant, and gastrointestinal stimulation. The plant is used in traditional medicine for the treatment of several ailments in different parts of the world. Such ailments include rheumatism, stomach disorder, diabetes, wounds, snake bite, baldness, toothache, respiratory disorders, arthritis, bleeding, rash, etc. The non-volatile extracts of the plant are known to possess antimicrobial and anti-inflammatory activities. Its efficacy in the treatment of wounds has been reported by Okoli *et al.*, (2007a). A decoction of the rhizome has been recommended for use in treating pulmonary haemorrhage and hemostasis.

Ginger is used extensively in food, beverage, and confectionery industries in products such as marmalade, pickles, chutney, ginger wine, liquors, and other bakery products. The chemical components of the ginger vary considerably, depending on the location of cultivation and postharvest treatments. Ginger contains polyphenol compounds such as gingerol and its derivatives (Rahaman *et al.*, 2013) such as zingiberene, bisabolene, camphene, geraniol, linalool, borneol and oleoresin (a combination of volatile oils and resin) that accounts for its characteristic aroma and therapeutic properties. Dry ginger contains essential oil 1-3%, oleoresin 5-10%, starch 50-55 % and moisture 7-12 % with small quantities of protein, fibre, fats and ash (Aruoma *et al.*, 2007).

The ginger rhizome contains several interesting bioactive constituents and has health-promoting properties. The demand for ginger in Mubi is on the increased due to its importance; no study has been carried out on ginger in Mubi. Therefore, this study was conducted to determine the minerals, phytochemicals and proximate composition of ginger for proper and effective use.

Materials and Methods

Study Area

This study was carried out in Mubi, located in the North-Eastern region of Nigeria between latitude 10° 14'N and 10^0 18'N of the equator and longitude 13°14'E and 13°19'E. The area has a tropical climate with an average temperature of 32°C and lies within the Sudan Savannah vegetation zone of Nigeria. The area has an average relative humidity ranging from 28% - 45% and an annual rainfall of about 1056mm (Adebayo, 2004).

Preparation of Plant Materials

Fresh ginger rhizomes were obtained from Mubi market. The rhizomes were shade dried until all the water molecules evaporated. The rhizomes were then ground using pestle and mortar into a very fine powder and kept in an airtight container with proper labelling before analysis.

Preparation of Plant Extracts

The method described by Amir *et al.*, (2005) and modified by Arawande *et al.*, (2013) was used. Ten gram of the powder sample was weighed into each of the five cleaned and dried 250 ml reagent bottles. 100 ml of each solvent (ethanol, chloroform, ethyl acetate, acetone ethanol, and water) were separately added to each of the bottles and left for 72h during which it was intermittently shaken on a shaking orbit machine. Each mixture was filtered separately through a 0.45 pm nylon membrane filter and the extract was evaporated to at 40°C by a rotary evaporator. The obtained extract was weighed and the extractive value of each solvent was calculated thus:

$$\% \text{ Extractive value of the solvent} = \frac{weight\ of\ extract}{Weight\ of\ Sample} \times 100$$

Method of Sample analysis

Two types of test were carried out on the plant: Quantitative and Qualitative Test

Quantitative Phytochemicals

A known amount of sample was weighed and dissolved with hexane in a 1.0ml vial. The prepared sample was then injected into a Buck Scientific (USA) BLC10/11 High Performance Liquid Chromatography (HPLC) system with a fluorescence detector (excitation at 295 nm and emission at 325 nm) and an analytical silica column (25 cm x 4.6mm ID, stainless steel, 5 pm) was used to analyse phytochemicals. The mobile phase used was hexane: tetrahydrofuran: isopropanol (1000:60:4 v/v/v) at a flow rate of l.0ml/min. Standard samples were also prepared using a similar method. The concentration of antioxidants in samples was calibrated using authentic standards. Using the results obtained the

concentration of antioxidants in the sample was calculated, using the formula below;

[PHYTO] = [A SAMPLE x [STD] (ppm) x V HEX (ml)]/ [A STD x Wt SAMPLE (g)]

Where;
[PHYTO] = concentration of Phytochemical in ppm [STD] = concentration of standard A SAMPLE = area of sample A STD = area of standard V HEX = volume of hexane Wt SAMPLE = weight of sample.

Qualitative Phytochemical test

Test for tannins

About 0.5 g of plant extract was mixed with 2mL of water and heated on a water bath. The mixture was filtered and 1mL of 10% FeCb solution was added to the filtrate. A blue-black solution was indicated the presence of tannins.

Test for flavonoids

Five millilitres of distilled water and about 0.2 g of plant extract was mixed thoroughly. And 1 mL of 1% $AlCl_3$ solution was added and shaken. A light yellow precipitate indicates the presence of flavonoids.

Test for saponins

About 0.2 g of plant extract was shaken with 4 mL of distilled water and then heated to boil on a water bath. The appearance of creamy miss of small bubbles (Frothing) shows the presence of saponins.

Test for Carbohydrates

Fehling's test: Five ml of Fehling's solution was added to 0.5 mg of extract and boiled in a water bath. Benedict's test: Five ml of Benedict's solution was added to 0.5 mg of extract and boiled in a water bath.

Test for Protein & amino acids

Biuret test: To 0.5 mg of extract equal volume of 40% NaOH solution and two drops of 1% copper sulphate solution was added.

Ninhydrin test: About 0.5 mg of extract taken and 2 drops of freshly prepared 0.2% ninhydrin reagent was added and heated.

Proximate analyses

Moisture was determined by hot treatments air oven method. Crude oil was determined by a Soxhlet extractor using hexane as a solvent. Crude proteins were calculated from the nitrogen content by Kjeldahl method using factor 6.25. The crude fibre was determined according to the Trichloroacetic acid digestion procedure of AOAC, 2000. Ash was determined by incinerating at 550°C in a muffle furnace for 6 hr (Genlab, UK). The total carbohydrate content (on a dry weight basis) was calculated by difference [100 (crude protein + crude lipids + ash + crude fibre)].

Minerals content

Samples were digested by concentrated nitric acid and sulfuric acid (3:1, v/v). Minerals (Fe, K, Na, Ca and Mg) were estimated using an atomic absorption spectrophotometer (210, Buck Scientific USA). Phosphorus (P) was measured by converting phosphates into phosphorus molybdenum blue pigment and measured at 700 nm.

Vitamins

HPLC Conditions:

Model: Buck scientific (USA) BLC10/11 Method: Isocratic HPLC (20uL loop injection). Detection: UV at 325nm Column: Prevail C-18,5u, 150 x 4.6mm Mobile phase: (95:5) 25) Methanol: Water Sample: Operator: Comments: 1.00mL/min

Results and Discussion

Phytochemicals are bioactive non-nutritive plant chemicals that have protective or disease preventive properties and they act as antioxidants, enzymes stimulant, anti-bacterial agents, anti-cancer agents as well as possessing hormonal action (Akinmoladun *et al*., 2007). The qualitative phytochemical constituents obtained revealed the presence of resins in chloroform and ethanol, glycosides (acetone, chloroform, ethyl acetone, and ethanol), steriods (Aqueous and acetone), saponins (aqueous and acetone), tannins absence in all solvents and flavonoids only in aqueous similar to the findings of Arawande et al., (2018); Okoli *et al.,* (2007) (Table 1). The quantitative study revealed the high presence of tannins (5.46mg/100g) which is similar to the studies undertaken by Njoku and Akumufula, 2007; Saxena *et al.,* 2012 (Table 2). Flavonoids 1.34 mg

/100 was reported by Onyeka and Nwambekwe, 2007 and Saxena *et al.,* 2012. Saponins 2.12mg/100g was low compared to a similar study by Sczkowski *et al.,* 2008 and Igidi and Edene, 2014 respectively. This could be due to the difference in variety and geographical location. Steroids were also low (6.78mg/100g) compared to a similar study by Firn, (2010). A high amount of glycosides was recorded in this study (3.14mg/100g); a similar study by Saxena *et al.,* 2012 was low (2.44mg/100g). Tannins (5.46mg/100g) the result is in agreement the works by Njoku and Akumufula, 2007 and Saxena *et al.,* 2012 respectively.

Table 1: Qualitative Phytochemical Composition of Ginger

Chemical constituents	**Aqueous extract**	**Acetone**	**Chloroform**	**Ethyl acetone**	**Ethanol**
Resins	-	-	+	-	+
Glycosides	-	+	+	+	+
Steroids	+	+	-	-	-
Saponins	+	+	-	-	+
Tannins	-	-	-	-	-
Flavonoids	+	-	-	-	-

Legend: + = present; - = absent;

Table 2: Quantitative Composition of Phytochemicals

Phytochemical constituent (mg/100g)	**Value**
Flavonoids	1.34 ±0.05
Saponins	2.12 +0.04
Steroids	6.78±0.04
Glycosides	3.14 ±0.03
Resins	4.13 ±0.03
Tannins	5.46+0.06

Results are expressed as Mean ± Standard deviation.

The proximate analysis of the plant exhibited high carbohydrate (62.43 ± 0.002mg/100g), moderate moisture (10.90 ± 0.007), fibre content (11.72 ± 0.003), ash (8.25 ± 0.004), low fat (1.85 ± 0.004) and protein (4.86 ± 0.007) respectively (Table 3). The results obtained from the analysis of *Zingiber officinale* for crude fibre (CF) was 11.72±0.007% this is in agreement with the study reported by Ganong, (2003). The moisture content of the rhizome of *Zingiber officinale* (10.90±0.003%) was higher than those of some common Nigerian rhizomes such as Alpina rhizomes (7.0±0.001%) (Laden *et al*., 2006) *Adansonia digitata* (0.002%), *Xanthosen sagitifolium* (0.001%). The carbohydrate contents were 62.43±0.002% which is higher than those reported for *Tribulus terresris* leaves 56.67% and water spinach leaves 54.67% but lower than 92.80% for *Corchorus trident* (NRC, 2000). This study revealed high protein content (4.86±0.007%) when compared to similar studies by Famurewa *et al.,* (2011); Jakes and Susan (2007). The fat content was low (1.85±0.004), compared to research by Adeniyi and Odufoworo, (2003) which was low.

Table 3: The Proximate Composition of Ginger

Components	**Value (%)**
Moisture	10.90 ± 0.003
Ash	8.25 ± 0.004
Fat	1.85 ± 0.004
Proteins	4.86 ± 0.007
Fibre	11.72 ± 0.007
Carbohydrate	62.43 ± 0.002

Data are mean± standard deviation of triplicate determination.

Table 4: Mineral Composition of the Sample (mg/100g)

Mineral components	Concentration (mg/100g)
Zinc	5.17 ± 0.05
Iron	8.37 ± 0.04
Phosphorus	595.66±0.04
Calcium	878.86±0.03
Magnesium	1.92±0.04
Potassium	0.72±0.06

Data are mean ± standard deviation of triplicate determination

Zingiber officinale constitutes a rich source of mineral elements which include the following Zinc (5.17 ± 0.05), Iron (8.37 ± 0.04), Phosphorus 595.88 ±0.04, Calcium (878.86 ± 0.03), Magnesium (1.92 ± 0.04) and Potassium (0.72 ± 0.06) (Table 4). This result is consonant with the works of Robert *et al.*, 2003, and Thomas and Krishnakumari, (2005). Phosphorous was high (595.66mg/100g) compared to a similar study by Emebu and Anyika, (2011).

Table 5: Vitamin Composition of the Sample (mg/100g)

Vitamin E	0.35± 0.04
Vitamin C	0.26± 0.02
Carotenoid	6.55± 0.09

Data are mean± standard deviation of triplicate determination.

The following vitamins were also present carotenoid, Vitamin E, and Vitamin C. with the following values (6.55±0.09), (0.35±0.04) and (0.26±0.02) respectively (Table 5). A high quantity of carotenoid was reported (6.55mg/100g) compared to a similar study by Oyeleke *et al.*, (2008) and (Adesina, 2006) who reported low value.

Conclusion

Zingiber officinale contains high levels of carbohydrates, some proximate parameters such as moisture, crude fibre; fat, protein, and ash were relatively low. The mineral elements composition revealed increased levels in calcium and phosphorus; however, minerals like zinc, iron, potassium, and magnesium were low. The phytochemical screening of *Zingiber officinale* shows the presence of glycosides, alkaloids, saponins, flavonoids, and steroids, but the absence of tannin in all the solvents used for the qualitative analysis. It also contains vitamin E, vitamin C, and carotenoid. Based on the results of this study, it can, therefore, be concluded that ginger has the potential to be used as a medicinal plant and to maintain good health.

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