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Nutrient composition and micronutrient potential of fresh and processed leaf of tree basil (*ocimum gratissimum .l*)

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Abstract

Introduction: There is increasing global search for novel sources of micronutrients currently recognized for their immense health benefits and promotion of indigenous foods as a means of meeting dietary needs of people and combat micronutrient deficiency. *Ocimum gratissimum*, a family of Basil cultivated as culinary herb and condiment is a source of essential oil for food, flavours and fragrance.

Materials and methods: The green aromatic leaves, used fresh as vegetable and dried form as flavourings or spices in sauces, stews, salad dressings and confectionery products, was studied for its nutrient composition, antinutritional factors and micronutrient potential. Samples of fresh, steamed and dried leaves were analysed using standard methods of analysis of AOAC.

Results: The results revealed that 100g portion of the fresh leaf contained 86.9g moisture, 3.0g protein, 4.0g crude fibre, 15.7mg calcium, 39.3mg phosphorus, 0.6mg iron, 3.7mg zinc, 571.6μg â-Carotene, 0.27mg niacin, 0.14mg riboflavin, 0.18mg thiamine, 36.5mg ascorbic acid, 0.63mg phytate, 1.04mg oxalates and 0.92mg saponins. The levels of antinutritional factors of fresh and processed leaves were low and most probably could not cause any health hazard even when consumed in large quantities. Steaming the leaf resulted in significant reduction in most of the nutrients and antinutrients ($p<0.05$). Drying significantly increased concentration of the nutrients especially protein, crude fibre, minerals and â-Carotene ($p=0.01$), with significant reduction in ascorbic acid, thiamine, riboflavin and antinutrients.

Conclusion: The leaf can serve as a good source of zinc, B-vitamins, and antioxidants (â-Carotene and ascorbic acid) which prevent free radical activities and cell degeneration currently implicated in many pathologic states.

Keywords: *Ocimum gratissimum leaf, micronutrients, antinutritional factors, steaming, sun-drying*

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Résumé

Il y a une augmentation de la recherché globale sur des nouvelles sources des micronutriments couramment reconnues pour leur immense bénéfices en santé et la promotion des mets traditionnelles comme un moyen d'atteindre ses besoins diététiques de la population et combattre les déficits micronutritionels. L'*Ocimum gratissimum*, de la famille du Basil cultivé comme une herbe culinaire et condiment est une source d'huile essentielle, de parfums et de fragrance. La feuille vertes aromatisée, utilisée fraiche comme des légumes et sèche comme parfum or épices dans les sauces, salades et confitures, était étudiée pour sa composition chimique, les facteurs antioxydants et le potentiel des micronutriments. Les échantillons fraiches, bouillies et sèches des feuilles étaient analysés par les méthodes d'analyses standards d'AOAC. Les résultats révélaient que 100g de portion de feuille fraiche contient 86.9g d'humidité, 3.0g protéines, 4.0g de fibre, 15.7mg de calcium, 39.3mg de phosphore, 0.6mg de fer, 3.7mg de zinc, 571.6mg de â-carotène, 0.27mg de niacine, 0.14mg de riboflavine, 0.18mg de thiamine, 36.5mg d'acide ascorbique, 0.63mg d'acide pythique, 1.04mg d'acide oxalique et 0.92mg saponines. Les taux des facteurs antinutritionnels des feuilles fraiches et feuilles transformées étaient faibles et probablement ne pouvait pas présenter un danger e en santé même quant consommer en large quantités. Les chauffages des feuilles résultaient à une réduction significative des nutriments et antinutriments ($p<0.05$). Les feuilles séchées augmentaient significativement en concentration des nutriments spécialement de protéines, fibres, minéraux et â-carotènes ($p=0.01$), avec une réduction significative de l'acide ascorbique, thiamine, riboflavine et antinutriments. La feuille peut server come une bonne source du zinc, vitamines B, et antioxydants, â-Carotene et d'acide ascorbique) Qui prévient les activités des radicaux libres et de dégénération cellulaires couramment impliqués dans les conditions pathologiques.

Introduction

Fruit and vegetables are good sources of micronutrients, especially minerals and vitamins. Basil, a member of the mint family, well known for its starring role in the Italian dish, pesto, is widely used in many cooked dishes and salads, particularly in the summer time. Its fresh flavour brings is similar to well known food plants such as cinnamon, clove, lemon, and thyme, while its dried form tastes more like curry [1].

Basil extract has been reported to have antioxidant activity and has been used as a medicinal plant in treatment of headaches, coughs, diarrhoea, constipation, warts, worms, and kidney malfunctions [2]. It is also thought to be an antispasmodic, stomach ache, carminative, stimulant and insect repellent. It protects against and reduces stress; enhances stamina and endurance. It helps increase the body's efficient use of oxygen; boosts the immune system; reduces inflammation; protects against radiation damage, stems rapid ageing, supports the heart, lungs and liver. The extract has antibiotic, antiviral and antifungal properties [2, 3].

Ocimum gratissimum L. (Tree basil) has fuzzy, lime-green leaves scented like pennyroyal. Making a tea of its leaves is used for colds and fevers [4], while the leaf is a popular treatment for diarrhoea, and burnt as mosquito repellant [2, 3, 6,7].

Alabi *et al.* [3], reported some chemical, selected vitamins and amino acids, as well as mineral composition of *Ocimum gratissimum* leaf; while Edeoga *et al.* [8], reported the chemical composition, some selected minerals, and antinutritional factors of the dried leaf.

Much work had been done on the anti-microbial effect and medicinal properties of *Ocimum gratissimum* [9-13, but little or no information is documented on the nutrient composition, micronutrient potential and antinutritional factors of fresh and processed *Ocimum gratissimum L* leaf. This study therefore was designed to determine the nutrient and anti-nutrient composition and micronutrient potential of this leaf.

Materials and methods

Fresh *Ocimum gratissimum* leaves were obtained from Institute of Agricultural Research and Training (IAR&T) of Obafemi Awolowo University, Moore Plantation, Ibadan. Composite sample of the leaves was divided into three portions of 100grammes each. One portion was heated to boiling at a temperature of 100°C for 5minutes and labeled as steamed sample; one portion was sun-dried for three days and labeled as dried sample; while the third portion was used as fresh sample.

Chemical analyses

The three samples were analysed in triplicate for moisture, crude protein, crude lipid, crude fibre and ash using standard methods of the Association of Official Analytical Chemists [14]. The carbohydrate content was obtained by difference. Potassium and sodium were determined using the modified method of Bonire *et al.* [15] by digesting the ash of the pulp with perchloric acid and nitric acid and taking the readings on Jenway digital flame photometer/spectronic20. Phosphorus was determined by vanado-molybdate colorimetric method. Calcium, magnesium, iron, zinc and manganese were determined spectophotometrically by using Buck 200 Atomic Absorption Spectrophotometer (Buck scientific, Norwalk) [16]; and their absorption compared with absorption of standards of these minerals.

The ascorbic acid content of the leaf was determined by titration with 2, 6-dichlorophenol-indophenol solution, while riboflavin was extracted using 5ml of 5M HCl and 5ml of dichloroethene and measurement made with fluorometer. Standard solution of riboflavin was prepared and readings taken; then the leaf riboflavin obtained through calculation. The leaf's beta-carotene was extracted with chloroform and determined through ultraviolet absorption measurement at 328nm. Calibration curve of standard â-carotene solutions absorption was made and the leaf â-carotene concentration estimated as microgram (ìg) of â-carotene/100g sample.

Oxalate was determined by extraction with water for about three hours. The absorbance of the leaf extract was read on spectrophotometer (Spectronic 20) at 420nm. Standard solutions of oxalic acid were prepared and their absorption was also read at 420nm to obtain a standard curve from which the amount of oxalate was estimated. Phytate was determined by titration method using ferric chloride solution [17]; while tannin content was determined by extracting the leaf with a mixture of acetone and acetic acid for five hours. Their absorbance was measured and compared with that of standard solutions of tannic acid at 500nm on spectronic 20 [18]. Saponin of the extract was determined by measuring its absorbance and comparing with that of standard solutions at 380nm [19]. Nitrates were determined by using EDTA solution, and nitrites with sulphanilamide/N-1-naphthylethelene diamine dihydrochloride solution, and absorbance measured at 538nm [20]. The results of the analyses were subjected to Chi square test and level of significance taken at 95% confidence level.

Results

The result of proximate composition of *Ocimum gratissimum* fresh, steamed, and dried leaf samples is as shown in Table 1. The fresh sample was high in moisture content, fairly high in crude fibre, low in carbohydrate and gross energy, and very low in crude protein and lipid. Steaming of the leaf led to significant reduction in value of crude protein, crude fibre and carbohydrate ($p = 0.02, 0.03, 0.02$ respectively), while drying resulted in concentration of all nutrients compared with the fresh sample.

Table 1: Proximate composition of *Ocimum gratissimum* Leaf (g/100g sample)

Nutrient	Fresh	Steamed	Dried
Moisture	86.9 ± 0.02[a]	90.9 ± 0.03[a]	7.0 ± 0.04[c]
Dry Matter	13.1 ± 0.02[a]	9.1 ± 0.03[b]	93.0 ± 0.04[c]
Crude Protein	3.0 ± 0.14[a]	1.9 ± 0.08[b]	11.4 ± 0.06[c]
Crude Lipid	0.9 ± 0.02[a]	0.9 ± 0.01[a]	3.7 ± 0.02[c]
Crude Fibre	4.0 ± 0.06[a]	2.9 ± 0.03[b]	13.7 ± 0.05[c]
Ash	1.0 ± 0.05[a]	0.9 ± 0.01[a]	16.4 ± 0.03[c]
Carbohydrates	4.2 ± 0.03[a]	2.5 ± 0.01[b]	47.8 ± 0.20[c]
Gross energy	43.9 ± 0.26[a]	30.8 ± 0.50[b]	297.0 ± 0.61[c]

Values with the same parenthesis (a) are not significantly different while those with different parentheses (a, b, c) are significantly different.

Table 2 shows the mineral composition of fresh, steamed and dried *Ocimum gratissimum* leaf. The fresh leaf was low in sodium, potassium, calcium, magnesium, iron, phosphorus and copper, but high in manganese and zinc. There was a significant loss in mineral content of the steamed leaf compared with the fresh sample ($p = 0.02, 0.03$). Drying on the other hand seemed to significantly concentrate the minerals ($p = 0.001, 0.02$) compared with the fresh sample.

Table 2: Mineral Composition of *Ocimum Gratissimum* Leaf (mg/100g)

Nutrient	Fresh	Steamed	Dried
Sodium	11.3 ± 1.53[a]	6.3 ± 0.58[b]	206.7±25.17[c]
Potassium	30.7 ± 2.52[a]	18.3 ± 2.52[b]	323.3±30.55[c]
Calcium	15.7 ± 1.15[a]	11.0 ± 2.00[b]	256.7±30.56[c]
Magnesium	14.3 ±1.15[a]	8.3 ± 0.16[b]	340.0±20.00[c]
Iron	0.3 ± 0.01[a]	0.2 ± 0.02[b]	2.4 ± 0.20[c]
Phosphorus	39.3 ± 7.44[a]	23.0 ± 2.00[b]	466.7±11.55[c]
Manganese	5.3 ± 0.20[a]	4.0 ± 0.31[b]	6.1 ± 0.20[c]
Zinc	3.7 ± 0.20[a]	2.2 ± 0.11[b]	4.1 ± 1.53[c]
Copper	0.3 ± 0.02[a]	0.3 ± 0.03[a]	5.4 ± 0.09[c]

Values with the same parenthesis (a) are not significantly different while those with different parentheses (a, b, c) are significantly different.

Table 3 shows *Ocimum gratissimum* leaf composition of selected vitamins. The fresh leaf was very rich in â-carotene and ascorbic acid but low in niacin and riboflavin. There was significant reduction in value of the vitamins in steamed sample ($p = 0.02, 0.03$) compared with the fresh one. Drying of the leaf brought significant reduction in value of water-soluble vitamins and an increase in concentration of â-carotene compared with the fresh sample ($p = 0.02$).

Table 3: Selected vitamin composition of *ocimum gratissimum* Leaf (mg/100g)

Nutrient	Fresh	Steamed	Dried
Niacin	0.27±0.04[a]	0.15±0.01[b]	0.11±0.01[c]
Riboflavin	0.14±0.01[a]	0.06±0.01[b]	0.03±0.01[c]
Thiamine	0.18±0.01[a]	0.11±0.01[b]	0.07±0.01[c]
â-Carotene (ì g/100g)	571.60±2.11[a]	482.03±2.20[b]	871.00±3.15[c]
Ascorbic acid	36.47±0.15[a]	18.47±0.25[b]	11.87±0.25[c]

Values of all parameters are significantly different for all the samples.

Table 4 shows the level of antinutritional factors and toxicants in the leaf. The fresh leaf was very low in all antinutritional factors and toxicants studied, and steaming and drying brought significant reduction in their values ($p = 0.03$).

Table 4: Antinutritional factors of *Ocimum gratissimum* leaf (mg/100g)

	Fresh	Steamed	Dried
Phytates	0.63 ± 0.03[a]	0.42 ± 0.03[b]	0.30 ± 0.02[c]
Oxalates	1.04 ± 0.02[a]	0.73 ± 0.03[b]	0.43 ± 0.04[c]
Saponins	0.92 ± 0.03[a]	0.67 ± 0.02[b]	0.56± 0.02[c]
Tannins	0.44 ± 0.01[a]	0.26 ± 0.02[b]	0.69 ± 0.04[c]
Nitrates (ìg)	0.51 ± 0.02[a]	0.29 ± 0.03[b]	0.18 ± 0.03[c]
Nitrites (ìg)	0.12 ± 0.02[a]	0.06 ± 0.00[b]	0.02 ± 0.00[c]

Values of all parameters are significantly different for all the samples.

Discussion

The moisture content of fresh *Ocimum gratissimum* fell within the range of values reported for fresh green leafy vegetables in the literature [21, 22]. Its high moisture content was indicative of low total solids. As common with most vegetables, the leaf was low in crude protein and lipid content. However, these values were comparable with those of cocoyam (*Colocassia esculenta*) [23], baobab and okra leaves, and higher than that of okra fruit [21].

The low value obtained for the lipid of fresh leaf might have resulted from loss of its volatile oil component during drying at 60°C in the oven for preservation before determination of its proximate composition. Several authors [2, 3, 6, 7] reported the leaf to be rich in volatile oil, and this may account for its low non-volatile lipid content. The fresh leaf was also low in carbohydrates and gross energy content. The low gross energy content of the leaf was attributable to its low crude protein, lipid, and carbohydrate content.

Steaming of the leaf led to significant reduction in value of most of the macronutrients. This reduction might have resulted from leaching of these nutrients into the steaming water, and this is suggestive of the fact that the leaf contained relatively high amount of soluble protein, carbohydrate and fibre.

Drying the leaf resulted in concentration of all nutrients in dried *Ocimum gratissimum* sample due to loss of moisture. The value obtained for moisture, dry matter and crude protein content of dried sample is in agreement with those reported in the literature for one species of the plant, while the crude lipid, carbohydrates and gross energy values were lower [8, 3]. The low carbohydrate and gross energy levels, coupled with high fibre content (which has a lot of health promoting potentials) qualify the leaf as a good vegetable for diabetics and the obese. Its low sodium content also qualifies it as a good vegetable for the hypertensive and the obese.

The reduction in mineral content of boiled sample is believed to be due to their leaching into the steaming water, since most minerals are readily soluble in water in their ionic form. Drying on the other hand seemed to significantly concentrate the minerals due to reduction in the moisture content of the dried sample. However, the values obtained for sodium, potassium, calcium and magnesium in this study were significantly lower than those reported by Edeoga *et al.* [8], but higher than those reported by Alabi *et al.* [3]. The phosphorus value on the other hand was significantly higher than those in the literature. The dried sample appears to be a good source of all the minerals studied. The leaf in its dry form is employed as curry, which is used in seasoning soup and stew, as well as in meat processing [1].

The fresh leaf is very rich in â-carotene and ascorbic acid, but low in niacin and riboflavin. Its high â-carotene content might have contributed in part to its green colouration [24], and qualifies it as a good source of pro-vitamin A, a micronutrient of great nutritional importance. Ascorbic acid and â-carotene have been implicated as micronutrients with potential of antioxidant activities, which prevent cancer and heart diseases [25], hence the leaf has health promoting potentials.

The reduction in vitamin content of steamed sample was more pronounced among the water-soluble ones. This might have resulted from their solubility in water. The reduction in â-carotene content of steamed sample may be due to its destruction since it is heat labile. Drying of the leaf brought significant reduction in value of water-soluble vitamins. However, drying resulted in increased concentration of the leaf â-carotene. The high ascorbic acid and â-carotene content of the fresh leaf confirm its reported antioxidant activity in the literature [2, 3], while these micronutrients coupled with the high fibre content of the leaf have potentials to prevent constipation and kidney malfunctions.

The reported protection against and reduction of stress, enhancement of stamina and endurance as well as helping increase the body's efficient use of oxygen; boosting the immune system, stemming of rapid ageing, and supporting the heart, lungs and liver is believed to be a direct result of the leaf's levels of antioxidants and fibre composition [26]. Good evidence exist that ingestion of high fibre diets results in increased removal of carcinogens, potential mutagens, steroids, bile acids and xenobotics by binding or absorbing to dietary fibre components and be rapidly excreted [27, 28].

The level of antinutrients and toxicants in *Ocimum gratissimum* leaf is very low. There was reduction in their values due to processing. The reduction was more pronounced in the dried sample; and this observation confirmed the fact that heat treatment reduces level of some antinutritional factors in raw foods [29]. The low level of antinutritional factors and toxicants in the leaf makes it safe for consumption on large scale.

Conclusion

The fresh leaf is very low in carbohydrate, gross energy, sodium, riboflavin and niacin, fairly high in crude fibre and very high in â-carotene and ascorbic acid values. It is also low in antinutritional factors. All these attributes qualify the leaf as a good vegetable which has antioxidant and health promoting characteristics. Its consumption is considered safe even at high quantity and may be applicable to all and sundry, including the vegetarians. However, to prevent loss of nutrients due to steaming, retaining steaming water for the cooking is recommended. Also, drying the leaf can serve as a means of its preservation, and the dried leaf can serve as additive or spice which can add more nutrients to cooking. The leaf can serve as good source of micronutrients such as zinc, manganese, â-carotene and ascorbic acid.

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