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***J. Nat. Prod. Plant Resour*., 2012, 2 (2):261-266**
(http://scholarsresearchlibrary.com/archive.html)

ISSN : 2231 – 3184
CODEN (USA): JNPPB7

Comparative evaluation of the nutritional benefits of some underutilised plants leaves

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ABSTRACT

Edible plants are good nutrients sources. Seven lesser known plant leaves (Tecoma stans (Tecom), Solenostemon monostachyus (SoleMon), Ficus exasperata (FicEx), Senna fistula (SenFist), Citrullus lanatus (CitLan), Ocimum gratissimum (OciGrat) and Ipomea involucrata (Ipocrata)) were assessed for their nutrients along with those commonly used for nutritional and medicinal purposes. Tecom (46.27 %); CitLan (58.22 %); SoleMon (4.64 %) and SenFist (5.12 %); SenFist (26.19 %); and FicEx (20.94 %) exhibited highest carbohydrate; protein; fat; crude fibre; and ash respectively. Variable levels of minerals were found in all except in OciGrat, FicEx, Tecom, Vernonia amygdalina and Talinum triangulare that lack copper. Ipocrata and Cymbopogon citratus were adequately rich in all the bulk nutrients. Cadmium and lead were generally high in all the plants. The underutlised leaves may useful as medicinal foods that are required in small quantity to prevent heavy metal toxicity.

Key words: Plants, underutilised, health, heavy metal, minerals, nutrients, vegetables.

INTRODUCTION

Herbaceous plants are sources of edible vegetables, which are rich in nutrients. Some vegetables, such as bitter and pumpkin leaves, also possess some medicinal properties [1]. The nutrients found in vegetables may prevent certain types of cancers and promote heart health. They serve as indispensable constituents of the human diet supplying the body with minerals, vitamins, dietary fiber and certain hormone precursors, in addition to protein and energy [1]. Scientific approach for exploration of a large number of unexplored medicinal plants in North-East India had been reported [2]. Their utilization, conservation and value addition may be the key points for entrepreneurship development by exploiting the indigenous technology knowledge [2].

Several vegetable species abound in Nigeria and most West African countries where they are used partly as condiments or spices in human diets or as supplementary feeds to livestock such as rabbits, poultry, swine and cattle [3]. The amounts of the mineral constituents in the more commonly used leaf vegetable species in Nigeria have been studied to some extent; the lesser known species remain virtually neglected. Lack of information on the specific nutrients in a large number of the native plant species is partly responsible for their under exploitation especially in areas beyond the traditional localities where they are found and consumed [4]. This work was therefore aimed at finding out the nutritive values of some underutilized leaves (*Ocimum gratissimum*, *Tecoma stans*, *Solenostemon* *monostachyus, Ficus exasperata, Senna fistula, Citrullus lanatus*, and *Ipomea involucrata*) along with those commonly used for nutritional (*Amaranthus viridis, Celosia argentea, Ocimum basilicum* and *Talinum triangulare*) and medicinal (*Vernonia amygdalina*, and *Cymbopogon citratus*) purposes.

MATERIALS AND METHODS

Chemicals and reagents

1-octanol, boric acid, petroleum ether, perchloric acid were obtained from BDH chemical Ltd. (Poole, England). Nitric acid was obtained from Merck chemicals (Germany). All chemicals used were of analytical grade.

Samples collection

The following plant samples were obtained from Covenant University, Ota, Ogun state and its environ: *Tecoma stans* (L) H.B.&K. (Tecom; FHI 108922), *Solenostemon monostachyus* (P.Beauv) Brig. (SoleMon; FHI108913), *Ficus exasperata* Vahl. (FicEx; FHI 108919), *Senna fistula* (SenFist; FHI 108994), *Ipomea involucrata* P. Beauv. (Ipocrata; FHI 108917), *Ocimum basilicum* L. (OciBas; FHI 110996), *Talinum triangulare* (Taligul; FHI 108918), *Celosia argentea* Linn (CelTea; FHI 108920), *Cymbopogon citratus* (DC) staff (CymRatus; FHI 108916), *Ocimum gratissimum* L. (OciGrat; FHI 108915), *Citrullus lanatus* (CitLan; FHI 108918), *Amaranthus viridis* Linn (Amar; FHI 108921) and *Vernonia amygdalina* Del. (VerMyg; FHI 108914). These plants were identified at the Applied Biology Unit of the Biological Sciences Department at Covenant University. They were reconfirmed and deposited at the Herbarium unit of the Forest Research Institute of Nigeria (FRIN), Ibadan, Nigeria. The allocated voucher numbers for each of the plants deposited at FRIN are indicated above for each plant. The samples were air dried at ambient temperature (37.8 ± 4.7 ^{o}C) and turned over regularly to aid in the drying process over a period of 2 weeks. The samples were then blended into powder forms and stored in clean air-tight containers prior to use.

Analysis

AOAC [5] was employed for the determination of samples moisture, fat and ash contents. The difference were expressed in percentage The method described by Theander and Aman [6] was used for the crude fibre determination. The fibre content was thereafter expressed as percentage. The methods described by Osborne and Vogt [7] were used for crude protein and total available carbohydrate determinations. The % Nitrogen obtained was multiplied by factor 6.25 to obtain the % crude protein. Total carbohydrate was calculated by difference using the formular 100 - (weight in grams [protein + fat + water + ash + alcohol + dietary fibre] in 100 g of food).

Sample preparation for AAS analysis

10 g of each sample was weighed into a crucible and pre-ashed using a heater for about 10 minutes. The appearance of a black colour was used to indicate the end of the pre-ashing process. This was heated using murffle furnance (Carbolite model MA450) at 500 °C for about 20 hours. Nitric acid solution (1 % v/v) was thereafter added to the ashed sample. The diluted sample was filtered using a whatmann filter paper. The filtrate was placed in a trace metal bottle for trace mineral analyses using a flame atomic absorption spectrophotometer (Schimadzu Model AA6800).

Statistical calculation

Three determinations were carried out for each analysis. The mean values and standard deviation were calculated using statistical software. The results were expressed as mean ± standard deviation.

RESULTS AND DISCUSSION

OciBas, OciGrat, VerMyg and SoleMon had the highest amount of moisture content, while CitLan, SenFist, and CelTea had the lowest moisture content after drying (Table 1). All the plants were dried successfully to or below the minimum safe moisture level (12.0 %) for dried fruits and vegetables [8]. The relatively high moisture plants were most difficult to dry. This may be due to their high protein content couple with their mineral salts and crude fibre contents that may prevent moisture loss during drying [9].

Ash level is a reflection of the minerals content in a sample [10]. SoleMon, VerMyg, SenFist and Tecom were generally low in ash. However, Amar, Taligul, FicEx, and CitLan exhibited high level of ash. This makes them very good sources of minerals, which are important for maintenance of normal health [11].

Table 1. Nutritional components of some selected plant leaves

S/N	Common name	Scientific name	Moisture	Ash	Crude Protein	Crude fibre	Fat	Carbohydrate
1.	Green amaranth	*Amaranthus viridis*	9.21 ± 0.82	18.60 ± 0.02	47.57 ± 0.40	11.02 ± 1.00	1.75 ±0.94	12.11 ±0.60
2.	Curry leaf	*Ocimum basilicum*	12.07 ± 0.95	13.24 ± 0.06	52.85 ± 0.13	12.10 ±1.00	3.02 ±0.50	6.30 ±0.12
3.	Scent leaf	*Ocimum gratssimum*	11.99 ± 1.00	12.14 ± 0.08	47.17 ± 0.20	12.08 ± 1.01	3.90 ±0.50	12.50 ±0.60
4.	Water leaf	*Talinum triangulare*	8.75 ± 1.00	25.79 ± 0.19	37.28 ± 0.17	13.04 ± 1.00	3.14 ±1.00	12.70 ±0.70
5.	Spinach	*Celosia argentea*	6.71 ± 0.27	10.28 ± 1.11	56.69 ± 0.58	10.89 ±1.00	0.62 ±0.01	14.72 ±1.00
6.	Bitter leaf	*Vernonia amygdalina*	11.05 ± 0.04	9.48 ± 1.73	50.83 ± 0.15	10.26 ± 1.10	1.82 ±0.80	16.03 ±1.00
7.	Sand paper leaf	*Ficus exasperate*	8.27 ± 1.15	20.94 ± 0.08	33.84 ± 2.66	14.04 ±1.00	3.14 ±1.00	17.82 ±1.00
8.	Lemon grass	*Cymbopogon citratus*	10.07 ± 0.03	7.44 ± 1.53	20.45 ± 1.07	27.63 ± 0.23	3.51 ±0.50	31.56 ±0.40
9.	Golden shower	*Senna fistula*	5.87 ± 0.55	9.49 ± 1.00	29.21 ± 2.03	26.19 ± 0.27	5.12 ±0.06	23.91 ±0.06
10.	Nubian senna	*Tecoma stans (L)*	8.65 ± 0.98	4.90 ± 0.40	26.24 ± 1.08	10.84 ±1.00	2.57 ±0.45	46.27 ±0.06
11.	Melon leaf	*Citrullus lanatus*	5.74 ± 0.41	17.85 ± 0.13	58.22 ±0.00	10.80 ±1.00	1.33 ±0.31	5.75 ±0.23
12.	Catrip	*Selonostenum monostachyus*	10.96 ± 0.18	9.54 ± 1.08	40.50 ± 0.80	12.90 ±1.00	4.64 ±0.03	21.39 ±0.06
13.	Dutchman's pipe	*Ipomea Involucrata*	8.93 ± 0.14	14.19 ± 0.03	42.10 ± 0.47	13.41 ±1.00	1.89 ±0.70	18.69 ±0.34

[ƒ]*Each value is expressed as the mean ±SD (n = 3).*

All the plants showed high amount of crude protein (Table 1) with CelTea having the highest value (56.69 ± 0.58 %). On the contrary, CymRatus and Tecom had lowest crude protein values. VerMyg, CelTea, CitLan and Amar may be the best protein source among the plants considered. The generally high crude proteins may be due to withdrawal of moisture during drying, as moisture was earlier reported to be the highest in fresh VerMyg [12]. Proteins are required for the maintenance of tissues, as well as being part of the enzyme and hormonal system [13].

Tecom, CelTea, and VerMyg had the lowest crude fiber (Table 1). CymRatus and SenFist however contain the highest crude fiber. This explains why the plants are sometimes used as a mild purgative [14]. Our crude fibre value (10.26 ± 1.10 %) obtained for VerMyg fall within its earlier reported range 6.5 to 29.2 % [15]. Crude fiber is the amount of cellulose and lignin in plants [11]. It helps in the prevention of colon cancer by nourishing the beneficial bifidobacteria in the colon, which enables the bacteria to prevent the growth of harmful bacteria [16].

All the plants had their lipid content (0.62-5.12 %) as the lowest of all the bulk nutrients considered. However, highest fat level was noticed in SoleMon and SenFist (Table 1). This makes them a good fat soluble vitamins source. Plant lipids are made up of unsaturated fatty acids, which are safer to consume because they do not contain cholesterol and reduce the risk of coronary heart disease [11].

Tecom, along with CymRatus were observed to contain the highest carbohydrate contents of about 46.27 ± 0.06 % and 31.56 ± 0.40 % respectively (Table 1). This implies that the plants may have potentials for providing energy. Carbohydrates are the major and preferable sources of fuels for cellular activities [14]. However, OciBas and CitLan contain very low carbohydrates (Table 1).

The amounts of the seven minerals (calcium, magnesium, zinc, iron, copper, lead and cadmium) in

Table 2. Mineral composition of some selected plant leaves

S/N	Common name	Scientific name	Ca	Mg	Fe	Zn	Cu	Pb	Cd
			mg/Kg dry weight						
1.	Green amaranth	*Amaranthus viridis*	2,673.20 ±0.01	195.35 ±0.10	120.59 ± 0.55	19.17 ± 0.03	13.40 ± 0.04	19.05 ± 0.00	20.08 ± 0.07
2.	Curry leaf	*Ocimum basilicum*	3,581.57 ± 0.29	208.03 ±0.08	110.78 ± 0.00	34.43 ± 0.03	36.62 ± 0.25	17.85 ± 0.05	19.98 ± 0.02
3.	Scent leaf	*Ocimum gratssimum*	3,797.59 ±2.12	197.17 ± 0.23	96.24 ± 0.23	64.03 ± 0.02	ND	16.99 ± 0.01	18.73 ± 0.20
4.	Water leaf	*Talinum triangulare*	1,563.87 ± 0.02	202.40 ± 0.00	99.01 ±0.00	23.48 ± 0.25	ND	18.36 ± 0.03	18.70 ± 0.06
5.	Spinach	*Cerosia argentea*	2,746.60 ±0.00	212.03 ±0.06	126.10 ± 0.07	40.13 ± 0.14	17.81 ± 0.01	17.77 ± 0.00	19.91 ± 0.06
6.	Bitter leaf	*Vernonia amygdalina*	2,074.43 ± 0.93	201.78 ± 0.00	76.09 ±0.00	34.97 ± 0.04	ND	19.32 ± 0.00	18.97 ± 0.03
7.	Sand paper leaf	*Ficus exasperate*	3,875.15 ± 0.00	199.58 ±0.39	21.98 ±0.04	8.62 ± 0.01	ND	21.56 ± 0.00	20.57 ± 0.49
8.	Lemon grass	*Cymbopogon citratus*	3,803.57 ± 0.42	208.07 ± 0.06	259.80 ± 0.20	39.08 ± 0.03	7.98 ±0.03	16.12 ± 0.10	20.34 ± 0.20
9.	Golden shower	*Senna fistula*	3,934.23 ±0.58	207.73 ±1.21	155.31 ± 0.09	126.44 ± 0.04	76.79 ± 0.01	20.63 ± 0.72	21.44 ± 0.10
10.	Nubian senna	*Tecoma stans (L)*	1,459.91 ±0.08	190.83 ±0.15	81.47 ±0.02	26.33 ± 0.00	ND	14.60 ± 0.24	20.11 ± 0.09
11.	Melon leaf	*Citrullus lanatus*	3,685.73 ± 0.23	214.92 ±0.00	305.61 ± 0.54	39.06 ± 0.05	8.37 ±0.03	21.33 ± 0.19	21.01 ± 0.01
12.	Catrip	*Selonostenum monostachyus*	3,679.65 ±0.33	187.84 ±0.95	95.50 ±0.46	21.62 ± 0.07	1.97 ±0.03	18.39 ± 0.00	19.90 ± 0.06
13.	Dutchman's pipe	*Ipomea Involucrata*	37.89 ± 0.13	193.50 ±0.79	83.33 ±0.02	20.68 ± 0.21	6.59 ±0.13	16.80 ± 0.06	20.21 ± 0.18

[1]*Each value is expressed as the mean ±SD (n = 3).*

all the plants considered are as indicated in Table 2. There were generally high calcium levels in many of the plants (Table 2). The high calcium noticed in some of the plant leaves shows that such plants are very nutritious. Calcium has been said to have positive influence in growth and development of bones and teeth in children and to a lesser extent, adults. SenFist contained the highest level of calcium (3,934.23 ± 0.58 mg/kg), which is well above the 800 to 1200 mg/day per day recommended calcium standard for an adults [17, 18]. Small amount of the plants should be taken so as to ingest the optimal level of calcium intake of about 1000 mg/day [17, 18].

CitLan (214.92 mg/Kg) had the highest magnesium level, while SoleMon (187.29 mg/Kg) had the lowest (Table 2). Magnesium is important in treating diarrhea and other gastrointestinal effects when taken in about 470 mg/day. It also has the ability to treat duodenal cancers when 1200 mg/day is ingested, secondary coronary heart diseases, and congested heart failure, when about 384 mg/day is taken [19]. The magnesium RDAs ranges between 26 -260 mg/day for the various human categories [17, 18]. All the plants contain optimal levels of magnesium for consumption when compared to the RDAs for magnesium.

It is obvious that the non heme iron concentrations in these plants (Table 2) are at optimal levels. However, the plant with the lowest iron content, FicEx, may be limiting in its ability to perform iron functions adequately. The dietary iron intake is linked to energy intake [20]. The daily intake of iron in many developing countries (15-30 mg) is usually higher than 8 to 18 mg of the developed countries [17, 18]. Iron in food from plants has more varied properties than iron in food from animals, where heme proteins are the most abundant form. The chemical form of non-heme iron in foods significantly affects dietary iron bioavailability, independent of other dietary components that can further alter bioavailability [21]. Iron is an essential micronutrient. As an integral part of hemoglobin, it is required for the transport of oxygen and carbon dioxide in blood. Iron is also a component of cytochromes that are critical for energy production, and enzymes involved in the immune system.

SenFist and OciGrat showed high levels of zinc that is a trace mineral. These two plants may be considered to be toxic if eaten in large amount due to their high zinc concentrations, since it is needed in the body in very minute amounts. The estimated average daily dietary zinc intakes range from 5.6 to 13 mg/day in infants and children (2 months -19 years), and from 8.8 to 14.4 mg/day in adults aged 20–50 years [17, 18]. Flesh foods (i.e., meat, poultry, fish and other seafood) are rich sources of readily available zinc, while fruits and plant leaves contain relatively low zinc concentrations [22]. The effects of zinc deficiency are well documented and may be severe [22]. Most of these effects are treatable with adequate amounts of zinc [22].

Copper was only found in the following few plants (Table 2) listed in their descending order of concentrations. SenFist> OciBas> CelTea> Amar> CitLan> CymRatus> Ipocrata> SoleMon. The other plants do not contain copper. Excessive consumption of the high copper containing SenFist and OciBas should be discouraged. The remaining plants showed moderate copper levels. Plants with low copper levels lack the ability to perform proper copper functions such as helping in gene expression, electron transfer, erythropoesis and many others [23]. The body cannot synthesize copper so the human diet must supply adequate amounts [24]. The estimated daily intake of copper from food is 1.0–1.3 mg/day or 0.014–0.019 mg/kg/day for adults [24].

Dietary exposure to heavy metals, namely Cadmium (Cd), Lead (Pb), Zinc (Zn), Copper (Cu) has been identified as a risk to human health through the consumption of vegetables [25]. The heavy metals have toxic and mutagenic effects even at very low concentration [26]. The maximum allowable limit for Cu, lead, and cadmium are 40, 0.3, and 0.2 mg/Kg respectively [27]. Lead concentration in plants depends on the environment the plant is cultivated [28]. Areas of high lead concentration such as highways, industrial areas may lead to high levels of lead in plants. Dietary supplement of iron, calcium, and vitamin C has been recommended in preventing lead poisoning [28].

The lead levels (Table 2) in all the underutilised plants except that of SolMon (19.90mg/kg) were found within the range of 20.11 – 21.01 mg/kg, which is slightly higher that those of the currently established plants (18.73 – 20.08). These plants therefore may be poisonous should they be consumed in large quantity [27]. The other plants that are currently been used for nutritional purposes should be adequately processed before ingestion so as to prevent poisoning. The underutilised plants showed similar high cadmium levels (19.90 – 20.57 mg/kg) along with the established plants (Table 2). Excessive consumption of such plants should therefore be discouraged to prevent the food poisoning effect of long term accumulation of cadmium in the body. The plants should also be subjected to adequate processing like microwaving and baking that could reduce/ or eliminate such heavy metal [29]. Dietary supplementation with garlic, ginger and cabbage at the rate of 10% may also be useful to reverse heavy metal toxicity like cadmium [30]. The heavy metals concentration of all fruits and vegetables earlier reported exceeded the allowable limit [25, 26]. The heavy metal encroachment into our plants can be attributed to our increasingly industrialisation, their presence in soil, and in water used for irrigation, or washing fruits and vegetables [31].

All the underutilized leaves (SoleMon, CitLan, SenFist, FicEx, Ipocrata and Tecom) as well as those eaten for their nutritional purpose (CelTea, OciGrat, VerMyg, Taligul, Amar and OciBas*)* considered in this study contained an appreciable amount of all the bulk nutrients. These leaves can contribute to the nutrient requirements and health management of man and livestocks. However, adequate processing methods, coupled with their consumption in little quantity are required to prevent toxicity that may be attributed to heavy metals like lead and cadmium. The high heavy metals in the plants may be attributed to the highly industrialized status of Lagos state, and Ota, Ogun state environ of Nigeria where the plants were sourced.

In conclusion, the consumption of these underutilized plant leaves could provide several essential health benefits and are recommended for pharmacological use. Adequate policy should be implemented in our industrialized towns to control heavy metal encroachment into our plants if they should be used in diets. Such policy may include restricting farming of such plants to the rural areas.

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