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Comparative Study of the Proximate, Mineral and Phytochemical Composition of *Zingiber officinale* (Zingiberaceae) Cultivated in Kano and Kaduna States, Nigeria

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Abstract: *The comparative study of the proximate, mineral and phytochemical composition of different samples of Zingiber officinale cultivated in Kano and Kaduna States were investigated. The result shows that Kano unpeeled sample had the highest moisture content (4.74 ± 0.3 %), crude lipid content (11.15 ± 0.2 %) and protein content (4.92 ± 0.1 %), while Kano peeled sample had the highest carbohydrate content (79.55 ± 0.3 %). The highest crude fibre content (1.15 ± 0.1 %) was recorded in Kaduna peeled sample. The mineral analysis shows that Kano unpeeled sample had highest magnesium (2030.80 ± 1.78 mg/kg), calcium (7287.86 ± 0.76 mg/kg) iron (39.13 ± 0.05 mg/kg), zinc (4.86 ± 0.02 mg/kg) and phosphorous content (3.68 ± 0.02 mg/kg); while Kaduna unpeeled sample had the highest manganese (45.78 ± 0.06 mg/kg) and potassium (666.50 ± 0.43 mg/kg) content. The highest sodium content (666.50 ± 0.17 mg/kg) was recorded in Kano peeled sample. The phytochemical constituents detected in all the samples include alkaloids, saponins, flavanoids, phenolic compounds, cardiac glycosides and steroids. The present study has shown that there were no significant differences in the proximate and phytochemical composition; however, Kano unpeeled sample contained higher amounts of most of the mineral elements quantified, consequently, the commercial cultivation of Z. officinale should be promoted in Kano State.*

Keywords: *Zingiber Officinale, Proximate, Mineral, Phytochemical Composition*

INTRODUCTION

Zingiber officinale belongs to the family Zingiberaceae; it is commonly known as ginger and locally called Citta by the Hausa people of Northern Nigeria. Ginger is a perennial creeping plant used as a cooking spice throughout the world, it has a long history of cultivation and is known to have originated from China and then spread to India, South Asia, Africa etc (Langner *et al.,* 1998). It is propagated from the rhizome and thrives in well drained loamy soil. It has been used as a traditional drug in many countries since pre-historic times; it is used to treat many diseases such as stomach upset, nausea, diarrhea, arthritis and painful menstrual periods (Altman and Marcussen, 2001).

The plant has been reported to possess numerous pharmacological properties such as antioxidant, antiinflammatory, analgesic, antidiabetic, cholesterol lowering effects etc (Thomson *et al.,* 2002; Keith, 2010).

It was also reported to reduce symptoms associated with motion sickness such as dizziness, nausea and vomiting (Portnoi *et al.,* 2003).

Phytochemical studies showed that the rhizome of *Z. officinale* contains a wide variety of biologically active compounds which are known to have numerous pharmacological properties. Essential oils, phenolic compounds, flavonoids, carbohydrates, proteins, alkaloids, glycosides, saponins, steroids, terpenoids and tannins were reported to be the major phytochemical constituents of ginger rhizome (Ali *et al.,* 2008). The species contains important compounds like gingerols, shogaols, paradols, zingerone, zingiberene etc (Langner *et al.,* 1998).

Nutritionally, the plant is used in a variety of foods because of its nutritional value and flavoring compounds. The rhizome is a rich source of vitamins such as vitamin B, C and E; it also contains mineral elements like calcium, manganese, zinc, iron, magnesium, phosphorous, potassium and sodium (USDA, 2013).

Kano State has been identified as the epicenter for ginger market in Nigeria, but this important cash crop is not cultivated in Kano; it is mostly supplied from Kaduna State, the major ginger producing State in Nigeria. In view of that, Bioresources Development Centre, Kano has introduced the cultivation of *Z. officinale* in the State in order to increase the incomes of the local farmers and improve the economy of the State through exportation. Preliminary data has shown that ginger has adapted to the climatic conditions of Kano State, therefore, there is need to also evaluate and compare the phytochemical and nutritional composition of ginger rhizomes cultivated in Kano and Kaduna State.

Materials and Methods

Samples Collection, Identification and Preparation

Fresh rhizomes of ginger were collected from Jaba Local Government Area, Kaduna State and Bioresources farm located within Bayero University, Kano, Nigeria. The plant was authenticated at the herbarium of Ethnobotany Unit of Bioresources Development Centre, Kano. A reference voucher number, BDCKN/EB/1899 was deposited in the herbarium. The rhizomes were divided into two portions; the outer skins of the rhizomes in the first portion were removed before air drying (peeled sample of *Z. officinale*), while the rhizomes in the second portion were air dried without removing the outer skins (unpeeled sample of *Z. officinale*). The dried samples were later ground into fine powder using mortar and pestle.

Proximate Composition

The proximate composition of *Z. officinale* cultivated in Kano and Kaduna States was determined using the standard methods of analysis of Association of Official Analytical Chemists (AOAC, 1995).

Mineral Analysis

The following elements were quantified in each sample using Atomic Absorption Spectrophotometer (AAS); calcium, manganese, zinc, iron, magnesium and phosphorous, while flame photometer was used to determine potassium and sodium (Chapman and Pralt, 1961; Agte *et al*., 1995).

Preliminary Phytochemical Screening

The Preliminary Phytochemical screening of the samples was conducted using the standard laboratory procedures as described by Brain and Turner, 1975; Ciulel, 1994, Evans, 1996; Safowora, 2008; Prashant *et al.,* 2011.

Statistical Analysis

All determinations were carried out in triplicates, and data was expressed as mean ± standard deviation (SD).

Results

The proximate composition of all the samples was presented in Table 1. The result shows that Kano unpeeled sample had the highest moisture content of 4.74 ± 0.3 %, followed by Kaduna peeled sample with moisture content of 4.66± 0.2 %.

The result also showed that Kano and Kaduna peeled samples had the highest ash content of 5.30 ± 0.01 % and 5.30 ± 0.1 % respectively. The highest crude fibre content, 1.15 ± 0.1 % was recorded in Kaduna peeled sample, while Kano unpeeled sample was observed to have the lowest fibre content of 0.2 ± 0.05 %.
On the other hand, Kano unpeeled sample had the highest crude lipid content of 11.15 ± 0.2 %, followed by Kaduna unpeeled and Kano peeled samples with lipid content of 7.30 ± 0.5 % and 6.25± 0.7 % respectively. The highest protein content, 4.92 ± 0.1 % was recorded in Kano unpeeled sample, while the highest carbohydrate content, 79.55 ± 0.3 % was recorded in Kano peeled sample.

Table 1: Proximate Composition of Different Samples of *Zingiber officinale*

S/N	PARAMETERS TESTED	KAPZ	KAUZ	KDPZ	KDUZ
1	Ash (%)	5.30 ± 0.01	5.05± 0.1	5.30±0.1	5.25± 0.2
2	Moisture (%)	4.26± 0.1	4.74± 0.3	4.66± 0.2	4.61± 0.4
3	Crude fibre (%)	0.26± 0.06	0.20± 0.05	1.15± 0.1	0.60± 0.02
4	Crude lipid (%)	6.25± 0.7	11.15± 0.2	6.10± 0.6	7.30± 0.5
5	Protein (%)	4.38± 0.4	4.92± 0.1	3.83± 0.2	4.38± 0.3
6	Carbohydrate	79.55 ± 0.3	73.94± 0.2	78.96± 0.4	77.86± 0.3

All values were mean ± standard deviation (SD) of triplicate determinations
Key:
KAPZ = Kano peeled sample of *Z. officinale*
KAUZ = Kano unpeeled sample of *Z. officinale*
KDPZ = Kaduna peeled sample of *Z. officinale*
KDUZ = Kaduna unpeeled sample of *Z. officinale*

For the mineral composition, Kano unpeeled sample had highest phosphorous, iron, zinc, magnesium and calcium content, while Kaduna unpeeled sample had the highest manganese and potassium content. Finally, the highest sodium content, 666.50 ± 0.17 was recorded in Kano peeled sample (Table 2).

Table 2: Mineral Composition of Different Samples of *Z. officinale*

S/N	Elements	KAPZ (mg/kg)	KAUZ (mg/kg)	KDPZ (mg/kg)	KDUZ (mg/kg)
1	P	2.68 ± 0.01	3.68 ± 0.02	2.68 ± 0.01	2.64 ± 0.01
2	Mn	18.60 ± 0.01	20.97 ± 0.07	30.67 ± 0.05	45.78 ± 0.06
3	Fe	36.17 ± 0.04	39.13 ± 0.05	10.94 ± 0.01	7.61 ± 0.03
4	Zn	4.77 ± 0.03	4.86 ± 0.02	1.62 ± 0.01	0.99 ± 0.01
5	Mg	1180.84 ± 0.02	2030.80 ± 1.78	14.01 ± 0.63	1258.06 ± 0.02
6	Ca	1971.55 ± 0.30	7287.86 ± 0.76	1275.00 ± 0.03	1641.95 ± 0.03
7	K	495.50 ± 0.58	429.00 ± 0.76	663.50 ± 0.57	666.50 ± 0.43
8	Na	666.50 ± 0.17	625.00 ± 0.17	208.35 ± 0.01	333.35 ± 0.76

All values were mean ± standard deviation (SD) of triplicate determinations
Key:
KAPZ = Kano peeled sample of *Z. officinale*
KAUZ = Kano unpeeled sample of *Z. officinale*
KDPZ = Kaduna peeled sample of *Z. officinale*
KDUZ = Kaduna unpeeled sample of *Z. officinale*

Table 3 shows the result of the phytochemical screening of different samples of *Z officinale* cultivated in Kano and Kaduna States, Nigeria. Alkaloids, saponins, flavanoids, phenolic compounds, cardiac glycosides and steroids were detected in all the samples, while tannins, anthraquinones and terpenoids were not detected in all the samples.

Table 3: Phytochemical Constituents of Different Samples of *Z. officinale*

Phytochemicals	KAPZ	KAUZ	KDPZ	KDUZ
Alkaloids	+	+	+	+
Flavonoids	+	+	+	+
Saponins	+	+	+	+
Tannins	-	-	-	-
Phenolic compounds	+	+	+	+
Cardiac glycosides	+	+	+	+
Anthraquinones	-	-	-	-
Terpenoids	-	-	-	-
Steroids	+	+	+	+

Key:
KAPZ = Kano peeled sample of *Z. officinale*
KAUZ = Kano unpeeled sample of *Z. officinale*
KDPZ = Kaduna peeled sample of *Z. officinale*
KDUZ = Kaduna unpeeled sample of *Z. officinale*
\+ = Present
\- = Absent

Discussion

There was no significant difference in the moisture content of all the samples; however, the values reported in this study were lower than those reported in previous studies (Nwinuka *et al*., 2005; Otunola *et al*., 2010; Ugwoke and Nzekwe 2010). The moisture content of foods indicates their freshness and time the foods could be stored without becoming unfit for consumption; higher moisture content subjects food to an increased microbial contamination and shorter shelf life, and vice versa (Dashak *et al.,* 2001; Adepoju and Onasanya, 2008).

The ash content of all the samples were lower than those reported by Otunola et al (2010) and Ugwoke and Nzekwe (2010). Higher ash content indicates higher mineral elements content, while lower ash content indicates low mineral elements (Bello, 1999; Oloyede, 2005). Similarly, the protein content of all the samples was lower than those reported by other workers (Nwinuka *et al*., 2005; Otunola *et al.,* 2010; and Ugwoke and Nzekwe, 2010).

Since *Z. officinale* is mostly used as a spice or an additive, the low levels of crude fibre detected in all the samples could serves as a boost to the total dietary fibre (Dashak *et al.,* 2001).

The result also shows that Kano unpeeled sample had the highest crude lipid content, this indicates that this sample could be a better source of lipid than the other samples tested, the oil could be extracted for use as an essential oil (Okwu and Nnamdi, 2008). Also, the proximate composition indicates that all the samples contained higher amount of carbohydrates suggesting that they can be ranked as carbohydrate rich.

The study also indicates that Kano unpeeled sample had highest magnesium, calcium, phosphorous, iron and zinc contents. The amounts of magnesium, calcium, iron and sodium contents in all the samples were significantly higher than the values reported in the previous studies, while that of phosphorous, manganese, zinc and potassium in all the samples were lower than those reported in the previous studies (Otunola *et al.,* 2010; USDA, 2013). All the mineral elements quantified in this study are very essential in human and animal nutrition. For example, calcium play a greater role in the normal pulse rate, transmission of nerve impulses and strong bones (Karppanen, 1994), while zinc is a micro element required in cell division, wound healing and also as a cofactor for insulin (Kimura, 1996).

The phytochemical screening shows that tannins, anthraquinones and terpenoids were not detected in all the samples. The absence of tannins and terpenoids did not agree with the previous studies (Ali, *et al.,* 2008; Otunola *et al.,* 2010 and Ugwoke and Nzekwe, 2010; USDA, 2013). The pharmacological activities of *Z. officinale* are attributed to some of the bioactive constituents detected in this study. For example flavonoids are well known for their antioxidant and antimicrobial properties (Okwu and Omodimiro, 2005), while alkaloids are reported to have analgesic, antimalarial, antiseptic and bactericidal activities (Evans, 1996).

Conclusion

The study has shown that there were no significant differences in the proximate and phytochemical composition; however, Kano unpeeled sample of *Z. officinale* contained higher amounts of most of the mineral elements quantified, consequently, the commercial cultivation of *Z. officinale* should be promoted in the State.

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