Original Research Article

Proximate Composition of Five Varieties of Spontaneous Leafy Vegetables Regularly Consumed In Côte D’Ivoire Areas

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A B S T R A C T

The aim of the study was to investigate on nutrient composition of Vernonia amygdalina (Abôvi), Talinum triangulare (Anangobrou), Ximenia americana (Kogolémrou), Piper guineense (Fêfèbrou) and Ceibapentandra (Nanmougou), five varieties of spontaneous leafy vegetables regularly consumed in Côte d’Ivoire. The fresh samples were analyzed for selected proximate constituents, nutrients and antinutrients. Results of proximate analysis showed dry matter (88.017 - 93.970 %), ash (6.001 - 22.001 %) and crude fiber (15.082 - 25.061 %). Kogolémrou had the highest protein (28.001 %). Substantial micronutrients amounts were obtained for Fêfèbrou with 0.309 mg/100 g (ß-carotene) and 0.4450 mg/100 g (iron). Abôvi had the high test content of vitamin B9 (11041 mg/100 g) and Anangobrou was richest in potassium (7372 mg/100 g), calcium (1629 mg/100 g) and magnesium (1780 mg/100 g). The sodium / potassium ratio was under 1 for all species. Appreciable level of polyphenols (10.17 - 16.73 mg/100 g) was recorded. In view of this, studied leafy vegetables constitute good sources of nutrients and could contribute to prevent diseases and remedy rural population diets deficiency.

Keywords
Spontaneous leafy vegetables, Proximate composition, Nutrients, Antinutrients, Diets deficiency.

Introduction

Non-timber forest products or vegetable plants are all organs of wild animal or plant species harvested in various ecosystems (Augustino et al., 2011). According to FAO (1988), vegetable plants are all plants whose leaves, fruits and roots are used in the preparation of sauces. For this purpose, spontaneous leafy vegetables play an important role in the diets of all the populations of the world, particularly in Africa. Many of them are resilient, adaptive, and tolerate adverse climatic conditions more than the exotic species (Raghuvanshi, 2001). Spontaneous leafy vegetables represent high quality nutritional sources, for the poor segment of the population especially where malnutrition is wide spread (Nnamani et al., 2009). They are valuable sources of nutrients especially in these areas where they contributes substantially to protein, minerals, vitamins, fibers and other nutrients which are usually in short supply in daily diets (Mohammed and Sharif, 2011). Moreover, a real interest for consumers is emerged since epidemiological studies have linked the dietary habits and the prevalence of certain...
diseases such as cancers, obesity and cardiovascular diseases (Li et al., 2014; Wang et al., 2016).

It is reported that an estimated amount of 6376 useful spontaneous African plants of which 397 are vegetables, about twenty (20) species are widely consumed and cultivated by Ivorian populations (PROTA, 2004; Fondio et al., 2007). The consumption of these leafy vegetables is linked to the region and ethno-botanical studies have stated that most people in Northern Côte d’Ivoire consume indigenous green leafy vegetables (Fondio et al., 2007; Soro et al., 2012).

Furthermore, many writers were mentioned the nutrient potential of certain leafy vegetable (Acho et al., 2014; Oulai et al., 2014 and 2015). However, there is data gap to offset regarded the large majority and wide diversity of spontaneous leafy vegetable available in Côte d’Ivoire. Vernonia amygdalina (Abovi), Talinum triangulare (Anangobrou), Ximenia americana (Kogolémrou), Piper guineense (Fèfèbrou) and Ceiba pentandra (Nanmougou) are regularly consumed in rural and urban areas of Côte d’Ivoire. In spite of the long term use of the vegetables leaves in various traditional dishes preparations, there is scarcity of information on their nutritive value. This study therefore targeted to assess proximate composition of these spontaneous leafy vegetables.

Materials and Methods

The five spontaneous leafy vegetables were collected fresh and at maturity from the local farmers in the Gagnoa district of West-Central Côte d’Ivoire. The fresh leaves were air dried in the laboratory. Thereafter, they were oven-dried, milled into powder and stored in polyethylene bags at room temperature prior to analysis. Proximate composition of the spontaneous leafy vegetables was determined using Official Method of Analysis (AOAC, 1990) procedures for the determination of dry matter, ash, crude fibre, crude lipid, crude protein and minerals. The determination of carotenoids (Pro-vitamin A) and water-soluble vitamin (folic acid) were carried out by high-performance liquid chromatography (HPLC) analysis respectively according to Miglio et al., (2008) and Hasan et al., (2013). The phenolic compounds were extracted following the procedure described by N’Dri et al., (2013), and determined by the Folin-Ciocalteu assay (Singelton et al., 1999). The oxalate and phytate content were determined respectively using method described by Day and Underwood (1986) and Mohammed et al., (1986).

Duncan’s Multiple Range Test was used to assess multiple comparisons at a probability (p) of 0.05. One way analysis of variance (ANOVA) with replicates were used to analyse the significant difference among the results of samples.

Results and Discussion

Physicochemical properties

The proximate composition of the vegetables examined in this study is presented in Table 1. The physicochemical parameters generally differed significantly (p < 0.05) from a leafy vegetable to another. All samples contained between 88.017 ± 0.018 % and 93.970 ± 0.058 % dry matter. This moisture content provides for lower activity of water soluble enzymes and co-enzymes needed for metabolic activities of these leafy vegetables. The ash content ranged from 6.001 ± 0.004 % (Kogolémrou) to 22.001 ± 0.003 % (Anangobrou). In view of their ash content, selected leafy vegetables could be considered as good minerals sources comparatively 2-10
% to cereals and tubers (FAO, 1986). There was a variation in the fibers content ranging from $15.082 \pm 0.464\%$ (Kogolémrou) to $25.061 \pm 0.005\%$ (Fèfèbrou). Results are in line with Acho et al., (2014) fluctuating $11.49\%$ (Corchius olitorus) and $24.00\%$ (Colocassia esculenta). Fiber intake has a number of health benefits, including maintenance of healthy laxation and the reduced risk of cardiovascular disease and cancer (Murphy et al., 2012; Madhu et al., 2017). Protein content varied from $17,002 \pm 0,006\%$ (Nanmougou) to $28,001 \pm 0,003\%$ (kogolémrou). Similar results were noticed with Oulaï et al., (2014).

**Nutritive and antinutritional properties**

Table 2 shows nutritive and antinutritional properties of the selected leafy vegetables. Significant difference ($p < 0.05$) between most of these parameters was observed. Vitamin B9 content ranged from $731.333 \pm 1.528\, \text{mg}/100\, \text{g}$ for Anangobrou to $11041\pm 1\, \text{mg}/100\, \text{g}$ for Abôvi. The vitamin B9 contents were considerably above the $400\, \mu\text{g}$ daily intake recommended for folate. Many authors have noted significant amount of folate in fresh green leafy vegetables (Chew et al., 2012, Maharaj et al., 2015). Therefore, these leaves in general and those of Abôvi in particular are good sources of folic acid and may be suggested for pregnant women in macrocytic anemia prevention, fetal malformations and for seniors in maintaining cardiovascular and cognitive health (FAO / WHO, 2004; Delchier et al., 2016). The β-carotene content depended on the leafy vegetables species. Fèfèbrou had the highest value ($0.309 \pm 0.002\, \text{mg} / 100\, \text{g}$). In Nigeria, Adegunwa et al., (2011) reported β carotene levels in fresh leaves ranging from $0.240$ to $0.264\, \text{mg} / 100\, \text{g}$. According Sluijs et al., (2015), diets high in β-carotene were shown to be associated with a reduced occurrence of type 2 diabetes. Adequate intake of these leafy vegetables could therefore be advantageous.

Table 2 showed total polyphenol at appreciable rates. Kogolémrou had the highest value with $9347 \pm 21\, \text{mg}/100\, \text{g}$. The substantial presence of polyphenol suggests a potential antioxidant activity. Wong et al., (2006) showed that plants with an appreciable amount of polyphenols also exhibited strong antioxidant activity and contributed to their medicinal properties. Consumption of high levels of leaves could lead to reduce oxidative stress liable to cancer, cardiovascular and neurodegenerative diseases (Mullen et al., 2007; Shen et al., 2010).

**Table 1** Physicochemical properties (%) of leafy vegetables (Dry basis)

| Vernacular name | Dry matter | Ash | Crudefiber | Protein | Lipid |
|-----------------|------------|-----|------------|---------|-------|
| Fèfèbrou       | $88.017\pm0.018^e$ | $12.333\pm0.003^b$ | $25.061\pm0.005^a$ | $18.001\pm0.004^d$ | $18.680\pm0.016^d$ |
| Nanmougou      | $90.023\pm0.044^d$ | $8.005\pm0.005^d$ | $24.017\pm0.007^b$ | $17.002\pm0.006^e$ | $19.000\pm0.010^c$ |
| Kogolémrou     | $92.002\pm0.007^b$ | $6.001\pm0.004^e$ | $15.082\pm0.464^e$ | $28.001\pm0.003^a$ | $22.000\pm0.003^b$ |
| Abôvi          | $93.970\pm0.058^a$ | $11.007\pm0.040^c$ | $23.080\pm0.002^c$ | $25.983\pm0.021^b$ | $34.010\pm0.036^a$ |
| Anangobrou     | $91.334\pm0.010^c$ | $22.001\pm0.003^a$ | $18.893\pm0.004^d$ | $22.673\pm0.003^c$ | $13.000\pm0.004^e$ |

The average values assigned to the same letter in the same column are not significantly different from the 5%
Table 2: Nutritive and antinutritional properties of leafy vegetables (mg / 100 g)

| Vernacular name | Vitamin B9  | β-carotene   | Total polyphenols | Oxalates  | Phytates  |
|-----------------|-------------|--------------|-------------------|-----------|-----------|
| Fèfèbrou        | 740.000±1.000 d | 0.309±0.002 a | 4532±43 d         | 291±3 c   | 1103±3 c  |
| Nanmougou       | 7250.333±1.528 b | 0.290±0.002 c | 5790±30 c         | 800±3 a   | 800±2 e   |
| Kogolémrou      | 6291.000±1.000 c | 0.305±0.002 b | 9347±21 a         | 870±3 a   | 882±3 d   |
| Abôvi           | 11041.000±1.000 a | 0.156±0.002 e | 4314±3 e          | 880±3 a   | 1280±3 b  |
| Anangobrou      | 731.333±1.528 e | 0.285±0.001 d | 9203±3 b          | 312±2 b   | 1310±3 a  |

The average values assigned to the same letter in the same column are not significantly different from the 5% level.

Table 3: Mineral composition of leafy vegetables (mg / 100 g)

| Vernacular name | K     | Ca    | Mg    | Na    | Fe    | Mn    | Cu    | Zn    |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|
| Fèfèbrou        | 3197±2 c | 1588±2 b | 647±2 b | 1.058±0.0002 b | 0.4450±0.0002 a | 0.1599±0.0002 a | 0.0308±0.0002 a | 0.0113±0.0002 c |
| Nanmougou       | 2288±2 d | 183±3 e  | 589±2 e  | 0.2871±0.0002 e | 0.3081±0.0002 d | 0.0432±0.0019 c | 0.0230±0.0002 a | 0.0089±0.0002 d |
| Kogolémrou      | 1527±2 e | 663±3 d  | 457±3 d  | 1.2347±0.0003 d | 0.2460±0.0003 d | 0.0342±0.0002 b | 0.0312±0.0002 a | 0.0032±0.0002 e |
| Abôvi           | 3324±2 b | 1023±3 c | 330±3 e  | 0.4680±0.0003 c | 0.4050±0.0003 e | 0.0391±0.0004 c | 0.0174±0.0004 d | 0.0182±0.0002 b |
| Anangobrou      | 7372±2 a | 1629±3 a | 1780±3 a | 0.5272±0.0002 b | 0.4370±0.0003 b | 0.0752±0.0002 a | 0.0282±0.0003 b | 0.0288±0.0002 a |

The average values assigned to the same letter in the same column are not significantly different from the 5% level.

Table 4: Different ratio of leafy vegetables

| Vernacular name | [Na] / [K] | [oxalate] / [Ca] | [Phytate] / [Ca] |
|-----------------|------------|-----------------|-----------------|
| Fèfèbrou        | 0.0003     | 0.1832          | 0.6945          |
| Nanmougou       | 0.0001     | 4.3715          | 4.3715          |
| Kogolémrou      | 0.0008     | 1.3122          | 1.3303          |
| Abôvi           | 0.0001     | 0.8602          | 1.2512          |
| Anangobrou      | 0.0000     | 0.1915          | 0.8041          |

Antinutrient contents are shown in Table 2. Amounts varied from 291 ± 3 to 880 ± 3 mg /100 g for oxalates and 800 ± 2 to 1310 ± 3 mg/100 g for phytates. Antinutrient levels are higher than others authors but could reduce drastically by cooking, blanching and boiling (Ilelaboye et al., 2013; Singh et al., 2015).

Mineral composition

Mineral grades were noted in Table 3. Amounts of potassium ranged from 1527 ± 2 to 7372 ± 2 mg / 100 g respectively for Kogolémrou and Anangobrou. Sodium and potassium are involved in membrane and cellular exchange, thus contributing to the regulation of plasma volume, acid-base balance and muscle contraction (Akpanyung, 2005). The calcium levels were between 183 ± 3 mg / 100 g (Nanmougou) and 1629 ± 3 mg / 100 g (Anangobrou). Calcium plays a major role in ossification and dentition and has a preventive effect on arterial hypertension in the elderly (Turanet al., 2003). All the analyzed plants were excellent sources of magnesium, ranging from 330 ± 3 mg /100 g (Abôvi) to 1780 ± 3mg /100 g (Anangobrou). Magnesium is a cofactor in over 300 enzymatic reactions that regulate various biochemical reactions in the body including protein synthesis, muscle function, blood glucose, blood pressure and heart rate regulation (Rude et al., 2009). The analize showed that Fèfèbrou was the richest in fresh...
iron with $0.4450 \pm 0.0002$ mg / 100 g while Kogolémrou had the highest sodium content. Manganese, copper and zinc were quantified respectively between $0.0342 \pm 0.0002$ and $0.1599 \pm 0.0002$, $0.0174\pm0.0004$ and $0.0312\pm0.0002$, $0.0032\pm0.0002$ and $0.0288\pm0.0002$. Copper is the major constituent of cuproenzymes, which are involved in energy production, iron metabolism and the metabolism of neurotransmitter synthesis (Mejía-Rodríguez et al., 2013). Iron plays an important role in the prevention of anemia while Zinc is important in neurological function (Yamada et al., 2014). Considering the recommended dietary allowance (RDA) for minerals, calcium (1000 mg/day); magnesium (400 mg/day), iron (8 mg/day) and zinc (6 mg/day) these leafy vegetables could cover RDA and contribute substantially for improving human diet (IOM, 2005).

All the samples analyzed had their sodium/potassium ratio less than 1 (Table 4). They could be used in diets of hypertensive individuals. Excepted Nanmougou, the oxalate/calcium and the phytates/Calcium ratios were lower than 2 (Table 4). The calculated Oxalates/Calcium and Phytates/Calcium ratios in all the species, excepted Nanmougou, were below the critical threshold of 2.5 known to affect calcium bioavailability (Hassan et al., 2007).

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