Seasonal variation in nutritional compositions of spider plant (*Cleome gynandra* L.) in south Côte d’Ivoire

A survey on leafy vegetables consumption was carried out in the district of Abidjan. Samples of spider plant, were collected from the fields during the dry and the rainy seasons. Nutrient analysis of spider plant leaf were performed on dry matter, pH, proteins, sugars, fibers, vitamin C, β-carotene, minerals and oxalic acid content. The survey revealed that spider plant was less known and consumed. Oxalic acid level is high in rainy season (10.17 mg/100g DW). Soluble fibers content is around 13.33 % in dry season and 16% in rainy season while, insoluble fibers rate is 25.1% in dry season and 23.07% in rainy season. The most β-carotene level was determined in rainy season (110.26 µg/100g FW). Iron content was about 23.93 mg/100g DW in dry season and 10.17 mg/100g DW in rainy season. Calcium content was high in rainy season (45.25 g/100g DW) whereas potassium content is more elevated in dry season (109.38 g/100g DW). Except vitamin C, the other nutrients differ statistically within the seasons. Spider plant could be harvested and consumed in the both seasons and there is a need to raise awareness on its nutritional benefit to promote its production and consumption.

**Key words:** Spider plant, dry season, rainy season, survey, nutritional composition.

INTRODUCTION

Leafy vegetables play an important role in the diet of Ivoirian population. These vegetables are affordable with accepted taste and good nutrients content. In Côte d’Ivoire, around 24 species of leafy vegetables from 15 families are often grown and available in urban and peri-urban centers (Fondio et al., 2007). The major ones are amaranths (*Amaranthus blitum, A. cruentus*), jute mallows (*Corchorus olitorius, C. tridens, C. trilocularis*), roselle (*Hibiscus asper, H. sabdariffa*), sweet potato leaves (*Ipomea batata*), black nightshade (*Solanum nigrum*), Lagos spinach (*Ceolasia argentea*), Malabar spinach (*Basella alba*), waterleaf (*Talinum fructicosum*), okra leaves (*Abelmoschus esculentus, Abelmoschus callet*) and spider plant (*Cleome gynandra*). Spider plant is an annual herb belonging to the family Cleomaceae and which grows up to a height of 60 cm. It’s an important source of micronutrients including minerals (iron, calcium, phosphorus and magnesium), vitamins (A, B and C), proteins and dietary fibers. According to Agbo et al. (2009) spider plant contains about 2.54 g/100g DW of calcium, 51.32 mg/100g DW of iron, 45.04 mg/100g DW of phosphorus and 0.74 g/100g DW of magnesium. It also contains oxalic acid (10.17 mg/100g DW). However, oxalic acid and calcium ratio is low (0.004), reducing the interference risk of this anti-nutritional factor with calcium absorption by forming insoluble salts of calcium (Gupta et al., 2004). It has a high antioxidant activity (61%) due to the...
presence of flavonoids and phenolic compounds (1327.33±1.66 mg/g) (Muchuweti et al., 2007). This antioxidant activity can help to overcome free radical and oxidant stress (Yeager, 2004).

As the others leafy vegetables, which take a pivotal role in the success of the World Health Organization’s (WHO) global initiative on fruits and vegetables consumption in the sub-continent (Smith and Eyzaguirre, 2007), spider plant can play an important part in alleviating hunger and malnutrition (Van Rensburg et al., 2004). Indeed, according to the Foods and Agriculture Organization (FAO) of the United Nations around 868 million people (12.5% of the world’s population) are undernourished in terms of energy intake and 2 billion people suffer from one or more micronutrients deficiencies (FAO, 2013). So, malnutrition and other diseases due to micronutrients deficiencies should be overcome while consuming leafy vegetables and particularly spider plant because of their nutritional composition.

However, although spider plant has high nutritional values, it remains underutilized due to a lack of awareness and promotion of production technologies and utilization (Sheela et al., 2004). In fact, spider plant is unknown by a large population of Côte d’Ivoire and it is usually consumed by non Ivorians.

The purpose of the study was to evaluate the nutritional value of spider plant grown in the two major climatic seasons of Côte d’Ivoire (the high dry season and the high rainy season) with a few to determining the best season for growing the vegetable.

**MATERIAL AND METHODS**

**Survey**

The study consisted of firstly a survey on leafy vegetables produced in urban and peri-urban areas and secondly in the chemical analysis of the edible parts of *Cleome gynandra* grown in two seasons. The survey was conducted from March to August 2006. Information required in a questionnaire was on leafy vegetables consumption frequency, choice criteria (price, energetic value, therapeutic value) and mode of conservation. The survey revealed that some leafy vegetables are cultivated only for leaves and others for both leaves and vegetables or fruits alone (okra, eggplant) and others for roots and leaves or roots alone (potatoes, cassava). The study considered only leafy vegetables which are cultivated for their leaves. These include: jute mallow (*Corchorus olitorus*), roselle (*Hibiscus sabdariffa*), spinach (*Basella alba*), amaranth (*Amaranthus hibridus*), Lagos spinach (*Celosia argentea*), black nightshade (*Solanum nigrum*) and spider plant (*Cleome gynandra*). However, this article has focused on spider plant a leafy vegetable that is not popular in Côte d’Ivoire but needs to be promoted.

**Field Sampling**

Spider plant samples were collected from different vegetable gardens in urban and peri-urban areas (site of airport, site of Mpouto village and site of Gbagba village) of Abidjan in 2007 during the dry season (December to March) and the raining season (May to July). On each site, samples were collected twice by cutting the stems (with the leaves). Samples were regrouped according to site and 500g were collected per site. Samples were placed in an isothermal cool box with ice packs and carried to the laboratory.

**Laboratory Analysis**

The samples were washed under running water and residual moisture was evaporated at room temperature. Ascorbic acid and β-carotene analysis were carried out from fresh leaf samples. For analysis of other nutritional components leaf samples were dried in an oven (Selecta Memmet, Germany) at 45 °C ± 2 during 24 hours. Each analysis was made in triplicate.

Nutritional analysis was performed in the laboratory to determine dry matter content, pH, ashes, proteins (N x 6.25) and oxalic acid using AOAC standard methods (AOAC, 2005). Soluble sugars were extracted with ethanol 80% (v/v) and analyzed by phenol-sulphuric acid method for total sugars (Dubois et al., 1956) and with dinitro-3.5-salicylic acid for reduced sugars (Bernfeld, 1955). Ascorbic acid was analyzed by volumetric method (Tomohiro, 1990) and β-carotene by HPLC with a Octadecylsilyl (ODS) Hypersyl C18 column. Mobile phase was acetonitrile – methanol – ethyl acetate (80 : 10 : 10, v / v / v) at pH = 8 and the detection was made at 450 nm in UV (Tee et al., 1996). Phosphorus content was measured by molybdovanadate method at 410 nm using a Spectrophotometer Shimadzu (Kyoto, Japan) (AOAC, 2005). Calcium and potassium were determined using Shimadzu AA-680 atomic absorption spectrophotometer (Japan) at their specified wavelengths (422.7 nm for calcium and 766.5 nm for potassium). Iron concentration was estimated using an UV visible spectrophotometer (Jasco V–530, Japan) at 510 nm. Soluble and insoluble fibers were also determined (Van Soest, 1963).

**Statistical analysis**

Data were analysed with SPSS 10.0 for Windows where data were subjected to descriptive statistics for calculation of frequencies. To compare means, one-way analysis of variance (ANOVA) was performed and means were separated using a Duncan multiple range test (p=0.05).
Table 1. Leafy vegetables consumption level according to urban and peri-urban housewives

<table>
<thead>
<tr>
<th>Leafy vegetables</th>
<th>Leafy vegetables consumption (%)</th>
<th>Ranking</th>
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</thead>
<tbody>
<tr>
<td>Patato leaf (Ipomea batatas)</td>
<td>70</td>
<td>1&lt;sup&gt;st&lt;/sup&gt;</td>
</tr>
<tr>
<td>Jute mallow (Corchorus olitorus)</td>
<td>45.5</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spinach (Basella alba)</td>
<td>43.9</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt;</td>
</tr>
<tr>
<td>Roselle (Hibiscus sabdariffa)</td>
<td>40.9</td>
<td>4&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Amaranth (Amaranthus hibiridus)</td>
<td>27.3</td>
<td>5&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Lagos spinach (Celosia argentea)</td>
<td>18.2</td>
<td>6&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Black nightshade (Solanum nigrum)</td>
<td>12.1</td>
<td>7&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Waterleaf (Talinum fructicosum)</td>
<td>10.6</td>
<td>8&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
<tr>
<td>Spider plant (Cleome gynandra)</td>
<td>3.03</td>
<td>9&lt;sup&gt;th&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Figure 1: Housewives choice criterion on leafy vegetables consumption

RESULTS

Survey data

The survey in Table 1 indicated that spider plant is not a popular vegetable in Côte d’Ivoire with only 3.03% and 7.1% housewives in urban and peri-urban cities respectively. For urban housewives, the first choice criterion of leafy vegetables is the taste whereas in the peri-urban area, women’s choice of leafy vegetables was based on energetic value (Figure 1).

Nutritional value of spider plant

All nutrients analyzed showed a significant seasonal effect except Vitamin C. Dry matter level is higher in dry season than in rainy season (Table 2). The pH is acid in both seasons with significant difference (5.26 in rainy season and 5.53 in dry season). Oxalic acid level is more elevated in rainy season (10.17 mg/100g DW) than in dry season (8.73 mg/100g DW). In addition, proteins levels are slightly influenced by the season and the highest value is in dry season (39.07 %). Total sugar is about 2.3 mg/100g DW and 5.09mg/100g DW in dry and in rainy season respectively while reduced sugar is around 0.62mg/100g DW in dry season and 1.02mg/100g DW in rainy season (Figure 2). Soluble and insoluble fibers values differ significantly between the seasons. Soluble fibers are lower in dry season (13.33%) than in rainy season (16%) while insoluble fibers are higher in dry season (25.1%) than in
Table 2. Dry matter, pH, ashes, oxalic acid and protein content in spider plant according to the seasons

<table>
<thead>
<tr>
<th></th>
<th>Dry matter (%)</th>
<th>pH</th>
<th>Ashes (%)</th>
<th>Oxalic acid (mg/100g DW)</th>
<th>Protein g/100g DW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry season</td>
<td>13.22 ± 0.18 b</td>
<td>5.53 ± 0.07 b</td>
<td>16.35 ± 0.66 a</td>
<td>8.73 ± 0.27 a</td>
<td>39.07 ± 2.2 b</td>
</tr>
<tr>
<td>Rainy season</td>
<td>11.95 ± 0.29 a</td>
<td>5.26 ± 0.05 a</td>
<td>17.7 ± 0.03 b</td>
<td>10.17 ± 0.09 b</td>
<td>37.17 ± 1.43 a</td>
</tr>
</tbody>
</table>

In column, means values with different letter differ statistically (p≤0.05) (Duncan test)

Figure 2: Total and reduced sugars content in spider plant collected in dry and rainy seasons
* There is a significant different between the season
* Bar indicate standard deviation

Figure 3: Soluble and insoluble fibers content in spider plant collected in dry and rainy seasons
* There is a significant difference between the seasons

Rainy season (23.07%) (Figure 3).
Vitamin C content in dry season (24.33 mg/100g FW) is lower than in rainy season (33.33 mg/100g FW) (Figure 4).
However, β-carotene values differ significantly within the season. Indeed, β-carotene is about 17.99 µg/100g FW in dry season and 110.26 µg/100g FW in rainy season (Figure 4).
5). Phosphorus and iron contents were more elevated in dry season than in rainy season and there is also a significant difference between the two seasons. So, iron content was about 23.93 mg/100g DW in dry season and 10.17 mg/100g DW in rainy season (Figure 6). Magnesium and calcium contents are more elevated in rainy season (15.08 g/100g DW) and 45.25 g/100g DW, than in dry season 7.28 g/100g DW and 22.65 g/100g DW respectively while potassium content is higher in dry season 109.38 g/100g DW than in rainy season 58.96 g/100g DW (Figure 7).

**DISCUSSION**

The fact that taste and energy value rank high in housewives choice suggest that leafy vegetables could help to alleviate nutritional insecurity of the populations (Rubaihayo, 2002). The augmentation of dry matter in dry season goes with the increase in insoluble fibers, protein, phosphorus, iron and potassium. Oxalic acid seasonal difference may be due to the fact that oxalic acid levels depend on agronomic and environmental factors (Causeret, 1985). Oxalic acid in dry season is similar to Mishra et al. (2011) who showed a content of 8.8 mg/100g DW. However, in comparison to other leafy vegetables this oxalic acid concentration in spider plant is low. Indeed, Sheela et al. (2004) revealed a content of 30.28 mg/100g DW in amaranth, 50.62 mg/100g DW in black nightshade, 60.84 mg/100g DW in spinach and 88.21 mg/100g DW in roselle. The fact that protein level is high in dry season could be simply due to the augmentation of dry matter in
dry season (Agbo et al., 2008). However, protein content is higher than that of Mishra et al. (2011) who indicated a value varying between 3.1-7.7 %. According to the same authors the plant’s nutritional value may vary with soil fertility, environment, plant type, plant age and the production techniques used. Soluble and insoluble fibers values in rainy season are similar to that of Soro et al. (2012) who indicated a content of 16 % for soluble fibers and 23.2% for insoluble fibers. This high level in spider plant is important considering that dietary fibers are essential for disease prevention and can also improve carbohydrate and lipid metabolism (Islam et al., 2004).
In this study, vitamin C content in the both seasons are higher than that of K’Opondo et al. (2005) who revealed a content of 13mg/100g FW but lower than that of Mibe et al. (2011) who obtained a content of 104.3mg/100g FW. This could be due to genetic factors, plant maturity level and degree of exposure to sun because vitamin C is destroyed at high temperature (Herzog et al., 1993). The fact that β-carotene value is high in rainy season could contribute to maintain the conformation of the pigment-protein complexes and to scavenge the harmful free radicals (Sen and Mukherji, 1999). However, β-carotene content is lower than that of K’Opondo et al. (2005) and Soro et al. (2012) who indicated a content of 10452 µg/100g FW and 3100 µg/100g FW respectively.

Phosphorus and iron contents were more elevated in dry season than in rainy season and this difference could be due to planting conditions such as climate, soil fertilisation, genetic and environmental factors (Boukari et al., 2001). For phosphorus, a content of 33.35 mg/100g DW in dry season is important because phosphorus is implicated in calcium assimilation. However, this value is lower than the result of K’Opondo et al. (2005) who obtained a phosphorus content of 111 mg/100g DW in spider plant. Therefore, a phosphorus content of 4.19 mg/100g DW in rainy season could lead to a phosphorous deficiency in the leaves and also a decrease of photosynthetic activity (Rao et al., 1993). Moreover, iron content is more elevated than (6 mg/100g DW) value revealed by Grubben et al. (2004). The iron content obtained in our study is good because only 1 to 5% of iron content of vegetables is absorbed in human (AFSSA, 2008). In fact, iron is implicated in the structure and function of red blood cells and deficiency leads to anemia, a common health problem in many developing tropical countries. Thus, African indigenous vegetables could be used in alleviating this problem (Abukutsa-Onyango et al., 2010).

In this study, magnesium values are more elevated than that obtained by Agbo et al. (2009) of 0.742 g/100g DW in spider plant collected in Abidjan market. Calcium content obtained in this study in dry and rainy seasons is also higher than that of Agbo et al. (2009) (2.542 g/100g DW) and K’Opondo et al. (2005) (0.29 mg/100g DW). Potassium content in this study is largely higher than the rate indicated by Mibe et al. (2011) which is about 104.9 mg/100g DW. This could be attributed to soil conditions and fertilizers used (Herzog et al., 1993; Boukari et al., 2001). The high values obtained in this study for magnesium and potassium are encouraging since magnesium content of the leaves is a component of chlorophyll and it is an important mineral element in connection to ischemic heart disease and also in calcium metabolism and in bones formation (Mibe et al., 2011). Potassium is an essential mineral for controlling the salt balance in human tissues. Therefore, spider plant could contribute in metabolic diseases prevention. However, we must take into account minerals bioavailability (Ifon, 1980).

CONCLUSION

Although spider plant is not popularly consumed as a leafy vegetable in Côte d’Ivoire, it contains several nutrients such as proteins, sugars, vitamins, β-carotene and minerals. However, the nutritional composition varies with seasons. Proteins, insoluble fibers, phosphorus, iron and potassium are high in dry season whereas oxalic acid, total and reduced sugars, soluble fibers, vitamin C, β-carotene, magnesium and calcium are higher in rainy season. Considering its high contents in proteins, minerals and β-carotene, spider plant can be recommended to overcome protein-energetic malnutrition, anemia and mineral deficiencies. However, to avoid loss of nutrients in preparation and cooking, spider plant should be harvested and prepared in fresh form and for a short cooking time.

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