EFFECT OF PROCESSING METHODS ON NUTRIENT AND ANTINUTRIENT COMPOSITION OF JUSTICIA SECUNDA LEAVES

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Abstract

Justicia secunda as a medicinal plant belongs to the family of Acanthaceae, the leaf is an under-utilized medicinal vegetable that is believed and utilized as blood tonic by the local people. The leaves were subjected to blanching pre-treatment before sun drying at 55°C for 48 hrs and solar drying for 120 hrs. The proximate, vitamins, minerals and phytochemical analysis were conducted on the samples using standard procedures. The results varied significantly (p<0.05) in all the parameters measured according to the different processing treatments. Proximate composition of the samples ranged for crude protein (18.20-21.73%), crude fat (7.80-9.10%), crude fibre (12.00-14.90%), ash (15.50-17.40%), moisture (8.00-9.00%) and carbohydrate (27.98-35.50%). Mineral composition ranged for calcium (18.20-34.10 mg/100g), magnesium (47.11-54.29 mg/100g), sodium (126.43-136.47 mg/100g), potassium (425.49-453.03 mg/100g), phosphorus (135.40-145.76 mg/100g) and iron (33.07-38.94 mg/100g). Vitamin composition showed that thiamine (B1) ranged from 0.04-0.31 mg/100g, riboflavin (B2) (0.21-1.7 mg/100g), niacin (B3) (0.49-1.89 mg/100g), vitamin C (6.31-19.48 mg/100g), while vitamin E ranged from (1.97-6.78 mg/100g). Anti-nutrient contents ranged for tannin (4.82-16.89 mg/100g), phenol (7.41-19.23 mg/100g), alkaloids (2.05-7.07 mg/100g) flavonoids (4.90-9.85 mg/100g) and saponin (3.25-8.35 mg/100g). Overall, the results revealed that air drying methods retained greater concentrations of fibre, minerals, vitamins and anti-nutrients than other processing methods. The high micro-nutrient contents of iron, anti-nutrient compounds and B group of vitamins in this processed vegetable reveals why it is used intuitively by the traditional people to boost health conditions due to the functional roles of iron, phytominerals and B group of vitamins in haemopoiesis in preventing morbidity and mortality especially among children.

Key words: Justicia secunda leaf; Proximate composition; Minerals composition; Vitamins concentration; Phytochemical concentration

Introduction

Justicia secunda, as a medicinal plant belongs to the family of Acanthaceae. It is known as “Blood root” and “Sanguinaria” in Barbados and Venezuela, respectively (Carrington et al., 2012). Justicia secunda, originally from South America is a perennial herb that grows up to 90cm with purplish stem, evergreen leaves and pink flowers. It is abundant in the low land rain forest of the...
Southern Nigeria and other tropical and sub-tropical countries. The plant *Justicia secunda* is locally called ‘Asindiri’ or ‘Ohowaazara’ (meaning medicine that gives blood) by the Ogbia people of Otouke Otuaba community in Bayelsa State of Nigeria. It is also locally known as ‘obiokakolo’ by the Igbo in the Eastern part of Nigeria where it is called ‘Blood leaf’ or ‘Blood tonic. The folkloric uses of the plant include wound healing, anemia, hypertension and abdominal pain (Kone et al., 2012). In Southeastern Nigeria, Congo and Southern Co’té’ d’Ivoire, the leaf decoction is consumed by Jehovah’s Witness believers in the management of anemia primarily because of their aversion for blood infusion. The anti-sickling, haematinic, antimicrobial and anti-hypertensive activities of *Justicia secunda* have been reported (Carrington et al., 2012). Phytochemical screening of this plant has shown the presence of tannins, flavonoids, alkaloids, quinines, anthocyanins, steroids and saponins (Theiler, et al., 2013). It is also a rich source of vitamins and minerals. Notwithstanding the popular uses of *Justicia secunda* in folkloric medicine, only few pharmacological studies have been done on the plant (Corré’a, et al., 2012).

This leaf is an under-utilized medicinal vegetable that is believed and utilized as blood tonic by the local people. Like several medicinal plants, it is a major source of traditional medicine amongst rural dwellers all over Southern Nigeria. Medicinal plants generally have assumed a very central stage in modern civilization as natural source of chemotherapy and up to 3.4 billion people in the developing world depend on plant-based traditional medicines for their basic healthcare (Ghosh, Bishal, Ghosh, Jana, Gayen, Sahu, & Debnath ,2023).

*Justicia secunda* and other medicinal plants are utilized in one or more ways for therapeutic purposes, or as precursors of chemopharmaceutical constituents (WHO, 1996). Mostly, the parts of leaves, roots, rhizomes, stems, barks, flowers, fruits, grains or seeds of plants are used in the control or treatment of disease conditions. They also contain chemical components (bioactive constituents) that are medically active for the treatment degenerative disorders and the boosting of immune competence.

Medicinal plants (*Justicia secunda* inclusive) have not only nutritional values, but also have important contributions in the healthcare system of local communities as the main source of medicine for the majority of the rural population Saha , Debnath , Rahman Md. &Islam 2012). More than 3.5 billion people in the developing world rely on medicinal plants as components of their healthcare as the vast majority of local people consult Traditional Medical Practitioners (TMPs) for their health improvement plans Busari, S. A. (2021). Extracts from plants (phytopharmaceuticals) like reserpine, taxol and ephedrine, digitoxin, atropine and narcotic have been used in modern medicine (N’guessan et al., 2010). Medicinal plants play a key role in the development and advancement of modern studies by serving as a starting point for the development of novelties in drugs (Ibrahim, & Kebede (2020).

Medicinal herbs are usually subjected to drying and longtime storage during production, and drying is considered a beneficial way to protect their phytochemical efficiency. Drying process increases the shelf life by slowing or stopping microbial growth and preventing certain biochemical reactions that might alter their organoleptic characteristics (Rahimmalek and Goli, 2013). Thomas and Gabriel (2013) stated that several of these vegetables are subjected to postharvest treatments of drying, blanching, or cooking to improve organoleptic properties and remove potential toxic components and for preservation purposes. However, some processing techniques alter nutrient content of plants.

Natural drying (drying in the shade or in the sun) and hot air drying are still the most widely used methods because of their lower cost. Natural drying has many disadvantages due to the inability to control large quantities and to achieve consistent quality standards. Conventional air drying is one of the most frequently used operations for food dehydration. Significant color changes occur during air drying and the final product has low sorption capacity. In addition, hot air drying presents some benefits such as low energy efficiency and lengthy drying time during the last stage of drying. Furthermore, in comparison to hot air drying, microwave drying techniques can greatly reduce the drying time of biological materials without quality degradation.
Recently, microwave drying has gained popularity as an alternative drying method for a variety of food products such as fruits, vegetables, snack foods and dairy products (Hamrouni-Sallami et al., 2011 and 2013). Freeze drying is one of the most advanced drying methods, which provides dry products with porous structure combined with small or negligible shrinkage, superior flavor and aroma retention and improved rehydration behavior compared to products of the alternative drying processes. As a result, by choosing a suitable drying method and appropriate conditions, the final product quality can be handled (Hamrouni-Sallami et al., 2013). The outstanding preservative method practiced in many homes in Nigeria is sun-drying, followed by air drying and oven drying methods. Therefore, the aim of this study was to determine the effects of different drying treatment methods on nutrient and phytochemical composition of *Justicia secunda* leaves obtained from Umuahia North LGA of Abia State, Nigeria.

**Design of Study**

Experimental research design was adopted for this research work. *Justicia Secunda* leaves were blanched and subjected to three treatment (Sun drying, Oven drying and Air –drying) while the control sample was un-blanched leaves dried under room temperature. Each of the treatment was then used to find out the proximate, nutrients and phytochemical composition of *Justicia Secunda* leaves.

**Area of Study**

The study was carried out in Umudike, Ikwuano Local Government Area of Abia State.

**Sample Collection**

Freshly harvested samples of *Justicia secunda* leaves were identified by Dr. Garuba Omosun of the Department of Plant Science and Biotechnology, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

**Sample Preparation**

The leaves were washed in potable water and allowed to drain off the water. They were then blanched in lukewarm water with 5% NaCl for 2 min. After draining, it was divided into three portions A, B and C and immediately taken to the laboratory for different drying treatments.

- Sample A was spread on a clean stainless tray and sun-dried for 72 h.
- Sample B was oven-dried at 55 °C for 48 h.
- Sample C was air-dried at room temperature (28 to 30 °C) for 120 h.
- The control sample was unblanched and dried in the air at room temperature for 120 h. The dried leaves were then milled with a laboratory mill to obtain the leaf powder and stored in an air-tight containers for the analysis of proximate, minerals, vitamins and anti-nutrients.

**Determination of the proximate composition of *Justicia secunda* leaves**

The moisture content was determined by the method of Maurizio et al. (2005). The ash content was determined according to the method described by Amitila et al. (2002). The total fibre was determined by the Weende method (AOAC, 2005). Crude protein content of the sample was determined by the use of Micro-kjeldahl method as described by Maurizio et al. (2005). Fat content was determined by continuous solvent extraction gravimetric method using Soxhlet apparatus according to the method of AOAC (2005), while the carbohydrate contents was determined by difference as calculated below: %carbohydrate (dw) = 100- (crude protein + crude fat + ash + moisture + crude fibre) (Maurizio et al., 2005).

**Determination of Vitamins content of *Justicia secunda* leaves**

Thiamin (vitamin B$_1$), riboflavin, niacin and vitamin C contents were determined using the spectrophotometric method of AOAC, (2005). Vitamin E content was determined using kirk and sawyer method (1998).

**Determination of Mineral Composition of *Justicia secunda* leaves**

Calcium, potassium, magnesium, sodium, iron and phosphorus contents of *Justicia secunda* leaves were determined by multiple nutrients wet acid digestion method (AOAC, 2005). The sample
digest was used to determine the calcium and magnesium contents by the ethyldiamine – tetraacetic acid (EDTA) complex metric titration method (AOAC, 2005). The flame photometric method was used to determine sodium and potassium contents of the sample. Phosphorus content was determined by the vanadomolydate yellow spectrophotometric method, while the iron content was determined by the method of Jinadasa et al. (1997) by using 969 Unicam Atomic Absorption Spectrophotometer.

**Determination of the anti-nutrient composition of Justicia secunda leaves**

Standard methods for anti-nutrient screening (phenol, flavonoids, tannins alkaloids and saponins) were employed according to Adewole, et al. (2015), Royal Society of Chemistry (2002) as modified by (Momoh, et al., 2012), and Obadoni and Ochuko (2001).

**Method of Data Analysis**

All the data collected from the different treatments were subjected to One-way Analysis of Variance (ANOVA) as outlined by Steel and Torrie (1991) in a completely randomized design at 5% level of significance. Means of results were separated by the Duncan’s multiple range test and reported as means ±SEM.

**Results**

**Effect of drying methods on the proximate contents of Justicia secunda leaves**

Table 1 shows the effect of processing methods on the proximate composition of Justicia secunda leaves. The results showed significant differences (p<0.05) among the various parameters tested. The unblanched and air-dried (control) sample revealed higher values of protein (21.73%), fat (9.10%), fibre (14.90%), ash (17.40%), moisture (9.0%), respectively. Blanched and oven dried method showed higher protein content (20.13%) than blanched and sundried sample (18.20%) and blanched and airdried sample (19.78%). In terms of drying treatment, oven dried method yielded higher protein value than others. On the other hand, fat (8.40%), ash (16.40%) and carbohydrate (35.50%) contents were higher in sun dried method than other methods, while crude fibre (14.0%) and moisture (8.7%) contents were higher in air dried method. Overall, the drying methods showed high proximate values that may be relied on in preserving Justicia secunda leaves.

| Table 1: Effect of drying methods on the proximate contents of Justicia secunda leaves (%dw) |
|-----------------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| Treatment                                   | Control                        | Oven-dried                      | Sun-dried                       | Air-dried                       |
| Crude Protein                               | 21.73 ± 0.11                  | 20.13 ± 0.00                   | 18.20 ± 0.28                   | 19.78 ± 0.14                   |
| Crude Fat                                   | 9.10 ± 0.14                   | 8.20 ± 0.28                    | 8.40 ± 0.14                    | 7.80 ± 0.00                    |
| Crude Fibre                                 | 14.90 ± 0.00                  | 13.80 ± 0.28                   | 12.00 ± 0.00                   | 14.40 ± 0.28                   |
| Ash                                          | 17.40 ± 0.00                  | 15.50 ± 0.00                   | 16.40 ± 0.28                   | 16.00 ± 0.00                   |
| Moisture                                     | 9.00 ± 0.00                   | 8.00 ± 0.00                    | 8.00 ± 0.14                    | 8.70 ± 0.14                    |
| Carbohydrate                                | 27.98 ± 0.18                  | 34.37 ± 0.57                   | 35.50 ± 1.56                   | 33.31 ± 0.55                   |
| Dry Matter                                   | 91.00 ± 0.00                  | 92.00 ± 0.00                   | 92.00 ± 0.14                   | 91.30 ± 0.14                   |

Values are means ± standard deviations of three determinations. Means with the same superscripts within the same row are not significantly (p>0.5) different.

**Effect of drying methods on the minerals content of Justicia secunda leaves**

Table 2 shows the effect of processing on the minerals composition of Justicia secunda leaves. The results revealed significant variations (p<0.05) in the minerals concentrations. The control sample (unblanched and air-dried at 28-30 °C for 120 h) exhibited the highest concentrations of mineral. The implication was that blanching of the vegetable with 5% NaCl for 2 min caused lixiviation or the solubilization of minerals, resulting in lower retention. For the blanched and dried samples, except for Ca (19.78 mg/100g), air dried samples posited greater retention of minerals: Mg (51.78 mg/100g), Na (132.03 mg/100g), K (440.36 mg/100g), P (143.61 mg/100g), and Fe (36.36 mg/100g) than oven and sun dried methods. Following similar trend, sun drying was better than oven drying method in terms of minerals retention for Mg (48.99 mg/100g), Na (129.03 mg/100g), K (430.94 mg/100g), Fe (34.35 mg/100g). Importantly, the ration of K to Na was more than 3fold despite the different processing methods. The Fe content
showed very high values, an indication that this vegetable is rich source of Fe and K for better minerals nutrition. Oven drying maintained the least retention of some of these minerals irrespective of the drying method.

Table 2: Effect of drying methods on the minerals content of Justicia secunda leaves (mg/100dw)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ca</th>
<th>Mg</th>
<th>Na</th>
<th>K</th>
<th>P</th>
<th>Fe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>34.10±0.21</td>
<td>54.29±0.00</td>
<td>136.47±0.81</td>
<td>453.03±0.16</td>
<td>145.76±0.00</td>
<td>38.94±0.36</td>
</tr>
<tr>
<td>Oven-dried</td>
<td>20.13±0.00</td>
<td>47.11±0.00</td>
<td>126.43±0.00</td>
<td>425.49±0.84</td>
<td>138.69±0.00</td>
<td>33.07±0.87</td>
</tr>
<tr>
<td>Sun-dried</td>
<td>18.20±0.28</td>
<td>48.99±0.33</td>
<td>129.03±0.88</td>
<td>430.94±0.35</td>
<td>135.40±0.00</td>
<td>34.35±0.81</td>
</tr>
<tr>
<td>Air-dried</td>
<td>19.78±0.14</td>
<td>51.78±0.00</td>
<td>132.03±0.52</td>
<td>440.36±0.00</td>
<td>143.61±1.57</td>
<td>36.36±1.04</td>
</tr>
<tr>
<td>Total</td>
<td>23.05</td>
<td>50.54</td>
<td>130.99</td>
<td>437.45</td>
<td>140.87</td>
<td>35.68</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations of three determinations. Means with the same superscripts within the same row are not significantly (p>0.5) different.

Effect of drying methods on the vitamin composition of Justicia secunda leaves

Table 3 shows the effect of drying methods on the vitamin composition of Justicia secunda leaves. The observation was that the control unblanched sample showed higher values of the vitamins. It was revealed that unblanched and dried samples were 1.5 to 2folds more than the blanched and air-dried samples and more than 3 to 8folds in blanched-oven and sun-dried samples. For example, the vitamin contents of the control sample were (mg/100g) B1 (thiamine) (0.31), B2 (riboflavin) (1.78), B3 (niacin) (1.89), vitamins C (ascorbic acid) (19.48) and E (tocopherol) (6.78), respectively. Air drying revealed higher values of vitamins among the blanched and dried samples and were about 1.5 to 4.5 times more when compared to sun and oven-dried methods.

Table 3: Effect on drying methods on the vitamins content of Justicia secunda leaves

<table>
<thead>
<tr>
<th>Treatment</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>C</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.31±0.01</td>
<td>1.78±0.08</td>
<td>1.89±0.00</td>
<td>19.48±0.32</td>
<td>6.78±0.00</td>
</tr>
<tr>
<td>Oven-dried</td>
<td>0.04±0.00</td>
<td>0.21±0.04</td>
<td>0.49±0.00</td>
<td>6.31±0.16</td>
<td>1.97±0.11</td>
</tr>
<tr>
<td>Sun-dried</td>
<td>0.07±0.01</td>
<td>0.37±0.00</td>
<td>0.61±0.05</td>
<td>7.90±0.00</td>
<td>2.57±0.25</td>
</tr>
<tr>
<td>Air-dried</td>
<td>0.18±0.01</td>
<td>0.83±0.09</td>
<td>1.12±0.19</td>
<td>9.53±0.13</td>
<td>3.29±0.16</td>
</tr>
<tr>
<td>Total</td>
<td>0.15</td>
<td>0.80</td>
<td>1.03</td>
<td>10.80</td>
<td>3.65</td>
</tr>
</tbody>
</table>
Effect of drying methods on the anti-nutrient composition of *Justicia secunda* leaves

Table 4 shows the effect of drying methods on the antinutrient composition of *Justicia secunda* leaves. As usual, the control treatment posited highest values of antinutrient contents of the dried *Justicia secunda* leaves, giving about 1.5 to 3.5 folds higher values than the blanched and dried samples. The values in the control sample (mg/100g) were for tannins (16.89), phenols (19.23), alkaloids (7.07), flavonoids (9.85), and saponins (8.35), respectively. Among the blanched and dried samples, air dried sample posited values of about 1.5 to 2 times of antinutrient compounds more than sun and oven drying samples. These air-dried values were for tannin (11.16 mg/100g), phenols (14.26 mg/100g), alkaloids (4.10 mg/100g), flavonoids (7.73 mg/100g), and saponin (5.80 mg/100g). On the other hand, the anti-nutrient values of oven and sun dried *Justicia secunda* leaves were statistically insignificant (p<0.05) and maintained values ranging from 4.82 to 5.51 mg/100g (tannin), 7.41 to 8.76 mg/100g (phenols), 2.05 to 2.56 mg/100g (alkaloids), 4.90 to 5.23 mg/100g (flavonoids), and 3.25 to 3.72 mg/100g (saponin), respectively. The results show that *Justicia secunda* leaf is a rich source of tannins, phenols and flavonoids and will therefore have high antioxidant constituents for free radical scavenging and for boosting of physiological health to consumers.

**Table 4: Effect of drying methods on the antinutrient content of *Justicia secunda* leaves**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tannin</th>
<th>Phenol</th>
<th>Alkaloid</th>
<th>Flavonoids</th>
<th>Saponin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>$16.89^d \pm 0.56$</td>
<td>$19.23^d \pm 0.00$</td>
<td>$7.07^a \pm 0.31$</td>
<td>$9.85^d \pm 0.35$</td>
<td>$8.35^d \pm 0.00$</td>
</tr>
<tr>
<td>Oven-dried</td>
<td>$4.82^a \pm 0.00$</td>
<td>$7.41^a \pm 0.30$</td>
<td>$2.05^a \pm 0.00$</td>
<td>$4.90^a \pm 0.00$</td>
<td>$3.25^a \pm 0.00$</td>
</tr>
<tr>
<td>Sun-dried</td>
<td>$5.51^a \pm 0.33$</td>
<td>$8.76^b \pm 0.00$</td>
<td>$2.56^a \pm 0.23$</td>
<td>$5.23^a \pm 0.11$</td>
<td>$3.72^b \pm 0.17$</td>
</tr>
<tr>
<td>Air-dried</td>
<td>$11.16^b \pm 0.13$</td>
<td>$14.26^c \pm 0.00$</td>
<td>$4.10^b \pm 0.00$</td>
<td>$7.73^b \pm 0.11$</td>
<td>$5.80^c \pm 0.00$</td>
</tr>
<tr>
<td>Total</td>
<td>9.59</td>
<td>12.41</td>
<td>3.95</td>
<td>6.93</td>
<td>5.28</td>
</tr>
</tbody>
</table>

Values are means ± standard deviations of three determinations. Means with the same superscripts within the same row are not significantly (p>0.5) different.

**Discussion**

Effect of processing methods on the proximate composition of *Justicia secunda* leaves

In Table 1, significant variations (p<0.05) in the proximate contents of *Justicia secunda* leaves were observed in the unblanched pre-treatment (control) sample, and blanched sun, blanched oven and blanched air-dried samples. Specifically, the unblanched pre-treated sample showed greater retention of proximate nutrients with exception of carbohydrate when compared to the blanched sun, oven and air-dried samples. It showed that proximate nutrients were lost primarily due to different type of drying (heat treatment) methods and lixiviation or the solubilization of these nutrients into the blanching water (5% NaCl at 2 min). However, for drying treatments, oven drying method yielded higher protein value than others. Fat, ash and carbohydrate contents were higher in sun dried method than other methods, while crude fibre and moisture contents were higher in air dried method. Similar observation was made by Eze and Akubor (2012) on the drying of fresh Okro fruits and Hesham *et al.* (2013) on the drying of some vegetable leaves in Egypt. Adverse effect of loss of nutrients in both blanching and drying as described by Roberts and Cox (1999) were noted and it included undesirable changes, discoloration and browning, and reduced nutritional quality.

Effect of processing methods on the mineral composition of *Justicia secunda* leaves

The mineral concentrations of *Justicia secunda* leaves as affected by processing treatments varied significantly as shown in Table 2. It was revealed that processing (drying) treatment and blanching affected the variant results of minerals. Unblanched and air-dried sample retained greater concentrations of the minerals (Ca, Mg, Na, K, P and Fe), followed by the minerals content of blanched air-dried sample. It revealed that oven and sun-dried minerals content showed lower values, an indication that temperature other than leaching into blanching water aided minerals losses especially in oven-dried *Justicia secunda* leaf. Other researchers that worked on drying of vegetables obtained similar reduction in minerals concentration (Oladele and Aborisade, 2009; Eze
and Akubor, 2012; Hesham et al., 2013). The evidence is that *Justicia secunda* leaf is a rich source of mineral nutrition for humans. Minerals are important not only for good nutrition but also in maintaining physiological balance. The ration of K to Na was more than 3fold despite the different processing methods and an indication that *Justicia secunda* leaf can be used to reduce the incidence of hypertension and related disorders. Secondly, the high Fe content shows that this vegetable can be used to boost haemopoisis and reduce the incidence of morbidity and mortality in children, the elderly and other medical conditions relating to anemia.

**Effect of processing methods on the vitamin composition of *Justicia secunda* leaves**

The results reveal that the vitamins (B₁, B₂, B₃, C and E) concentration of *Justicia secunda* leaves varied significantly (p<0.05) in response to the processing treatments. It showed that unblanched and air-dried sample maintained higher vitamin values, followed by blanched air-dried sample, followed by blanched sun-dried sample, and lastly, blanched oven-dried sample, respectively. Appreciable amounts of vitamins were observed in *Justicia secunda* leaves irrespective of the processing treatments. These results correspond to the work of Onyeabo et al. (2017) on *Justicia carnea* that showed appreciable amount of Vitamin A, C, and E and Faiza et al. (2013) on the vitamin concentrations of *Justicia pectoralis* leaf. These vitamins (B₁, B₂ and B₃) can offer important vitamin nutrition for the vulnerable groups and also for the antioxidative properties (vitamins C and E) in scavenging free radical actions to preventing cellular destruction.

**Effect of processing methods on the anti-nutrient content of *Justicia secunda* leaves**

The result of the anti-nutrient content shows that the *Justicia secunda* leaves measured varying concentrations. The unblanched and air-dried sample exhibited higher anti-nutrient values when compared to the blanched and dried samples. It was revealed that blanching and drying reduced the anti-nutrient contents of *Justicia secunda* leaves following the order blanched air-dried > blanched sun-dried > blanched oven-dried methods. It was observed that oven-drying, with higher temperature affected the anti-nutrients more resulting to lesser concentrations. The implication was the thermal degradation of these anti-nutrients. Moukimou et al. (2014) observed high presence of these anti-nutrients in the leaf extracts of *Tectona grandis*, *Uvaria chameae* and *Justicia secunda* that were used in traditional medicine in Benin. Sharma et al. (2018) had earlier reported on the reduction of anti-nutrient concentrations in basil leaves processed by oven and sun drying methods. From the results, we opine that air dried leaves of *Justicia secunda* will offer better preservation of the bioactive substances for its medicinal uses. These bioactive substances of tannin, phenols, flavonoids are important antioxidant that possess broad spectrum of chemical and biological activities including radical scavenging properties. They have also been associated with possible role in the prevention of several chronic diseases involving oxidative stress as well as their protective effect against low – density lipoprotein oxidation (Shanaz et al., 2011).

**Conclusion**

The effect of processing method on the proximate, minerals, vitamins and anti-nutrient compositions of *Justicia secunda* leaf was studied. The results showed that *Justicia secunda* leaf was a rich source of protein, fibre, K, Fe, vitamins and anti-nutrients (important phytonutrients). The processing methods revealed that air-drying (blanched and unblanched) method retained higher concentrations of most of the measured parameters. Thermal treatment of blanched and oven and sun-dried methods offered lower values of nutrient retention.

Due to high concentrations of functional K, Fe and phytonutrients in *Justicia secunda* leaves, the processed leaf can be used to supplement other foods as a functional ingredient and in value addition. Being rich in dietary antioxidant constituents, medicinal preparations or extracts from the leaf can be used to boost endogenous antioxidant compounds to ameliorate the effects of degenerative disorders *in vivo*. The high micronutrient contents of iron, anti-nutrient compounds and B group of vitamins in this vegetable reveals why the concoction is used intuitively by the traditional people to boost health conditions due to the functional roles of iron, phytonutrients and B group of vitamins in hemopoisis in preventing morbidity and mortality especially among children.
Recommendation:

Based on the findings, the following recommendations were made:

- **Justicia secunda** leaves, the processed leaf can be used to supplement other foods as a functional ingredient and in value addition.
- **Justicia secunda** leaves can be used to boost endogenous antioxidant compounds to ameliorate the effects of degenerative disorders *in vivo*.
- **Justicia secunda** leaves can be used to boost health conditions due to the functional roles of iron, phytonutrients and B group of vitamins in hemopoiosis in preventing morbidity and mortality especially among children.

References


Busari, S. A. (2021). Relationship of information accessibility, knowledge acquisition, management and transfer system among traditional herbal medical practitioners in south-west, Nigeria (doctoral dissertation repository futminna.edu.ng)


