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Phytochemical Properties, Proximate and Mineral Composition of *Curcuma longa* Linn. and *Zingiber officinale* Rosc.: A Comparative Study

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Authors' contributions

This work was carried out in collaboration between all authors. Author A. Abdulsalam Taoheed carried out laboratory work, contributed to the experimental design and the protocol (writing of the manuscript). Authors A. Adeniran Tolulope, ABS and MU carried out laboratory work and contributed to the protocol. Author OGO contributed to the experimental design and the protocol. Author RMS supervised the work, performed the statistical analysis and contributed to the protocol. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To investigate the phytochemical property, proximate and mineral composition of *Curcuma longa* and *Zingiber officinale* dried rhizomes.
Study Design: Activity directed phytochemical screening, proximate analysis and mineral composition investigation of *C. longa* and *Z. officinale* rhizomes using *in vitro* methods.
Place and Duration of Study: Medicinal Plants Section, Bioresources Development Centre, Ogbomoso, Nigeria between October and November, 2016.
Methodology: *C. longa* and *Z. officinale* rhizomes were separately washed dried (at room temperature) and pulverized. The powdered rhizomes were then used for phytochemical screening, proximate analysis and mineral composition investigation.

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Results: Phytochemistry of the rhizomes of the two plants revealed the presence of eleven diverse classes of secondary metabolites of plants. *C. longa* rhizomes were rich in steroids, anthraquinones and terpenes metabolites when compared with those of *Z. officinale.* Values obtained for the proximate analysis of *C. longa* and *Z. officinale* were; moisture (76.02% and 75.84%), carbohydrate (16.37% and 16.23%), ash (3.04% and 3.28%), crude fibre (1.95% and 2.03%), proteins (1.83% and 1.91%), and fat (0.80% and 0.83%) respectively. There was also a significant increase ($P<0.05$) in the percentage moisture content of *C. longa* rhizome when compared with those of *Z. officinale.* Mineral composition analysis of the rhizomes of both plants gave the following values; iron (0.57% and 0.54%) > potassium (0.42% and 0.42%) > magnesium (0.05% and 0.04%) > phosphorus (0.03% and 0.03%) > calcium (0.02% and 0.02%) > sodium (0.01% and 0.01%) respectively.

Conclusion: The current study revealed that *C. longa* rhizomes have high moisture content and is rich in steroids, anthraquinones and terpenes phytochemicals than *Z. officinale*. Therefore, *C. longa* could be screened and investigated for novel pharmacologically active compounds to combat degenerative diseases for possible integration into the healthcare.

Keywords: Curcuma longa; Zingiber officinale; proximate analysis; mineral composition; phytochemistry.

1. INTRODUCTION

Curcuma longa (Linn.), commonly known as turmeric, is a tropical perennial monocotyledonous herbaceous plant of South and South-eastern Asia [1]. It belongs to the family *Zingiberaceae* [2]. It is locally known as Atale pupa in Yoruba; Gangamau in Hausa; Nwandumo in Ebonyi; Ohu boboch in Enugu (Nkanu East); Gigir in Tiv; Magina in Kaduna; Turi in Niger State and Onjonigho in Cross River (Meo tribe) [1]. The plant is found primarily grown in tropical regions of Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, Phillipines and Nigeria. It grows to about 2 feet in length with a broad pulpy, orange leaves [3]. Its rhizome is pungent, bitter and widely used in folk medicine and household remedies for the treatment of diabetes, high cholesterolemia, abdominal pains, menstrual disorder, wounds, eczema, jaundice, inflammations, cancerous symptoms and as a blood purifier [4,5]. The powdered rhizome contains 70-76 percent curcumin, an active ingredient and yellow coloured [6]. Curcumin is a powerful antioxidant responsible for the soothing portion of turmeric and its vast biological activities include free radicals scavenging, cholesterol lowering, anti - inflammatory, anti - platelet, antibacterial and antifungal effect [7].

Zingiber officinale Rosc., known as ginger, belongs to the family *Zingiberaceae*. It is a major crop, primarily cultivated in India, China and Nigeria and exported worldwide. Ginger is a 2 - 4 foot tall perennial plant with linear, grass-like leaves and oblong yellowish green flowers in a few scarious bracts [8]. Ginger's distinguishing characteristic flavour is due to the presence of volatile essential oils (1-3%) andoleoresins (4-7.5%) which accounts for its pungent flavour and also possesses extensive antioxidant activity [9]. According to [10] the active components of ginger include α-zingiberene (22.29%), 6-gingerol (9.38%), β-sesquiphellandrene (8.58%), 6-shogaol (7.59%), α-farnesene (3.93%), β-bisabolene(3.87%) and α-curcumene (2.63%). It is a well known herb widely used as spice all over the world and acclaimed for the treatment of certain ailments in folk medicine from time immemorial [11]. Ginger contains several therapeutically active plant-derived secondary metabolites of high pharmacological importance such as antioxidant, antimicrobial, cardiovascular protection, anti-inflammatory, glucose lowering and anti-cancer activities [12,13]. Modern scientific researchers have revealed that ginger inhibits the formation of inflammatory compounds such as inflammatory cytokines and chemokines [14] and direct anti-inflammatory effects by partial inhibition of cyclo-oxygenase (COX) [15] and 5-lipoxygenase (LOX) [16], the two major enzymes implicated in chronic inflammatory conditions and processes. It increases reducing antioxidant enzymes necessary for the improvement of inflammatory diseases and prevention of their complications [12]. [17] reported that ginger can help in the treatment of chronic inflammatory diseases such as fatty liver, asthma, cancer and arthritis through anti-inflammatory, immunoregulatory and antioxidative mechanisms.

This research work compares the phytochemical properties, proximate and mineral composition of *Curcuma longa* Linn. and *Zingiber officinale R*osc. rhizomes.

2. MATERIALS AND METHODS

2.1 Plant Material

Rhizomes of *Curcuma longa* Linn. were obtained from were obtained from Medicinal Plants Section, Bioresources Development Centre, Ogbomoso, Nigeria, while *Zingiber officinale* Rosh. was obtained from Sabo market, Ogbomoso, Oyo State, Nigeria. The plants were identified and authenticated at the Department of Botany, Obafemi Awolowo University, Ile-Ife, Nigeria. A specimen with voucher number: IFE-17578 and IFE-17577 for *Curcuma longa* Linn. and *Zingiber officinale* Rosh. respectively were deposited at Ife Herbarium, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria.

2.2 Preparation of *Curcuma longa* Linn. and *Zingiber officinale* Rosc. Rhizomes Ethanolic Extracts

Curcuma longa and *Zingiber officinale* rhizomes were air dried at room temperature to a constant weight on the laboratory bench, cut into pieces and pulverized into powder with electric blender. The milled plant materials (10 g) each was extracted in 20 mL of absolute ethanol for 72 hours at room temperature on a flask shaker and filtered with Whatman No. 1 filter paper [18]. The filtrates obtained were used to screen for the secondary metabolites constituents of the two samples.

2.3 Phytochemical Screening

Curcuma longa and *Zingiber officinale* ethanolic extracts were screened for the presence of plant secondary metabolites using standard procedures described by [19,20,21]. Qualitative plant secondary metabolite test was carried out on the ethanol extracts of *Curcuma longa* and Zingiber *officinale* samples using standard chemical procedures as follows

2.3.1 Test for taninns

The extracts (1 mL) was boiled in 20 mL of water in separate test tubes for the two extracts and filtered. Few drops of ferric chloride (0.1%) were added to each test tube. The presence of green or a blue – black coloration confirms the presence of tannins.

2.3.2 Test for phlobatannins

Deposition of a red precipitate when 2 mL of the extract of the two samples were boiled with aqueous hydrochloric acid (1%) respectively was taken as evidence for the presence of phlobatannins.

2.3.3 Test for saponins

About 5 mL of the ethanolic extract was boiled in 20 mL of distilled water in a water bath and filtered. The filterate (10 mL) was mixed with 5 mL of distilled water and shaken vigorously for a stable and persistent froth. The frothing was mixed with 3 drops of olive oil and shaken vigorously. The formation of emulsion confirms the presence of saponins.

2.3.4 Test of flavonoids

Aluminium chloride solution (3 mL of 1%) was added to 5 mL of the ethanolic extracts in each in two test tubes. A yellow coloration was observed indicating the presence of flavonoids. Dilute aqueous ammonia 5mL was added to the two mixtures followed by addition of concentrated H_2SO_4. The yellow coloration disappeared when left undisturbed indicates a positive test for flavonoids.

2.3.5 Test for steroids

Acetic anhydride (2 mL) was added to the extract (2 mL) of each samples followed by careful addition of H_2SO_4 (2 mL). The colour changed from violet to blue or green indicate the presence of steroids.

2.3.6 Test for terpenoids (salkowski test)

The extract (5 mL) was mixed with chloroform (2 mL) and concentrated H_2SO_4 (3 mL) was carefully added to form a layer. A reddish brown coloration at the interface was formed to show positive results for the presence of terpenoids.

2.3.7 Test for cardiac glycosides and cardenolides (keller - killani test)

The extracts (5 mL) were treated with glacial acetic acid (2 mL) containing one drop of ferric chloride solution. This was underplayed with concentrated sulphuric acid (1 mL). A brown ring

at the interface indicates a deoxysugar characteristic of cardenolides which confirms the presence of cardenolides. A violet-green ring appearing below the brown ring, in the acetic acid layer, indicates the presence of glycosides.

2.3.8 Test for alkaloids

The extracts (1 mL each) were stirred with 1% aqueous hydrochloric acid (5 mL) on a steam bath and filtered while hot. Distilled water was added to the residue and 1 mL of the filtrate was treated with a few drops of Mayer's reagent (Potassium mercuric iodide- solution). The formation of a cream colour with Mayer's reagent gives a positive test for alkaloids.

2.3.9 Test for anthraquinones

The extracts (5 mL) were mixed with Benzene (10 mL), filtered and 10% ammonia solution (5 mL) was added to the filtrate. The mixture was shaken and the presence of pink, red or violet colour in the ammoniacal (lower) phase indicated the presence of anthraquinones.

2.3.10 Test for chalcones

Ammonia solution (2 mL) was added to each extracts (5 mL). Formation of a reddish colour confirmed the presence of chalcones.

2.3.11 Test for phenols

The extracts (5 mL) were pipetted into a 30 mL test tubes and 10 mL of distilled water was added. Solutions of ammonium hydroxide (2 mL) and concentrated amyl alcohol (5 mL) were added and left to react for 30 mins. Development of bluish green colour was taken as a positive test for the presence of phenols.

2.4 Proximate Analysis

Chemical composition of the pulverized samples were determined according [22] methods described for 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), were assayed and carbohydrate was obtained by difference.

2.5 Mineral Elements Composition Determination

The percentage sodium and potassium composition were determined photometrically as described by the [22] methods (975.11) using the Jenway Digital Flame Photometer (PFP7 Model) with filters corresponding to each mineral element. The magnessium, iron and calcium composition of the samples were determined on aliquots of the solutions of the ash by established atomic absorption/emission spectrophotometer model 200-Aproduced by Buck Scientific. Phosphorus was determined spectrophotometrically using the Vanado-molybdate (yellow) method 975.16 [22].

3. RESULTS AND DISCUSSION

The results of the approximate nutrient composition of *C. longa* and *Z. officinale* rhizomes showed that there was no significant ($P>0.05$) difference in the percentage of crude protein, carbohydrate, fat, fibre and ash content. There was a significant increase in the percentage moisture content of the rhizome of *C. longa* when compared with that of *Z. officinale* (Table 1). The results also showed that *C. longa* and *Z. officinale* rhizomes have high moisture content followed by carbohydrate, ash, crude fibre, protein and fat. The essential nutritional composition of ginger reported by [23] was in accordance with the report of our research work with high moisture preceding carbohydrate and ash content, while crude protein was higher than the fibre content as reported by the present work.

Mineral composition analysis showed that *C. longa and Z. officinale* rhizomes have similar percentage of sodium, potassium, calcium and phosphorus (Table 2). There was no significant difference in the mineral composition results obtained for *C.longa* and *Z. officinale*. Constant feeding on turmeric could be important in sustaining strong bone, muscle contraction and relaxation, blood clothing, reduce blood pressure, and help in haemoglobin formation due to the thiamine, riboflavin, potassium and iron contents [24,25]. Calcium is a major factor for sustaining strong bones and plays a dominant role in muscle contraction and relaxation, blood clotting cascade reaction and absorption of vitamin B12. Potassium and magnesium are known to reduce blood pressure. Potassium also plays a role in controlling skeletal muscle contraction and nerve impulse transmission. The potassium and calcium and content of the extract might be important to patients with soft bone problems to improve bone mineralization and reduces bone resorption [25]. The iron content present in the extracts can help in heamoglobin formation [24] and hence recommended for iron deficiency in anaemia. Various minerals are also co-enzymes in certain biochemical reactions in the body

which underscores the importance of the plant in metabolic reactions.

Table 1. Proximate Analysis of Curcuma longa and Zingiber officinale

Parameters (%)	*C. longa*	*Z. officinale*
Crude protein	1.83 ± 0.04	1.91 ± 0.04
Crude fat	0.80 ± 1.02	0.83 ± 0.02
Crude fibre	1.95 ± 0.01	2.03 ± 0.01
Ash	3.04 ± 0.02	3.28 ± 0.13
Moisture	76.02 ± 0.04*	75.84 ± 0.02
Carbohydrate	16.37 ± 0.01	16.23 ± 0.00

Values are mean ± SEM; n = 3
**Significantly different from C. longa at P < 0.05*

Table 2. Mineral Composition of Curcuma longa and Zingiber officinale

Mineral element (%)	*C. longa*	*Z. officinale*
Sodium	0.01 ± 0.00	0.01 ± 0.00
Potassium	0.42 ± 0.00	0.42 ± 0.00
Magnessium	0.05 ± 0.00	0.04 ± 0.00
Calcium	0.02 ± 0.00	0.02 ± 0.00
Phosphorus	0.03 ± 0.00	0.03 ± 0.00
Iron	0.57 ± 0.01	0.54 ± 0.01

Values are mean ± SEM; n = 3

The phytochemistry results of *C. longa* and *Z. officinale* revealed the presence of eleven diverse classes of secondary metabolites of plants which include alkaloids, tannins phlobatannins, saponins, flavonoids, anthraquinones, steroids, terpenes, cardenolides, phenols and cardiac glycosides (Table 3). *C. longa and Z. officinale* rhizomes are rich in alkaloids, tannins, saponins, phenols, and cardiac glycosides. Similarly, both rhizomes have moderate amount of phlobatannins and flavonids while chalcones is completely absent. Appreciable amount of steroids and anthraquinones as well as moderate amount of terpene were detected in *C. longa*, while moderate anthraquinones, trace amount of steroids and terpenes were detected in the rhizomes of *Z. officinale.* The presence of alkaloids in the rhizomes of *C. longa* (turmeric) and *Z. officinale* (Ginger) shows that both plants could be used to alleviate headache associated hypertension, manage cold, chronic catarrh and migraine [26]. Also, the plants could be utilized in managing inflammation, improve sex hormone, lower blood cholesterol level, prevent accumulation of cytotoxins and could have antioxidant property due to the presence of saponins [26] and phenolics which have the ability to scavenge biological radicals (such as reactive oxygen and nitrogen species thus promoting good health. The presence of tannins in the rhizomes of *C. longa* and *Z. officinale*s hows that the plants could be used as antioxidant in the treatment of intestinal disorder such as diarrhoea and dysentery [27]. Similarly, both plants could exhibit antihyperglycemic activities due to the presence of tannins, flavonoids, phenols, saponins and terpenes [28,29,30,31]. The phytochemical results of the ethanolic extracts revealed that *C. longa* contains higher quantities of anthraquinones, steroids and terpenes when compared to those of *Z. officinale*. This observation may suggest potential diverse compounds from *C. longa* of anthraquinone, steroidal and terpenoids origin which could elicit various pharmacological properties including antimalarial, anti-bacterial, antiviral, anti-inflammatory and anti-tumor activities. The present result of the secondary metabolites constituent of *C. longa* was in accordance with nutritional composition of *Curcuma longa* [32].

Table 3. Phytochemistry of Fresh Curcuma longa and Zingiber officinale

Secondary metabolites	*C. longa*	*Z. officinale*
Alkaloids	+++	+++
Tannins	+++	+++
Phlobatannins	++	++
Saponins	+++	+++
Flavonoids	++	++
Anthraquinones	+++	++
Steroids	+++	+
Terpenes	++	+
Cardenolides	+	+
Phenols	+++	+++
Chalcones	-	-
Cardiac glycosides	+++	+++

Key: + = Present, - = Absent

4. CONCLUSION

Data from the current study revealed that the rhizomes of *C. longa* has high moisture content than *Z. officinale*, while the two plants contain similar amount of carbohydrate > ash > crude fibre > protein > fat. Similarly, the rhizomes of *C. longa* and *Z. officinale* are rich in iron > potassium with trace amount of magnesium > phosphorus > calcium > sodium. *C. longa* rhizome also has more steroids, anthtaquinones, and terpenes phytochemical thus suggesting

more pharmacological active compounds in these plants.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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