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Nutritional Components of Some Non-Conventional Leafy Vegetables Consumed in Cameroon

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Abstract: The human population in tropical Africa depends largely upon a large number of edible leaves to meet up with shortages in minerals and vitamins. Data base on the nutritional value of these diverse plant foods is incomplete. Herein we report the nutritional components in four species of non conventional vegetables. *Vernonia calvoana* var. bitter, *V. amygdalina*, *V. colorata* and *V. calvoana* var. non bitter have high levels of proteins [between 18.16 and 24.12 g/100g Dry Weight (DW)]. Their amino acid composition compare favourably with that of WHO protein standard with the exception of the s-amino acids being the limiting amino acids. They also contain high levels of carotenoids (between 30 and 41.5 mg/100g DW), vitamin C between 137.5 and 197.5 mg/100g DW and dietary fibre (24.9-30.1 g/100g DW). Comparatively, the average nutritive value of the *V calvoana* non bitter is superior to those the other species analyzed. High levels of some anti-nutritional factors like oxalic acids, polyphenols and saponins, were also found in all the species analyzed thereby rendering some of the important nutrients in the leaves less bio-available.

Key words: Vegetables, nutrients, saponins, oxalic acid, polyphenols

Introduction

Most tropical countries are blessed with a diversity of foodstuffs which play a basic role in nutrition and healthy body development. Unfortunately an estimated 789 million people in developing countries still suffer from malnutrition especially infants and children of rural areas (WHF, 2005). Malnutrition can be tremendously reduced with an increase use of foods rich in energy, proteins, iron and vitamin A most especially those from the rural environment. The lack of nutritional information and inadequate development of nutritionally improved products from local raw materials have direct bearing on nutrition. Much effort has been concentrated on seeds while leafy vegetables have to a large extent been ignored. Leaves are reportedly inexpensive and easy to cook. They are known as potential sources of minerals and vitamins (Ifon and Basir, 1979; Oshodi, 1992; Ejoh *et al.*, 1996). They are rich especially in carotenoids as well as in iron, calcium, ascorbic acid, riboflavin and folic acid and appreciable amounts of other minerals (Devadas and Saroja, 1980). They occupy an important place in the diets of Cameroonians.

Cameroon like other tropical countries has abundance of leafy vegetables that grow all year round. Most species that are found in the rural areas grow wild. Domestication of some species has recently been successful especially in semi urban and urban areas. *V. colorata, V. calvoana* var. non bitter, *V. amygdalina* and *V. calvoana* var. bitter are known to be amongst the leafy vegetables consumed in Cameroon. They are grown mostly in the forest and savannah regions of the country. They are drought resistant plants, with some species grown by gardeners through irrigation in the heart of the dry season. They are used as ingredient in soups and therefore serve as complements to most cereal and tuber staples. Their nutritional contribution has not been widely exploited. Nutritional information on these species of vegetables will be useful for the nutritional education of the public as a means to improve the nutritional status of the population. In this study, we determined the nutritional components of these non conventional vegetables consumed in Cameroon.

Materials and Methods

Preparation of samples: The young shoots and fresh leaves of some non conventional vegetables species (two bitter-*V. amygdalina* and *V. calvoana* var. bitter and two non bitter-V. *colorata* and *V. calvoana* var. non bitter), harvested from an experimental farm in Ngaoundéré, were rinsed in water to remove dust. They were then sorted and sliced. While some of the samples were used fresh for analysis of moisture, the rest of the samples were dried at 45°C to constant weight, using a prototype electric dryer (CKA200AUF), ground to fine powder in a stainless still mill (colattic polymix model bioblock m35109) passing through 1.0mm mesh and stored in air tight containers for laboratory analysis.

Chemical and statistical analysis: The recommended methods of the Association of Official Analytical Chemists (AOAC, 1997) were adopted for the determination of the proximate composition, dietary fibre,

Table 1: Proximate composition and digestible protein of the different leafy vegetable species (/100g dry weight)

	V. amygdalina	*V. calvoana* var. bitter	*V. colorata*	*V. calvoana* var. non bitter
Moisture (%)	79.92±0.42[a]	86.82±0.65[c]	78.85±0.01[a]	89.01±0.49[b]
Dry matter (%)	20.08±0.08[a]	13.18±0.13[b]	21.15±0.11[c]	10.99±0.15[d]
Crude protein (g)	19.23±0.20[a]	21.34±0.32[b]	18.16±2.30[a]	24.12±0.98[c]
Digestible protein (g)	16.58±0.31[a]	19.44±0.54[b]	15.72±0.22[a]	22.63±0.61[c]
Total Carbohydrate (g)	68.35±1.33[a]	64.14±0.78[b]	62.81±1.25[c]	61.35±2.11[c]
Ash (g)	7.72±0.11[a]	10.52±0.30[a]	11.84±0.27[a]	11.96±0.15[a]
Reducing sugar (g)	14.31±0.40[a]	15.79±0.14[a]	14.81±1.53[a]	13.08±1.44[a]
Dietary fibre (g)	25.47±0.29[a]	27.58±0.47[b]	24.88±0.25[a]	30.12±0.46[a]
Total lipids(g)	4.70±0.40[a]	4.00±0.40[a]	7.19±0.17[a]	2.57±0.45[a]
Energy(Kcal)	392.67	377.92	388.59	365.01

Means not sharing a common superscript letter in a line are significantly different at $p<0.05$

total carotenoids and calorific value while minerals were determined by method described by Kawashima and Soares (2003). The total reducing sugar analyzed by colorimetric method (Dubois *et al*., 1956), the vitamin C levels were determined using N-Bromo-succinimide (Evered, 1960) recommended for the pigmented solutions. The amino acid analysis was carried out according to the method described by Cooper *et al.* (2000). Bio-available iron was estimated by the method described by Miller *et al.* (1981) and *In vivo* digestibility of protein was done as described by Savoie *et al.* (1982). Average Nutritive (AN) values of the leaves were calculated using the empirical formula proposed by Grubben (1978). The quantification of saponin levels was done by Afrosimetric method (Koziol, 1990). Polyphenols were determined by colorimetric method (Marigo, 1973) while total and soluble oxalic acids analyzed by AOAC (1997) method.

All the analyses were done using triplicate samples. Experimental results were subjected to analysis of variance (ANOVA) (Statsgraphics, 2000).

Results and Discussion

Proximate composition: The proximate composition of the different species of vegetables is shown in Table 1. *V. calvoana* var non bitter had the highest moisture content of 89.01% followed by *V. calvoana* var bitter with a value of 86.82%. The high level of moisture in all the samples investigated suggests that the leafy vegetables would not store for long without spoilage since a higher water activity could enhance microbial action bringing about food spoilage. It has been reported that fruits and vegetables contain as high as 85% water (Jenson, 1978) consistent with the range of moisture level obtained in this study.

The protein values for the unprocessed samples varied with species with *V. calvoana* non bitter and *V. colorata* falling within the extremes of higher (24.12 g/100g dry weight) and lower (18.16 g/100gDW) protein values. Values for these samples are close to values obtained by Igile *et al.* (1995), for *V. amygdalina* and Fevrier and Viroben (1996) for other leafy vegetables. The percentage digestibility are highest for the *V. calvoana* bitter and *V. calvoana* non bitter with 91 and 93.8% respectively while *V. colorata* had 86.6% and *V. amygdalina* 86.2%. Plant foods, when rightly combined with other foods can be of high biological value and satisfactorily meet the protein needs of adults (Fevier and Viroben, 1996). This justifies the non use of these leafy vegetables in diets as a sole protein source for the alleviation of kwashiorkor. The crude protein in the leafy vegetables would require dietary supplementation with proteins from cereals and legumes.

Total carbohydrate levels in these leafy vegetables were relatively high. The non bitter species had lower carbohydrate values than the bitter species. These carbohydrate sources are not generally used because most of them remain undigested. No significant difference in carbohydrate were observed between the different species ($p>0.05$). Igile *et al.* (1995), found slightly higher values in *V. amygdalina*. The difference may be due to the physiological state of the plant before harvesting (Singhal and Kulkarni, 1987).

The vegetables have high levels of dietary fibre which varied significantly in the different species. Craplet and Craplet-Meunier (1979) and Tanya *et al.* (1997) affirmed that leafy vegetables are particularly rich in dietary fibre. Eun-Hee *et al.* (1993) found the average levels of dietary fibre in leafy vegetables of Asian countries to be 33% dry weight. The present study reports values that are slightly lower. High levels of dietary fibre in leafy vegetables are advantageous for their active role in the regulation of intestinal transit, increasing dietary bulk and increasing faeces consistency due to their ability to absorb water (Jenkin *et al*., 1986).

Total lipid levels for the raw samples varied with species with the highest value of 7.19 g/100g dry weight observed in *V. colorata*. Igile *et al.* (1995), found similar values for *V. amygdalina*. Singhal and Kulkarni (1987) reported higher values for *Amaranthus* spp. Generally these low values of total lipids in these samples corroborate the findings of many authors which showed that leafy vegetables are poor sources of lipids. (Ejoh *et al*., 1996). Due to the generally low level of crude fat in the vegetable leaves, their consumption in large amounts is a good dietary habit and may be recommended to individuals suffering from overweight or obesity.

Table 2: Amino acid values of the different leafy vegetable species

Amino acids	*V. amygdalina*	*V. calvoana* var. bitter	*V. colorata*	*V. calvoana* var. non bitter	FAO/WHO reference pattern
Alanine	8.4	9.5	9.1	8.7	
Arginine	7.3	8.4	8.8	8.6	
Aspartic acid	11.4	9.9	10.3	7.6	
Methionine	1.6	1.5	1.5	1.4	
Cystine	1.3	1.4	1.1	1.3	
Total Sulfur amino acids	2.9	2.9	2.6	2.7	3.5
Glutamic acid	14.3	15.7	16.4	16.9	
Glycine	7.1	5.9	6.7	5.8	
Histidine	8.9	9.6	9.1	10	
Isoleucine	4.5	5.9	6.9	6.4	4.0
Leucine	7.0	9.4	10.5	9.9	7.0
Lysine	7.2	8.8	9	7.5	5.5
Tyrosine	2.1	2.4	1.9	3.3	
Phenylalanine	5.9	7.7	6.3	7.1	
Total aromatic amino acid	9.6	9.1	8.2	10.4	6
Serine	4.9	5.5	4.6	5.1	
Threonine	4.6	5.5	4.9	4.2	4
Tryptophan	1.1	1.0	1.4	1.4	1
Proline	6.6	6.9	5.8	7.2	
Valine	7.6	8.8	8.1	7.9	5
Total EAA	44.5	51.4	51.6	50.4	36
EAA score on 8)	7	7	7	7	-

Amino acid content is expressed as mg amino acid per 100 g N

The high values of ash observed in all the species of vegetables is a good indicator that these food samples are good sources of minerals when compared to values obtained for cereals and tubers (FAO, 1968). These values were also found to be higher than values obtained for *Amaranthus* species (Singhal and Kulkarni, 1987).

The energy values of these species are all between 360 and 400 kcals per 100g of dry sample with the highest levels found in the bitter species. This levels are low due to low crude fat and relatively high levels of moisture. The daily energy requirement of 2500 to 3000 kcal has been reported for adults (WHO/FAO, 1985). For an adult to obtain from any of these leafy vegetables an energy value of 2750 kcal per day which is within the range reported by Bingham (1978), the individual would need to consume 700 g of *V. amygdalina* and 753g *V. calvoana* non bitter in dry state. Because only up to 40% of each of these amounts is eaten by an individual per day, these leafy vegetables can therefore be classified as low energy foods.

Amino acid values: Data presented in Table 2 show the amino acid composition of vegetable samples. These vegetables proteins are all rich in essential amino acids where the levels are comparable to that of the FAO/WHO reference pattern (Steinke *et al*., 1980). However, total sulfur amino acids were slightly deficient. Therefore, these vegetables proteins would complement well those protein sources that are low in lysine and tryptophan but rich in methionine. These results are close to those reported by Ejoh *et al*. (1996) for other leafy vegetables. However Wallece *et al*. (1998) found that the essential amino acids were lower than the /FAO/ WHO reference protein in some non conventional leafy vegetables. Comparatively most of the amino acid profile was similar for all the different species of leafy vegetables. However *V. amygdalina* had slightly lower essental amino acids than the other species and this is evident as values of isoleucine, leucine and valine were lower than for the other samples. Histidine, tyrosine and proline were highest in *V. calvoana* non bitter while *V. amygdalina* has the highest level of aspartic acid, glysine and methionine. Deosthale *et al*. (1970) showed that excess leucine in foods interfered with the utilization of isoleucine and lysine.

Vitamins, minerals and antinutritional factors: Table 3 shows the levels of total carotenoids, vitamin C, calcium, iron and some antinutritional factors in the different species of vegetables. Vitamin C values for these vegetables were generally high. Singh *et al*. (2001) obtained closely similar values for vitamin C in some Indian leafy vegetables.

Total carotenoid levels ranged from 30 in *V. amygdalina* to 41.5 mg/100g dry weight in *V. colorata* for the raw samples. Vitamin A deficiency remains a major problem in Cameroon, affecting mostly the people in the Northern provinces (Minsante/UNICEF, 2001). Its role in vision and growth regulation has made the public health officials to look for urgent and rapid methods of combating the problem. This leafy vegetable therefore can serve as a potential source of pro vitamin A (carotenoids) to the population.

Table 3: Some vitamins, minerals and anti-nutrients of the different species of leafy vegetables on dry weight basis

	V. amygdalina	*V. calvoana* var.bitter	V. colorata	*V. calvoana* var. non bitter
Vitamin C (mg/100g).	166.5±2.1[a]	178.5±16.2[a]	197.5±3.5[a]	137.5±3.3[b]
Carotenoid (mg/100g).	30.0±1.0[a]	38.5±0.3[b]	41.5±0.9[b]	35.8±0.2[c]
Ca (g)	0.97±0.02[a]	1.44±0.06[b]	1.13±0.07[c]	1.22±0.05[c]
Fe(mg)	7.52±1.57[a]	6.39±0.26[b]	15.22±0.35[c]	12.0 8±0.45[d]
Bioavailable iron (mg)	2.84±0.12[a]	2.76±0.18[a]	2.67±0.09[a]	2.15±0.15[b]
Average nutritive value	1.10±0.08[a]	1.27±0.03[b]	1.11±0.04[a]	1.391±0.03[c]
Oxalic acid (mg/100g))	5.36l±0.14[a]	3.49±0.12[b]	7.56±.0.60[c]	6.12±0.08[d]
Total Soluble	3.17±0.04[a]	2.41±0.22[b]	2.64±0.34[b]	4.83±0.13[c]
Polyphenols (mg/100g)	9.75±0.58[a]	6.84±0.34[b]	8.68±1.24[b]	4.37±0.15[c]
Saponin (mg/100g)	1.425±0.49[a]	0.920±0.325[a]	0.825±0.064[a]	1.905±0.191[a]

Means not sharing a common superscript letter in a column are significantly different at $p<0.05$

Calcium values are close to those found by Igile *et al.* (1995), FAO (1968) and Udosen and Ukpanah (1993) for *V. amygdalina*. *Amaranthus spinsosus* contained comparatively high amounts of calcium which could serve as rich sources of this mineral compared to these leafy vegetables (Barminas *et al.*, 1998)

The non-bitter species (*V. colorata* and *V. calvoana* var. non bitter) had higher levels of iron. The high values of iron observed in all four species is a good indicator that these food samples are good sources of this mineral when compared to values obtained for other leafy vegetables (Singhal and Kulkarni, 1987). The differences in total ($p<0.05$) and bioavailable iron ($p<0.05$) were statistically significant for the different species.

When one considers the roles of protein, fiber, Ca, Fe, total carotenoids and ascorbic acid in human nutrition, the average nutritive value of the *V. calvoana* non bitter is superior to those the other species (Table 3). This is followed by *V. calvoana* bitter with *V. amygdalina* having the least nutritive value. These values are lower than values obtained by Kuti and Kuti (1999) for different species of spinach.

There exist a significantly higher oxalic acid levels in the non bitter species than the bitter species. For all the species the levels are generally high and stand the risk of complexing with minerals such as calcium (Pingle and Ramasastri (1978). Oke (1967) in Nigeria obtained similar observations. Similar values in amaranth (Vityakon and Standal, 1989) and spinach leaves (Kikunaga *et al.*, 1995) have been reported earlier. Munro and Bassir, 1969 set the toxic level of oxalic acid at 3g per day.

Polyphenol values ranged from 1.23 to 4.37 mg/100g dry weight for *V. calvoana* var. non bitter to 1.51 to 9.75 mg/100g dry weight for *V. amygdalina*. Higher polyphenol content in fenugreek leaves and lower in amaranth leaves have been reported earlier (Gupta *et al.*, 1989; Yadav and Sehgal, 2003).

Saponin values for these species ranged from 0.83 in *V. calvoana* to 1.91 mg/100g dry weight in *V. calvoana* var. non bitter. The existence of no significant differences between the non bitter and the bitter species is indicative that saponins in foods can be astringent (Ridout *et al.*, 1991) or not bitter (Koziol, 1990). Saponins in plants have been known to protect the plant from fungal and insect attacks (Ridout *et al.*, 1990). Other studies have proven that saponins have the ability to reduce the cholesterol levels in man and animals (Gee *et al.*, 1989).

Conclusion: The different species of vegetables are good sources of proteins, carotenoids, vitamin C and dietary fibre with levels particularly higher in most cases in the non bitter species (*V. colorata* and *V. calvoana* var. non bitter). These species contained substantial quantities of minerals like iron, calcium, phosphorus, potassium, magnesium and zinc. The non-bitter species (*V. colorata* and *V. calvoana* non bitter) were found to be richer in iron, potassium and magnesium. Comparatively, the average nutritive value of the *V. calvoana* non bitter is superior to those the other species analyzed.

These species also contain high levels of some anti-nutritional factors like oxalic acids, polyphenols and saponins, which are required to be removed to improve the nutritional quality of these leafy vegetables.

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