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Minerals Determination of Turmeric (*Curcuma Longa* Linn) Leaves and Rhizomes

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To investigate the mineral composition of *Curcuma longa* dried rhizomes. Activity directed mineral composition investigation of *C. longa* rhizomes using *in vitro* methods. The study was carried out at the medicinal plants section of National Root Crop Research Institute Umudike in Abia State, Nigeria. *C. longa* rhizomes were separately washed dried (at room temperature) and pulverized. The powdered rhizomes were then used for proximate analysis and mineral composition investigation. Values obtained for the proximate analysis of *C. longa* were; moisture (76.02%), carbohydrate (16.37%), ash (3.04%), crude fibre (1.95%), proteins (1.83%), and fat (0.80%) respectively. There was also a significant increase (P<0.05) in the percentage moisture content of *C. longa* rhizome. Mineral composition analysis of the rhizomes of *C. longa* gave the following values; iron (0.57%) > potassium (0.42%) > magnesium (0.05%) > phosphorus (0.03%) > calcium (0.02%) > sodium (0.01%) respectively. The current study revealed that *C. longa* rhizomes have high moisture content and is rich in steroids, anthraquinones and terpenes. 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, proximate analysis, mineral composition

INTRODUCTION

Curcuma longa (Linn.), commonly known as turmeric, is a tropical perennial monocotyledonous herbaceous plant of South and South-eastern Asia (Nwaekpe *et al.,* 2015). It belongs to the family of *Zingiberaceae* (Jilani *et al.,* 2012). 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) (Olatunde *et al.,* 2014). The plant is found primarily grown in tropical regions of Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, Philippines and Nigeria. It grows to about 2 feet in length with a broad pulpy, orange leaves. Its rhizome is pungent, bitter and widely used in folk medicine and household remedies for the treatmet of diabetes, high cholesterolemic, abdominal pains, menstrual disorder, wounds, eczema, jaundice, inflammations, cancerous symptoms and as a blood purifier (Sawant and Godghate, 2013). The powdered rhizome contains 70-76 percent curcumin, an active ingredient and yellow coloured (Gopinathan *et al.,* 2011). 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 (Peter, 2000; Cooper *et al.,* 1994).

Minerals

Minerals are naturally occurring chemical compound, usually of crystalline form and biogenic in origin. A mineral has one specific chemical composition, whereas rock can be an aggregate of different minerals or mineraloids, there are over 5,300 known mineral species. In March 2017, over 5230 of these have been approved by International Mineralogical Association (IMA). Turmeric contains minerals such as Calcium, Potassium, Phosphorus, Iron, Magnesium, Manganese, and Zinc. Minerals are inorganic substances present in the body tissues and fluids and their present is necessary for the maintenance of certain phytochemical processes which are essential to life. Minerals are chemical constituents used by the body in many ways. They have important roles to play in many activities in the body. Every form of living matters requires these inorganic elements or minerals for their normal life processes.

Minerals may be broadly classified as macro (major) and micro (trace) elements. The macro-minerals include Calcium, Phosphorus, sodium, Potassium, Magnesium, while the micro-mineral elements include Iron, Copper, Cobalt, Zinc, Manganese, Chromium, Sulphur (Eruvbetine, 2003)

Macro-minerals

Calcium (Ca)

Calcium functions as a constituent of bones and teeth, regulation of nerve and muscle function. In blood coagulation, calcium activates the conversion of prothrombin to thrombin and also takes part in milk clothing. It plays a role in enzyme activation. Calcium activates large number of enzymes such as adenosine triphosphates' (ATPase), lipase etc. It is also required for membrane permeability, involved in muscle contraction, normal transmission of nerve impulses.

Dietary calcium and phosphorus are absorbed mainly in the upper small intestine, particularly the duodenum and the amount absorbed is dependent on source, calcium-phosphorus ratio, intestinal pH, lactose intake and dietary levels of calcium, phosphorus vitamin D, Iron, aluminum, manganese and fact. In children, calcium deficiency causes rickets due to insufficient calcification by calcium phosphate of the bones in growing children. The bones therefore remain soft and deformed by the body weight. In adults, it causes osteomalacia, a generalized demineralization of bones. Source of calcium include beans, nuts, leafy vegetables, small fishes such as sardines bone.

Phosphorus P

Phosphorus is found in every cell of the body and is vitality concerned with many metabolic processes, including those involving the buffers in body fluids. It functions as a constituent of bones, teeth, adenosine triphosphate (ATP), phosphorylated metabolic intermediates and nucleic acids. Vitamin D is probably involved in the control of phosphorus absorption and serum levels are regulated by kidney reabsorption. Phosphorus is also needed for soil fertility; it is an essential macronutrient for plants and one of the three nutrients generally added to soils in fertilizers because of its vital role of energy transfer in living organisms and in plants.

Adequate phosphorus availability stimulates early growth and hastens maturity in plants. Deficiency of phosphorus in children causes rickets and in adult it causes osteomalacia. Sources of phosphorus include phosphate food additives, green leafy vegetables and fruits especially banana.

Sodium Na

Sodium is the principal cations in extracellular fluids. It regulates plasma volume and acid-base balance, involved in the maintenance of osmotic pressure of the body fluids, preserves normal irritability of muscles and cell permeability, activates nerve and muscle function and involved in Na^+/K^+ ATPase, maintenance of membrane potentials, transmission of nerve impulses and the absorptive processes of monosaccharide's, amino acid and bile salts. Sodium is readily absorbed as the sodium ion and circulates throughout the body. Excretion occurs mainly through the kidney as sodium chloride or phosphate. Low level of sodium in the serum is hyponatraemic and this leads to vomiting, diarrhea, burns and intestinal obstruction. Sources of sodium include table salt, salt added to prepared foods and most natural foods that contain sodium.

Potassium K

Potassium is the principal cations in intracellular fluid and functions in acid-base balance, regulation of osmotic pressure, conduction of nerve impulses, muscle contraction particularly the cardiac muscle, cell membrane function and Na^+/K^+ ATPase. Potassium is required during glycogenesis. It also helps in the transfer of phosphate from ATP to pyruvic acid and probably has a role in many other basic cellular enzymatic reactions. Low level of potassium causes hypokalemia which leads to diarrhea. Deficiency of potassium leads to muscular weakness, paralysis, mental confusion (Murray *et al.,* 2000). Potassium deficiency affects the collecting tubules of the kidney, resulting in the inability to concentrate urine, and also causes alterations of gastric secretions and intestinal motility. Sources include vegetables, fruits and nuts.

Magnesium Mg

Magnesium is an active compound of several enzyme systems in which thymine pyrophosphate is a co-factor. Oxidative phosphorylation is greatly reduced in the absence of Magnesium. It is also an essential activator for the phosphate transferring enzymes myokinase, creatine, kinase etc. It also activates pyruvic acid carboxylase, pyruvic acid oxidase and the condensing enzyme for the reactions in the citric acid cycle. It is also a constituent of bones, teeth, enzyme cofactor (Murray *et al.,* 2000). Magnesium is absorbed in the intestines and then transported through the blood to cells and tissues. Deficiency of magnesium leads to vomiting, diarrhea, convulsions, depressed deep tendon reflexes and respiration. Physiological deficiency of magnesium can be prevented by magnesium supplementation of a salt or grain mixture and adequate consumption is also very important (Murray *et al.,* 2000). Sources include green leafy vegetables (Containing chlorophyll).

Micro-Minerals

Chlorine Cl

Chlorine is involved in fluid and electrolyte balance and gastric fluid. It is the principal anion in extracellular fluid. It is involved in the regulation of extracellular osmotic pressure and makes up over 60% of the anions in this fluid compartment and is thus important in acid-base balance. It is the chief anion of the gastric juice and is accompanied by the hydrogen ions in nearly equal amounts. The chloride of the gastric secretions is derived from blood chloride and is normally reabsorbed during the later stages of digestion in the lower intestine (Murray *et al.,* 2000). Deficiency of chlorine leads to vomiting, diuretic therapy, renal disease. Chlorine is excreted in the faeces, sweat and urine primarily as sodium or potassium chlorides. Sources include table salt and drinking water.

Chromium Cr

Chromium is an essential element for animals and humans. It has been found in nucleoproteins isolated from beef liver and also in RNA preparation. It plays a role in maintaining the configuration of the RNA molecules, because Chromium has been shown to be particularly effective as a cross-linking agent for collagen. Chromium has also been identified as the active ingredient of the glucose tolerant factor, a dietary factor required to maintain normal glucose tolerance in the rat. Chromium compounds have a wide variety of industrial uses, including production of stainless steel and other alloys, high-melting refractory materials, pigments and mordant for paints and dyes. Chromium deficiencies may exist, particularly in children suffering from protein-calories malnutrition. In experimental animals, chromium deficiency leads to a reduced rate of removal of ingested glucose, due to low sensitivity of peripheral tissues to insulin. Toxicity of chromium leads to kidney, liver, nervous system and blood problems. Sources include liver, meat, whole-grains, nuts and cheese.

Copper Cu

Copper is an essential micronutrient necessary for the haematological and neurologic system (Tan *et al.,* 2006). It is necessary for the growth and formation of bone, formation of mylin sheaths in nervous system, helps in the incorporation of Iron in haemoglobin, assist in the absorption of Iron from the gastrointestinal tract (GIT) and in the transfer of Iron from tissues to the plasma (Murray *et al.,* 2000). Clinical disorders associated with copper deficiencies include anemia, bone disorders, de-pigmentation and abnormal growth of hair, fur or wool, impaired growth and reductive performance, heart failure and gastrointestinal disturbances (Murray *et al.,* 2000).

Manganese Mn

Manganese is a cofactor of hydrolase, decarboxylase and transferase enzymes (Murray *et al.,* 2000). Manganese is a part of enzyme involved in urea formation, pyruvate metabolism and galactotransferase of connective tissue biosynthesis. Absorption of manganese is inhibited by the presence of excessive amounts of calcium and phosphorus in the diet. Sources include whole-grains, tea, legumes, nuts and seeds.

Zinc Zn

Zinc is distributed widely in plant and animal tissues and occurs in all living cells. It functions as a cofactor and is a constituent of many enzymes like lactate dehydrogenase, glutamic dehydrogenase, DNA and RNA polymerase. Zinc dependent enzymes are involved in macronutrient metabolism and cell replication. In mature hens, zinc deficiency reduces egg production and hatchability. In pigs, zinc deficiency causes a marked depression of appetite. Sources include red meat, fish meats, eggs, liver, vegetables and some seafood’s.

MATERIALS AND METHODS

Plant material

Rhizomes of *Curcuma longa* Linn were obtained from National Root Crop Research Institute Umudike in Abia State, Nigeria. The plants were identified and authenticated at the same venue.

Preparation of *Curcuma longa* Linn. Rhizomes ethanolic extracts

Curcuma longa 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 h at room temperature on a flask shaker and filtered with Whatman No. 1 filter paper (Das *et al*., 2010). The filtrates obtained were used to screen for the secondary metabolites constituents of the two samples.

Mineral elements composition determination

The percentage sodium and potassium composition were determined photo-metrically as described by the (AOAC, 2005) methods (975.11) using the Jenway Digital Flame Photometer (PFP7 Model) with filters corresponding to each mineral element. The magnesium, 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 Vanadomolybdate (yellow) method 975.16 (AOAC, 2005).

Determination of calcium and magnesium

Calcium and magnesium content of the digested sample were determined by complexiometic titration. 10 ml of the sample solution was dispensed into separate conical flasks, pinch of the masking agents (Potassium cyanide, potassium ferrocyanide, hydroxyl hydrochloride) were measured into the content of each flask 20 ml of ammonia buffer was added to one of the flasks to raise the pH to 10.0 while 10 ml of NaOH solution was added to the other to raise the pH to12.0. To the flask at pH 10.0 (for calcium and magnesium) Erichrome dark black indicator was added and titrated against 0.02 N EDTA solution the other flask at pH 12.0 (for calcium alone) Selechrome dark blue indicator was added and titrated against 0.02 N EDTA solution at pH 12. Calcium complexes with EDTA while at pH 10. Both calcium and magnesium form complexes with EDTA. A reagent blank was titrated as a control. The calcium and magnesium content of the samples were calculated using the standard that 1ml of 1N EDTA has an equivalence of 24 mg magnesium and 20.04 mg calcium.

Sodium and potassium determination

Sodium and potassium were determined by flame photometry method. The instrument (photometer) was set up according to the manufacturer's instruction. 1 ml of prepared potassium and sodium standard solution were aspirated into the machine and sprayed over the non – luminous butane gas flame. The sodium and potassium emission (having been appropriately filtered) from the different concentrations were recorded and made into standard curve subsequently, the optical density emissions recorded form each of the sample were against those in the curve, thus using the curve to extrapolate the quality of each (sodium and potassium) in the sample.

Determination of phosphorous

The phosphorus in the sample was determined by the vanado-mohybdate (yellow) spectrometry described by James (1995).1 milliliter extract from the sample was dispensed into a test tube. Similarly, the volume of standard phosphorus solution as well as water were put it to other test tube to serve as standard and blank respectively the content of each tube were mixed with equal volume of the vanado-molybdate colour reagent. They were left to stand for 15minutes at room temperature before their absorbance was measured in Jenway electronic spectrophotometer at wavelength of 420 nm. Measurements were taken with the blank at zero.

RESULTS AND DISCUSSION

The results of the approximate nutrient composition of *C. longa* 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* (Table 1).

Table 1. Proximate analysis of curcuma longa

Parameters (%)	*C. longa*
Crude protein	1.83 ± 0.04
Crude fat	0.80 ± 1.02
Crude fibre	1.95 ± 0.01
Ash	3.04 ± 0.02
Moisture	76.02 ± 0.04*
Carbohydrate	16.37 ± 0.01

Values are mean ± SEM; n = 3
*Significantly different from C. longa at ($p < 0.05$).

The results also showed that *C. longa* rhizomes have high moisture content followed by carbohydrate, ash, crude fibre, protein and fat. The essential nutritional composition of ginger reported by (El-Ghorab *et al.,* 2010) 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* 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*. 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 (Latunde-Dada, 1980). 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 B_{12}. Potassium and magnesium are

Table 2. Mineral composition of curcuma longa.

Mineral element (%)	C. longa
Sodium	0.01 ± 0.00
Potassium	0.42 ± 0.00
Magnesium	0.05 ± 0.00
Calcium	0.02 ± 0.00
Phosphorus	0.03 ± 0.00
Iron	0.57 ± 0.01

Values are mean ± SEM; n = 3

Table 3. Proximate analysis of turmeric (Curcuma longa) rhizome and leaves.

Parameter	*Turmeric Rhizome*	*Turmeric Leaves*
Moisture content	10.54 ± 0.08	10.27 ± 0.03
Dry Matter	89.46 ± 0.08	89.72 ± 0.03
Ash	7.87 ± 0.04	11.37 ± 0.04
Crude Protein	6.54 ± 0.07	17.87 ± 0.10
Fat	6.29 ± 0.01	2.41 ± 0.01
Crude Fibre	4.14 ± 0.02	15.29 ± 0.01
Carbohydrate	*64.58 ± 0.04*	*42.74 ± 0.05*

Means of three determinations on a dry weight basis ± standard deviation.

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 (Kubinarawa *et al.,* 2007). The iron content present in the extracts can help in haemoglobin formation (Okwu and Josiah, 2006) 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.

Conclusion

Data from the current study revealed that the rhizomes of *C. longa* has high moisture content and high amount of carbohydrate > ash > crude fibre > protein > fat. The rhizomes of *C. longa* are rich in iron > potassium with trace amount of magnesium > phosphorus > calcium > sodium. *C. longa* rhizome also has more steroids, anthraquinones, and terpenes phytochemical thus suggesting more pharmacological active compounds in these plants.

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