Comparative Studies on the Effect of Open Air and Oven Drying on the Antinutrient Content of Some Leafy Vegetables of Eastern Nigeria

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Abstract

Five leafy vegetables; Pterocarpus mildbreadii (Oha); Talinum triangulare (water leaf), Telfaria occidentalis (fluted pumpkin), Cucurbita maxima (Bread pumpkin), and Vitex doniana (uchakiri) were selected for the study of the effect of open air (sun), and oven drying on the antinutrient content. Each sample was shared into four equal parts representing, freshwet, sun drying, oven drying at 70°C, and 100°C respectively. The portions for sun, and oven drying were dried to constant weight before grinding into fine powder form. This was sieved and stored in a polythene bag at room temperature, and used for all the analysis. The result shows that tannins levels ranged from 1.89 ± 0.03 mg/100g in T. triangulare to 3.17 ± 0.01 mg/100g in P. mildbreadrii. Phytic acid from 19.96 ± 0.01 mg/100g in V. doniana to 22.27 ± 0.01 mg/100g in C. maxima. Oxalates from 2.34 ± 0.08 mg/100g in T. triangulare to 3.50 ± 0.01 mg/100g in P. mildbreadrii; Alkaloids from 0.48 ± 0.06 mg/100g in V. doniana to 4.15 ± 0.02 mg/100g in C. maxima, and Saponins from 4.85 ± 0.02 mg/100g in V. doniana to 9.76 ± 0.1 mg/100g in C. maxima. The levels of flavonoids and cyanogenic glycosides were relatively low in all the samples compared to other antinutrient factors determined. Sun drying increased the levels of tannins, phytic acid, oxalates, and saponins, while the levels of alkaloids, flavonoids and cyanogenic glycosides decreased as compared with the result of wet samples. Similar result was obtained when oven dried at 70°C and 100°C. However, the level of cyanogenic glycosides increased when oven dried at 100°C as compared to both sun, and oven drying at 70°C.

Keywords: Antinutrient, Drying, Vegetables

Introduction

Vegetables can be defined as plant parts usually herbaceous that contain edible portion which is suitably served with the main course of a meal (Tindall, 1975). Although, the line between vegetables and fruits is sometime vague, the stipulation that plant part be herbaceous in case of vegetables has helped to clarify the definition. The nutritional contribution of vegetables cannot be over emphasized particularly in the Eastern part of Nigeria. Most vegetables are low in calories and protein; however, they still contribute to the energy and protein content of the diet especially when accompanied or supplemented with animal protein (Eka, 1977). Vegetables in general are excellent source of micronutrients (vitamins and minerals): Calcium, iron, magnesium, sodium, potassium, and copper are among the minerals found in appreciable amount in leafy vegetables (Fox, and Cameron, 1984; Ikechoronye and Ngoddy, 1985; Oguntola, 1998). Vitamins C, E and A are also found in high quantity in many vegetables.

It has been pointed out that it is not enough that a particular food is rich in nutrient, such nutrient must be biologically available (Nwachukwu, 2002). Most of the antinutrient factors form complexes with minerals, vitamins and even proteins, and thus make them unavailable for their biochemical roles. In severe cases, manifest symptoms of the nutrient deficiency may result. Oxalate is known to form complex with calcium (Fox and Cameron, 1984) while phytic acid also chelates a number of divalent elements like magnesium, iron, calcium, etc. Saponins, on the other hand complex with protein, hindering digestion or enzyme activity. (Onwuuka, 1992). Antinutrient content of some seeds, roots, shoots, and vegetables of some plant species have been studied (Nwokolo and Bragg, 1977; Charkrabarty and Eka, 1978; Ikechoronye and Ngoddy, 1985; Okolie and Ugocnuwku, 1989; Onwuuka, 1992; Oguntola, 1998). Studies on the effect of drying are few and in most cases limited to a single plant species or to a particular antinutrient content.

In this study therefore we investigated the comparative effect of open air and oven drying on the antinutrient content of some leafy vegetables commonly found in Eastern Nigeria.

Materials and Methods

Materials: Four of the vegetables: Pterocarpus mildbreadrii, (Oha), Talinum triangulare (water leaf), Telfaria occidentalis (fluted pumpkin) and Cucurbita maxima (bread pumpkin) were purchased from Nsukka central market Enugu State. Vitex doniana (Uchakiri) was collected from Asu and farmland in Orumba south L.G.A. of Anambra state. All the samples were scientifically identified by Taxonomist from Department of Botany University of Nigeria, Nsukka.

Processing of the samples: The samples were sorted to select the good ones. Each sample was then shared into four equal parts representing,
Effect of open air and oven drying on the antinutrient content of some leafy vegetables

fresh/wet, open air/sun, drying, and oven drying at 70°C and 100°C respectively. The portions for drying were dried to constant weight before grinding with Author Thomas milling machine. The powdered form was sieved using 1 mm sieve. It was then stored at room temperature, and used for all the analysis. The portion for wet analysis was ground with a mortar into a paste and used immediately for the analysis.

Determination of antinutrients: Tannins were determined by the method of Desphandes et al. (1986). Phytic acid was determined by the method of Marfor et al. (1990), oxalate according to the method of Oke (1992). The method of Cheeke (1989) was used to determine, alkaloids, saponins, and cyanogenic glycoside, while the method of Ozo and Caygill (1996) was used to determine flavonoids.

Results

Table 1 shows the antinutrient content of the wet sample analysis. Flavonoids and Cyanogen glycosides levels were the least of all the antinutrient factors determined in the samples. Tannins level ranged from 1.89 ± 0.3 mg/100g in T. triangulare to 3.17 ± 0.02 mg/100g in P. mildbraedii. Phytic acid from 19.96 ± 0.01 mg/100g in V. doniana to 22.27 ± 0.01 mg/100g in C. maxima; oxalates from 2.34 ± 0.01 mg/100g in V. doniana to 3.5 ± 0.01 mg/100g in T. occidentalis and 2. mildbraedii respectively, alkaloids from 2.48±0.06 mg/100g in V. doniana to 4.15 ± 0.02 mg/100g in C. maxima, and saponins from 4.85 ± 0.02 mg/100g in V. doniana to 9.76 ± 0.11 mg/100g in C. maxima. It appears that V. doniana, and C. maxima were the samples with the least and highest level of all the antinutrient factors determined.

In Table 2, the result shows that open air (sun) drying generally increased the levels of all the antinutrient except for the values of Flavonoids and Cyanogen glycosides which rather decreased. In Table 3, the levels of tannins, phytic acid, oxalates, Cyanogen glycoside and saponins were increased by oven drying at 70°C. However, the levels of alkaloids, flavonoids decreased except again in V. doniana where the values increased as compared with the result of wet analysis. Saponins levels increased except for the level in T. triangulare which decreased as compared with the result of wet analysis. In Table 4, similar result was obtained when the samples were dried in the oven at 100°C. However, the levels of Cyanogen glycosides increased as compared with the result of wet analysis. Tannins are found relatively high in may plant species. Similar result had been reported by Okoh et al. (1982) on the tannin index of ten (10) varieties of sweet potatoes. Tannins are known to reduce protein digestibility by forming strong interaction with dietary protein leading to complexes that are not easily digested. Protein energy malnutrition and loss of weight may result. Damage to gastrointestinal tracts can also occur (Ihekorkonye and Ngoddy, 1985). Tannins can also interact with dietary iron and prevent the absorption. The increase in the levels when dried could have been due to conversion of hydrolysable tannins to condensed ones. Again tannins are not easily destroyed by heat due to the high molecular weight (Ozae et al., 1996). Phytic acid level in the wet samples (Table 1) ranged from 19.96 ± 0.01 mg/100g in V. doniana to 22.27 ± 0.07 mg/100g in C. maxima. Drying in the sun, and in the oven at 70°C and 100°C (Tables 2, 3, and 4) increased the level as compared with the result of wet analysis. Phytic acid content of food and food stuffs commonly consumed in Nigeria had been reported by Eka (1977). He concluded that the quantity of phytate and oxalates in traditional food in Nigeria were below toxic level, though their role in preventing the proper utilization of calcium and phosphorus could be considerable. Phytic acid has twelve (12) replaceable hydrogen atoms, and therefore could form insoluble salt with many metals like calcium, iron, zinc, magnesium (Guthrie and Picciano, 1995). The formation of these insoluble salts renders the minerals unavailable for absorption into the system. Nwokolo and Bragg (1977), showed that in chicken, there is significant inverse relationship between phytic acid and the availability of calcium, magnesium, zinc and phosphorus in food stuffs like soybean, palm kernel seeds, rapeseed and cotton seed meals. Oke (1965) reported that phytate is not easily destroyed by processing temperatures. The increase in the level after drying could be due to the concentrating effect of the phytic acid after the loss of moisture. Also phytic acid occurs as the storage form of phosphorus in plants in association with proteins. The Protein component may have been denatured by heat leading to further concentration of pure phytic acid.

Beneficial effects of phytic acid have been suggested. In vitro studies indicate that there are interactions between phytic acid and heavy metals such as lead and cadmium (Nolar et al., 1987). It has been reported that lowest lead accumulation was achieved when calcium and phytic acid were given simultaneously (Wise, 1981), and that phytate was responsible for a considerable decrease in the intestinal absorption of cadmium (Jack et al., 1985). Phytic acid has also been known as to have antioxidant functions. The dietary protective effect of phytic acid was observed in azoxy methane dimethyl hydrazine induced carcinogenesis (Nelson et al, 1989). The mechanism of the protective effect is explained by the inhibition of the iron- induced radical generation (Nelson et al, 1989).

Oxalate level in wet analysis (Table 1) ranged from 2.34 ± 0.01 mg/100g in V. doniana to 3.50 ± 0.01 mg/100g in T. occidentalis and P. mildbraedii respectively.
Table 1: Antinutrient content of wet samples (mg/100g)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Tannins</th>
<th>Phytic acid</th>
<th>Oxalate</th>
<th>Antinutrient Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. mildbreadii</td>
<td>3.17 ± 0.02</td>
<td>22.25 ± 0.02</td>
<td>3.50 ± 0.01</td>
<td>2.91 ± 0.01 1.01 ± 0.01 1.88 ± 0.02 7.66 ± 0.16</td>
</tr>
<tr>
<td>T. triangulare</td>
<td>1.09 ± 0.03</td>
<td>21.45 ± 0.06</td>
<td>2.34 ± 0.06</td>
<td>2.33 ± 0.16 1.05 ± 0.02 1.73 ± 0.12 6.00 ± 0.02</td>
</tr>
<tr>
<td>T. occidentalis</td>
<td>2.28 ± 0.01</td>
<td>21.37 ± 0.01</td>
<td>3.50 ± 0.01</td>
<td>2.60 ± 0.06 1.00 ± 0.12 1.45 ± 0.32 6.67 ± 0.12</td>
</tr>
<tr>
<td>C. maxima</td>
<td>2.64 ± 0.02</td>
<td>22.27 ± 0.01</td>
<td>2.34 ± 0.20</td>
<td>4.15 ± 0.02 1.30 ± 0.03 2.93 ± 0.01 9.76 ± 0.11</td>
</tr>
<tr>
<td>V. doniana</td>
<td>2.01 ± 0.10</td>
<td>19.06 ± 0.01</td>
<td>2.34 ± 0.01</td>
<td>0.45 ± 0.06 0.32 ± 0.02 0.28 ± 0.02 4.85 ± 0.05</td>
</tr>
</tbody>
</table>

Table 2: Effect of sun drying on the antinutrient content of the samples (mg/100g)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Tannins</th>
<th>Phytic acid</th>
<th>Oxalate</th>
<th>Antinutrient Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. mildbreadii</td>
<td>4.69 ± 0.30</td>
<td>24.28 ± 0.92</td>
<td>15.18 ± 0.13</td>
<td>1.77 ± 0.02 0.67 ± 0.06 1.65 ± 0.16 5.00 ± 0.17</td>
</tr>
<tr>
<td>T. triangulare</td>
<td>3.55 ± 0.02</td>
<td>24.23 ± 0.05</td>
<td>7.00 ± 0.06</td>
<td>1.88 ± 0.03 0.81 ± 0.02 1.74 ± 0.02 8.34 ± 0.23</td>
</tr>
<tr>
<td>T. occidentalis</td>
<td>3.65 ± 0.13</td>
<td>26.00 ± 0.23</td>
<td>6.54 ± 0.05</td>
<td>0.83 ± 0.02 0.09 ± 0.01 1.63 ± 0.02 8.31 ± 0.11</td>
</tr>
<tr>
<td>C. maxima</td>
<td>3.99 ± 0.02</td>
<td>24.49 ± 0.28</td>
<td>4.65 ± 0.02</td>
<td>1.61 ± 0.16 0.69 ± 0.02 1.74 ± 0.09 11.80 ± 0.19</td>
</tr>
<tr>
<td>V. doniana</td>
<td>7.15 ± 0.06</td>
<td>28.29 ± 0.09</td>
<td>23.35 ± 0.02</td>
<td>3.72 ± 0.19 0.94 ± 0.01 3.85 ± 0.15 12.27 ± 0.21</td>
</tr>
</tbody>
</table>

Table 3: Effect of oven at 70°C on the antinutrient content of the samples (mg/100g)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Tannins</th>
<th>Phytic acid</th>
<th>Oxalate</th>
<th>Antinutrient Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. mildbreadii</td>
<td>3.89 ± 0.12</td>
<td>23.50 ± 0.28</td>
<td>7.90 ± 0.07</td>
<td>1.29 ± 0.02 0.95 ± 0.02 5.74 ± 0.01 9.84 ± 0.16</td>
</tr>
<tr>
<td>T. triangulare</td>
<td>2.00 ± 0.06</td>
<td>23.80 ± 0.19</td>
<td>16.68 ± 0.16</td>
<td>1.21 ± 0.18 0.74 ± 0.01 1.78 ± 0.01 7.56 ± 0.17</td>
</tr>
<tr>
<td>T. occidentalis</td>
<td>4.92 ± 0.20</td>
<td>26.00 ± 0.15</td>
<td>10.51 ± 0.06</td>
<td>2.41 ± 0.10 1.20 ± 0.12 1.78 ± 0.16 11.25 ± 0.15</td>
</tr>
<tr>
<td>C. maxima</td>
<td>4.98 ± 0.01</td>
<td>25.73 ± 0.21</td>
<td>7.01 ± 0.02</td>
<td>2.25 ± 0.02 1.93 ± 0.02 1.63 ± 0.02 12.34 ± 0.04</td>
</tr>
<tr>
<td>V. doniana</td>
<td>3.62 ± 0.05</td>
<td>26.71 ± 0.23</td>
<td>7.24 ± 0.01</td>
<td>1.04 ± 0.09 0.74 ± 0.07 0.67 ± 0.07 7.74 ± 0.01</td>
</tr>
</tbody>
</table>

Table 4: Effect of oven drying at 100°C on the antinutrient content of the samples (mg/100g)

<table>
<thead>
<tr>
<th>Samples</th>
<th>Tannins</th>
<th>Phytic acid</th>
<th>Oxalate</th>
<th>Antinutrient Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>P. mildbreadii</td>
<td>4.62 ± 0.17</td>
<td>26.49 ± 0.19</td>
<td>8.17 ± 0.06</td>
<td>1.03 ± 0.06 0.77 ± 0.01 2.63 ± 0.16 9.33 ± 0.19</td>
</tr>
<tr>
<td>T. triangulare</td>
<td>3.55 ± 0.08</td>
<td>27.50 ± 0.22</td>
<td>17.51 ± 0.12</td>
<td>1.52 ± 0.01 0.76 ± 0.01 1.78 ± 0.12 11.82 ± 0.21</td>
</tr>
<tr>
<td>T. occidentalis</td>
<td>4.93 ± 0.04</td>
<td>26.80 ± 0.15</td>
<td>8.17 ± 0.02</td>
<td>3.03 ± 0.07 0.96 ± 0.07 2.45 ± 0.11 12.34 ± 0.26</td>
</tr>
<tr>
<td>C. maxima</td>
<td>0.88 ± 0.01</td>
<td>27.86 ± 0.20</td>
<td>7.01 ± 0.05</td>
<td>1.69 ± 0.06 0.04 ± 0.02 1.17 ± 0.01 13.63 ± 0.25</td>
</tr>
<tr>
<td>V. doniana</td>
<td>3.64 ± 0.04</td>
<td>30.77 ± 0.25</td>
<td>14.01 ± 0.01</td>
<td>1.58 ± 0.02 1.17 ± 0.02 1.17 ± 0.02 7.72 ± 0.01</td>
</tr>
</tbody>
</table>

The levels were also increased by open air-drying and oven drying at 70°C and 100°C respectively. This could be due to the crystal form of oxalate in plant species which is not easily destroyed by heat.

According to Munro and Bassir (1989), the possibility of oxalate poisoning in Nigeria from the consumption of fruits and vegetables is as remote as it is in other part of the world. The level found in this study is relatively high but may not be a hazard considering the various processing methods the vegetables may undergo before eating. Oxalic acid is an antinutrient interferes with mineral availability particularly calcium. It binds with calcium and forms insoluble calcium oxalate which cannot be absorbed in the body. This may lead to death due to hypocalcemia in the renal tubules. (Murray et al., 2003).

The levels of alkaloids in the wet analysis (Tables 1) were relatively low and ranged from 0.48 ± 0.06 mg/10g in V. doniana to 4.15 ± 0.02 mg/100g in C. maxima. The levels were generally reduced by open air drying and oven drying at 70°C and 100°C respectively as compared to the result of wet samples.

Alkaloids are not strictly regarded as antinutrient, rather are grouped within natural food toxics. Secondly, most alkaloids are known for their pharmacological effect rather than for their toxicity. However, when alkaloids occur in foods they cause gastrointestinal upset and neurological disorders. For instance pyrrolizidine are known to be mutagenic (Okave et al., 1992). Alkaloids generally act as stimulants by prolonging the action of several hormones. The mechanism is believed to be by prolonging or intensifying the action of cAMP and hence the action of the hormones dependent on the cAMP. Flavonoids and Cyanogen glycosides levels were the least in all the samples in the wet samples. Both open air, and oven drying at 70°C and 100°C generally reduced the levels except in V. doniana. According to McWilliam (1979), flavonoids are destroyed by increased drying temperature. Flavonoids are currently regarded as essential nutrients rather than antinutrient. Some flavonoids like rutin, antocyanidins are known to strengthen the blood capillary and other connective tissues (Bourne, 1990) while others like quercitin has been reported to block the sorbitol pathway that is linked with many health complications associated with diabetes (Alais and Guy, 1991).

Others such as naringenin and isoflavones are known as to be anticancerogenc due to the antioxidant properties (Wink, 1993). Cyanogen glycosides on the other hand are precursors of hydrogen cyanide, a well known natural toxicant in foods. However, the low levels in these samples and the fact that drying decreased the levels
suggest that there is no hazard associated with their presence in these vegetables.

Saponin levels generally increased when sun dried except for the levels in P. mildbreadii and T. triangulare which decreased (Table 2). Oven drying at 70°C increased the levels except for the values in T. triangulare which decreased (Table 3). When oven dried at 100°C, the levels increased in all the samples (Table 4). Saponin is another antinutrient factor that supposed toxicological effect should be balanced with the benefits. For instance, saponins have been shown to possess hypocholesterolemic effect as well as cytotoxic permeabilization of the intestine, though the biological activities depend on the structure (Price et al, 1987). Saponins also have hemolytic effect on red blood cells (Ihekoronye and Ngoddy, 1985).

According to Onwuka (1992), though saponin can be highly toxic under experimental conditions, acute saponin poisoning is relatively rare in both man and animals.

This study has shown the presence of the antinutrients determined in all the samples. Tannins, phytic acid, oxalate, alkaloids and saponins levels were relatively high. Another important aspect of this result is the increase in the levels of some of the antinutrients by drying. However, the high levels may not necessarily translate into hazard because of the various processing methods like washing, soaking, drying and cooking which are known to reduce the levels. Again these vegetables are often eaten in little quantity and in combination with staple foods. It will then be difficult for any of these antinutrients to build up in concentration to hazard level.

References


