

## Research Article

### Nutrient Contents and Fatty Acids Profiles of Leaves and Seeds of *Croton zambesicus*

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**Abstract:** *Croton zambesicus* leaves and seeds were investigated for nutrient contents and fatty acids of their oils. Proximate analysis showed that the leaves and seeds contained (g/100 g) moisture (7.88, 7.94); crude protein (13.13, 9.64); crude fibre (16.63, 15.45), crude fat (15.42, 26.73); ash (9.28, 4.15) and carbohydrate (55.35, 67.09), respectively. The seed contained higher level of potassium (2.2 g/100 g); iron (467.53 mg/100 g) and strontium (869.27 mg/100 g) while the leaf contained higher level of calcium (3.04 g/100 g). The leaves and seeds oils have iodine value above 100 mg/g oil and peroxide value below 10 Meq/kg. Palmitic acid, oleic acid and linoleic acids were higher in concentrations in both the leaves and seeds oil among the saturated, mono unsaturated and polyunsaturated fatty acids detected. The oils contained more polyunsaturated than saturated fatty acids. Both parts could be explored as food supplements.

**Keywords:** *Euphorbiaceae*, fatty acids, minerals, proximate composition, supplements

## INTRODUCTION

In recent years, natural extracts have been in high demand by the food manufacturers, cosmetics and pharmaceuticals due to the growing interest of consumers in the ingredients from the natural sources. Spices and essential oils are also well known for their various beneficial effects on human health. The use of aromatic plants and spices in phytotherapy is, most of the time, due to the essential oils and their various biological activities such as antimicrobial, spasmolytic, antiviral, anti-carcinogenic and hepatoprotective functions (Briskin, 2000). However, most of these plant species contain many other compounds with beneficial pharmacological, nutraceutical and dietetics properties. Among the plants that have wide application in African folkloric medicine is *Croton zambesicus* (Kumar *et al.*, 2011).

*Croton zambesicus* Muell. Arg. (syn. *C. amabilis* Muell. Arg., *Euphorbiaceae*) is a Guinea-Congolese species widely used in tropical Africa. It is an ornamental shrub or small tree, 9-15 m high and 0.9 m in girth, sometimes with a distinct bole and scaly bark, cultivated around villages in West Africa. It is commonly known in Nigeria as *Kirobalcen maser* in Hausa and *Ajeobale* or *Ajeofole* in Yoruba (Usman *et al.*, 2009). The leaves were described to be approximately 15×5 cm, oblong-lanceolate or elliptic, acuminate, base rounded, pale green, with whitish and

brown scales beneath and have up to 12 pairs of lateral nerves. The fruits are scaly, three-celled, with remains of stigmas at apex. The wood is pale yellow and fine-grained, the stems are used for house posts, the roots are used as an aperient, leaf decoction is used as a wash for fevers and internally for dysentery, fever or convulsions, the seeds are also used medicinally in some parts of West Africa (Fekam-Boyom *et al.*, 2002).

Most of the research on the plant centered on the medicinal value of the leaf and stem bark extracts, the constituents essential oils of the various parts and their antimicrobial activities. Pulverized leaves essential oil revealed the abundance of hydrocarbon, oxygenated monoterpenoids and sesquiterpenoids (Usman *et al.*, 2009). The ethanolic extract of the leaf was reported to produce a significant reduction in blood glucose level of diabetic rat (Okokon *et al.*, 2011). The extract also possesses considerable antiplasmodial activity, which can be exploited in malaria therapy (Okokon *et al.*, 2005) as well as anticonvulsant properties (Okokon and Nwafor, 2009). The water extract of the leaves was also reported to possess central nervous system depressant, sedative and hypnotic activity (Ayanniyi and Wanang, 2008). However, little or no information is available on the nutritional quality of the leaves and seeds of this plant used as ornamental/house plants and for medicinal purposes even though most of the times these parts are ground and ingested with food. Thus, the proximate

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constituents, level of mineral elements and fatty acids profile of the oils of leaves and seeds were reported.

## MATERIALS AND METHODS

**Materials:** Fresh leaves and seeds of *Croton zambesicus* were collected from Isale General Area, Ogbomosho, Nigeria. Samples were dried at room temperature and ground to fine powder with Marlex Excella blender (China). The ground samples were stored in airtight containers and kept in refrigerator prior to analyses.

**Determination of proximate constituents:** Procedures of Association of Analytical Chemists AOAC (1990) were adapted for the determinations. Moisture content was determined by heating 2.0 g of each sample to a constant weight in a crucible placed in an oven maintained at 105°C. Crude fat was obtained by exhaustively extracting 5.0 g of the samples in a soxhlet apparatus using Petroleum ether (40-60°C) as the extractant. Crude protein (% total nitrogen x 6.25) was determined by the Kjeldahl method, using 2.0 g of ground samples. Ash was determined by the incineration of 1.0 g of sample placed in a muffle furnace maintained at 550°C for 5 h, while crude fibre content was estimated by consecutive acid and alkali digestion of sample followed by washing, drying, ashing at 600°C and calculating the weight of ash free fibre. The carbohydrate contents were determined by difference.

**Quantification of mineral elements:** The sample mineral elements were analysed using X-Ray Fluorescence (XRF) transmission emission technique at the Center for Energy Research and Development (CERD), Obafemi Awolowo University, Ile-Ife, Nigeria, with model: PX2CR Power Supply and Amplifier for the XR-100CR Si Detector. The samples were pulverized, pelletized and then irradiated with X-Ray for 1000s, to obtain the characteristics spectral, each spectral was made up of peaks which was characteristics of certain elements contained in the sample. The spectrum was checked on the computer system and then interpreted for quantitative determination of elements by direct comparison of count rates.

**Fatty acids analysis and quantification:** A 50 mg of the extracted oil from the leaves and seeds sample was esterified separately for 5 min at 95°C with 3.4 mL of the 0.5M KOH in dry methanol. The mixture was neutralized by using 0.7M HCl and 3 mL of 14% boron trifluoride in methanol; then heated for 5 min at the temperature of 90°C to achieve complete methylation process. The fatty acid methyl esters were thrice extracted from the mixture with redistilled n-hexane. The content was concentrated to 1 mL for gas chromatography analysis and 1 µL was injected into the injection port of the gas chromatography (HP6890 Powered with HP Chem Station Rev. A 09.01 (1206)

Software) equipped with a flame-ionization detector and a 30×0.25 m column coated with a 0.25 µm film of HP INNOWAX. Split injection (split ratio 20:1) was performed, with nitrogen as carrier gas at a flow rate of 22 psi. The column temperature was maintained at 60°C for 1 min after injection then programmed at 12°C min<sup>-1</sup> for 20 min to 250°C, held for 2 min and then at 15°C min<sup>-1</sup> for 3 min, held for 8 min. The injection port temperature was 250°C and detector temperature was 320°C. The fatty acids were identified by comparing their retention times with those of standards and the content of fatty acids was expressed as percentage of total fatty acids.

**Chemical characteristics of the oil:** The oils were extracted with petroleum spirit (40-60°C boiling range, Sigma) using the Soxhlet extraction method. The chemical parameters were determined using AOAC 965.33 and AOAC 920.158 for peroxide value and iodine value (AOAC, 1990).

## RESULTS AND DISCUSSION

The proximate constituents of both the leaves and seeds of *Croton zambesicus* were reported in Table 1. The samples have low Moisture Content (MC) which can enhance the shelf life and provide protection against microbiological spoilage. The MC in the seed is lower than 8.90/100 g in *Moringaoleifera* seed (Anwar and Rashid, 2007) while the MC in the leaf is lower than 9.53 g/100 g in *Moringaoleifera* leaf (Moyo *et al.*, 2011). The ash content which is a measure of the mineral content in biological mass is high in both parts of the plant. Lower ash was observed in the seed compared to that in the leaf, this is similar to the trend of 2.4/100 g ash in seed and 8.10/100 g leaf of *Sabaflorida* (Omale *et al.*, 2010). This is an indication that the leaves of these plants might be a better source of inorganic elements than the seeds.

The crude protein content in the leaves is higher than that in the seed. Both values are higher than 8.26/100 g dry matter in fruit pulp of *Carica papaya* (USDA, 2005). The protein content in the leaves compared favorably with protein content of 12.8% in cabbage and 14% in lettuce. Thus, the leaf and seed could be a dietary source of protein in combating protein energy malnutrition. Both plant parts contained high Crude Fiber (CF) which could be of health benefit. The CF in the leaves is higher than that in the seed. The CF in the seed is higher than 7.70/100 g and 8.55/100 g CF in *Azeliaafricana* and *Pachiraglabra* seed flours, respectively (Ogunlade and Ajayi, 2011) while the CF of leaves was higher than 10.51/100 g in *Spondiasmombin* leaves. High dietary fiber confer laxative effect in the gastrointestinal tract, thereby shortening transit time of food in the tract and increasing water-holding capacity of faeces. As a result, the likely incidence of the disorders such as constipation, diverticulitis, irritability bowel

Table 1: Proximate composition of *Croton zambesicus* leaf and seed

Parameters (g/100 g)	Leaf	Seed
Moisture	7.88±0.03	7.94±0.02
Ash	9.28±0.00	4.15±0.01
Crude protein	13.13±0.12	9.64±0.14
Crude fibre	16.63±0.34	15.45±0.21
Crude fat	15.42±1.49	26.73±0.32
Carbohydrate	55.35±0.32	67.09±2.28

Table 2: Mineral composition of seed and leaf of *Croton zambesicus*

Elements	Seed	Leaf
Potassium (g/100 g)	2.224±0.004	1.682±0.031
Calcium (g/100 g)	1.999±0.035	3.043±0.036
Titanium (g/100 g)	0.036±0.003	0.026±0.002
Iron (mg/100 g)	467.530±7.620	275.030±4.770
Manganese (mg/100 g)	71.610±0.810	71.210±2.350
Strontium (mg/100 g)	869.270±10.000	707.800±10.00

syndrome, gall stone and colorectal cancer is prevented. Fibres are known to slow down glucose absorption and reduce insulin secretion which is of great importance to diabetic patients (Ijeomah *et al.*, 2012). *Croton zambesicus* leaf and seed could be recommended to diabetic patients as food supplements in their meals. This property might partly be responsible for the antidiabetic activity of the leaf extract reported by Kumar *et al.* (2011). The leaves of *Crotonzambesicus* contain high oil content compared to most leafy vegetables, a range of 1.75/100 g in *Cochorusolitorius* to 3.75/100 g in *Amaranthus hybridus* was observed by Mohammed and Mann (2012). The oil in the seed is higher than 14/100 g in wheat germ, 20 g/100 g in soya bean, 23/100 g in rice bran and 25/100 g in cotton seed (Abayeh *et al.*, 1998). The leaf and seed could be a good source of fixed oil thus complementing the conventional sources; they could also be a good source of essential fatty acids and fat soluble vitamins. The level of carbohydrate in the leaf and seed could be a good source of energy.

The level of mineral elements in the leaves and seeds of *Croton zambesicus* was reported in Table 2. Few elements were detected in the sample by XRF. Calcium was in highest quantity in the leaves, while potassium was highest in the seed. The level of calcium is higher than 750.37 mg/100 g in *Melociacorchorifolia*, a wild leafy vegetable which is relished by the majority of populace where the plant is grown (Hassan *et al.*, 2011). Calcium is a major factor sustaining strong bones and plays a part in muscle contraction and relaxation, blood clotting, synaptic transmission and absorption of Vitamin B12 (Mensah *et al.*, 2008). The high content of calcium in the plant parts may be of therapeutic value in hypocalcaemic state like osteoporosis. Potassium also regulates osmosis and aqueous equilibrium, which impacts nerve transmission, muscle tone, renal function and heart muscle contraction. Occasional potassium deficiencies are diagnosed by symptoms including renal disorder, diabetic acidosis, vomiting, diarrhea and excessive sweating (Poersch *et al.*, 2011). Consumption of the seed as food supplement could complement other food sources in the supply of potassium to the body system.

Iron deficiency is a menace in developing countries. Seshadri (2001) reported that 46% of Nigerian pregnant women are anaemic while 48% were iron deficient. A Nigerian food consumption and nutritional survey also highlighted that 34% of the Nigerian children under the age of five are anaemic while 40-60% of children (6-24 months old) are at risk of disrupted brain development due to iron deficiencies (Bilbis, 2007). The leaves and seeds are good sources of iron, as they could complement other food sources in tackling the menace of iron deficiency.

Manganese was detected in both the leaf and seed of *Croton zambesicus*. Manganese, in the proper levels, is an important element used by the body to complete many important functions, such as the metabolism of cholesterol, carbohydrates and amino acids. Low levels of manganese was reported to lead to many health problems including joint pain, arthritis, inflammation and diseases such as Parkinson's, schizophrenia, osteoporosis and epilepsy. A deficiency of manganese could also cause skeletal deformation in animals and inhibits the production of collagen in wound healing (Keen and Zidenberg-Cherr, 1996). The leaf and seed could thus serve as nutraceutical in the prevention of these health related problems. Titanium was detected in both the leaf and seed. Titanium has been reported to be non-toxic even in large doses and does not play any natural role inside the human body. An estimated quantity of 0.8 mg of titanium could be ingested by humans each day, but most passes through without being absorbed. However, an unknown mechanism in plants may use titanium to stimulate the production of carbohydrates and encourage growth (Emsley, 2001). The level in the leaves and seeds might not be of any health treat.

Strontium was detected in both the leaf and seed. The human body has been reported to absorb strontium as if it were calcium, due to the chemical similarity of the elements. The stable forms of strontium might not pose a significant health threat; in fact, the levels found naturally may actually be beneficial. The drug strontium ranelate, made by combining strontium with ranelic acid, was found to aid bone growth, increase bone density and lessen vertebral, peripheral and hip fractures (Meunier *et al.*, 2004). The level of strontium in the plant parts could complement calcium in enhancing strong bones.

The peroxide value, iodine value and fatty acids profile of the oil of leaf and seed of *Croton zambesicus* were reported in Table 3. The iodine values of the parts are above 100 and thus could be classified as semi drying oil, the iodine values compared favorably with those of edible oil; cotton seed oil, sunflower seed oil and passion fruit seed oil with a range of 105-144, 110-143 and 133-141 g iodine/100 g oil, respectively (Abayeh *et al.*, 1998). The peroxide value is used as an indicator of deterioration of oils; fresh oils have values less than 10 mEq/kg, values between 20 and 40 mEq/kg results in rancid taste (Eka *et al.*, 2009). The peroxide

Table 3: Chemical characteristics and fatty acids profiles of oils of leaf and seed of *Croton zambesicus*

Parameters	Leaf	Seed
Iodine value (gI <sub>2</sub> /100 g)	153.31±1.33	148.53±1.28
Peroxide value (meq/kg)	9.80±0.02	8.00±0.01
Saturated Fatty Acids (SFA)		
Lauric acid C12:0	1.04	1.10
Myristic acid 14:0	1.41	1.50
Palmitic acid C 16:0	32.03	30.72
Stearic acid C 18:0	4.81	4.92
Arachidic C 20:0	0.59	0.54
Behenic C 22:0	1.35	1.44
Lignoceric C 24:0	0.59	0.63
Mono unsaturated fatty acids		
Palmitoleic acid C 16: 1	2.99	2.91
Oleic acid C 18:1	33.28	34.14
Erucic acid C 22:1	0.69	0.74
Polyunsaturated fatty acids		
Linoleic acid C 18: 2	18.27	18.46
Linolenic acid C 18: 3	2.93	2.90

values of the oil of the leaf and seed were below 20 mEq/kg and they might not easily go rancid.

Twelve fatty acids were identified in both the leaves and seeds oils. The leaves had 41.82% saturated fatty acids, 36.96% monounsaturated fatty acids and 21.20% polyunsaturated fatty acids while the seeds had 40.85% saturated fatty acids, 37.79% monounsaturated fatty acids and 21.36% polyunsaturated fatty acids. Thus, in both plant parts, the proportion of unsaturation is higher than saturation. Emphasis have been placed on lowering consumption of saturated fats, minimizing or eliminating trans-fat and increasing polyunsaturated and monounsaturated fats in order to improve the integrity of cardiovascular system (Ijarotimi and Keshinro, 2012), consumption of croton leaves and seeds could therefore, prevent cardiovascular disease and other nutritional related diseases.

Both parts contain higher proportion of palmitic acid among the saturated acids, but the level was lower than 41.78 palmitic acid in palm oil (Chowdhury *et al.*, 2007). The proportion of oleic acid is higher than 6.8% in *Salvia hispanica* seed (chia), the linoleic acid in the leaf and seed was higher than 18.4% in chia seed (Ayerza, 2013). The contents of linolenic acid in both the leaf and the seed were higher than 0.0002, 0.001 and 0.403% in raw, germinated and fermented African locust bean flour respectively (Ijarotimi and Keshinro, 2012). This showed that the leaf and seed of *C. zambesicus* might be a better source of these health benefitting fatty acids than the highly prized chia and commonly consumed African locust bean.

### CONCLUSION

Leaves and seeds of *Croton zambesicus* were found to contain higher level of fiber, crude protein and crude fat and mineral elements with health benefits. The proportions of unsaturated fatty acids are higher than that of saturated fatty acids which make the oil suitable for consumption. Both the plant parts could be harnessed for both medicinal purposes and as food supplements.

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