Effect of Domestic Processing Methods on Dry Matter, Total Sugar, Phenolics and Mineral Composition in Different Developmental Stages of *Parkia roxburghii* G. (Don.) Pods

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Abstract

*Parkia roxburghii* is considered delicious in the Northeastern part of India, especially in the state of Manipur. Though it is widely used, information about the biochemical composition and its changes, after processing, is hardly available. In the present experiment, effect of processing methods on dry matter, soluble sugar, phenolics and mineral composition in different developmental stages of *P. roxburghii* pods were studied. Total soluble sugar (TSS), total phenols (TP), and orthodihydric phenols (ODHP) were determined, also sodium (Na), potassium (K), sulphur (S) and phosphorus (P) were estimated. Calcium (Ca), magnesium (Mg), manganese (Mn), zinc (Zn), iron (Fe), copper (Cu) and cobalt (Co) were analyzed in an atomic absorption spectrophotometer. Processing methods reduced dry matter, soluble sugar and phenolics in all the stages of the pod. TP and ODHP lost up to the extent of 72.78% in tender stage due to ordinary cooking, while higher loss of ODHP recorded in immature stage of the pod due to pressure cooking. Ca, Mg, K and Zn in different stages were found to be affected significantly by different methods of cooking, while no such changes were observed in case of S, P, Fe, Mn and Cu. The level of iron amongst the micro minerals is appreciably high recording up to 51.0 mg/100 g in the immature stage of the pod. As iron, zinc and manganese are antioxidant micronutrients, their higher presence in *P. roxburghii* might be of some nutritional importance.

Keywords: minerals, *Parkia roxburghii*, phenolics, processing methods, soluble sugar

Introduction

There are at least 3000 edible plant species known by man out of which, merely 300 crops contribute to more than 90% of the world’s calorie intake, and only 120 crops are economically important on an international scale which implies that world’s food security rests on a slender base of 4% of known edible plants (Cooper et al., 1996). Therefore, from the point of view of meeting the challenges of food security, it is necessary to widen the food base by establishing more and more new food crops.

Due to topography and climatic conditions the North-Eastern region of India is noted for its great diversity of edible plants. This is evidenced by the fact that about 40% of the total flora of the country is said to be represented in the north eastern part of India, which means an approximate number of 6000 to 7000 species. Out of these some of the plants are used as edible green vegetables, edible fruits and for other purposes. Many investigators feel that the nutritional value of the identified wild edible plants worked out, so that their contribution to human health in terms of nutrition can be recommended for the benefit of people at large scale (Barua et al., 2007; Kayang, 2007; Ramachandra, 2007). As the legumes are a member of the *Leguminosae* family, *P. roxburghii* (common name: Parkia or tree bean; Local name: Yongchak) also shares some of the anti-nutritional substances, endemic to legumes (Salam et al., 2010). It is important to reduce these anti-nutrients to improve the biological utilization of the plant. In India, the most important/common domestic processing and cooking methods include soaking, hulling, germination, ordinary and pressure cooking. These methods may reduce the anti-nutrients in legumes. There are a number of reports dealing with such information in the case of popular legumes, whereas no information is available regarding *P. roxburghii*, which is considered nutritious in this part of the country, especially in the state of Manipur and its adjoining areas. This paper reports part of a series of system-
atic investigations undertaken to determine the biochemical composition of this lesser known legume (Salam et al., 2009; 2010; Sharma et al., 1993).

Materials and methods

Different stages of *P. roxburghii* pods were collected from a plant grown at Iroisemba, near the Central Agricultural University campus, and classified them into 3 groups based on the mean thickness of the pod measured at the site of seeds as tender (6 mm and below), immature (6.1 to 10 mm) and mature (more than 10 mm). All the pods were scrapped to remove the outer green peel. The margin of the pods were neatly removed with the help of a knife and cut into 10 cm (approximate) pieces. They had been divided into three groups of equal weights. Out of which, two groups had been subjected to different methods of cooking following the method of Saroj and Neelam (1994), while the third group was kept as control. All the process/cooked pods were air dried and kept in the oven at 60±5°C for 48 hours. The loss in dry matter was found out by subtracting the weight from the control and reported in percentage. The moisture free samples were then ground using a Remi grinder and subsequently sieved (1 mm). The powder samples were collected and kept for various analyses.

The ethanol extract evaporated to dryness and dissolved in a known volume of water, used for the determination of total soluble sugar, total phenols, and ortho-phydroxlic phenols as per the methods of Morris (1948), Bray and Thorpe (1954) and Mahadevan and Sridhar (1986).

Wet digestion method of Capar et al. (1978) was followed for the analysis of mineral elements. Sodium (Na) and potassium (K) were estimated in a systronics-105 flame photometer. Sulphur (S) and phosphorus (P) were estimated in a UV-VIS double beam spectrophotometer following the procedures described by Tandon (1993). Calcium (Ca), magnesium (Mg), manganese (Mn), zinc (Zn), iron (Fe), copper (Cu) and cobalt (Co) were analyzed in a Parkin Elmer atomic absorption spectrophotometer, Analyst AA-200. Standard errors of mean differences (S. Ed±) and critical differences were calculated as per standard statistical procedures.
Results

Changes in dry matter (DM) and total soluble sugar (TSS) content in pods: DM content increased from 19.1% in tender pod to 26.7% in mature pod. Processing methods affect DM content in all stages of the pod (Fig. 2A). Pressure cooking (PC) indicated higher loss of DM recording up to 27.7% in tender stage of the pod (Fig. 2B). Similarly, TSS content increases with the age of the pod by containing 6.92% in raw tender pod to 8.06% in the mature pod (Fig. 3A). However, the effect of processing methods was more pronounced in case of TSS recording a loss of 78.36% of TSS by PC in the mature stage of the pod (Fig. 3B).

Changes in phenolics in the pods: Total phenol (TP) decreases with the age of the pod by containing 61.42 mg/g in tender, 52.25 mg/g in immature and 37.70 mg/g in mature raw pods, which decreased to 16.72, 17.82 and 13.58 (mg/g) in ordinary cooking (OC) and to 20.10, 18.71 and 15.72 (mg/g) in PC (Fig. 4A). Different processing methods removed total phenols up to the extent of 72.78%, 65.89% and 63.98% of the original content in tender, immature and mature stages of the pod by OC and 67.27%, 64.19% and 58.30% by PC, respectively (Fig. 4B).
The same trend was also observed in orthodihydric phenols (ODHP). ODHP in the raw pod decreased with the pod maturation, which decreased to 0.63, 0.54 and 0.52 mg/g in OC and to 0.74, 0.35 and 0.52 mg/g in PC (Fig. 5A). ODHP removed due to different processing methods was 81.14%, 76.21% and 51.85% by OC and 77.84%, 84.58% and 51.85% by PC, respectively (Fig. 5B).

Changes in mineral content in the pods: Tab. 1 indicates changes in the major element composition in different stages of the pod. Ca content in raw tender (238 mg/100 g), immature (404.01 mg/100 g) and mature (398.53 mg/100 g) pods decreased to 174.02, 288.01 and 250.01 mg/100 g due to OC, while it decreased to 177.92, 328.52 and 300.52 mg/100 g due to PC. Mg and K content (226.20 and 2760 mg/100 g) in tender stage of the pod decreased to 156.20 and 2400 (mg/100 g) in ordinary cooking and to 150.0 and 2440 (mg/100 g) in pressure cooking. Similar trends were observed in immature stages.

Fig. 5. Effect of different cooking methods on orthodihydric phenol (ODHP) content in P. roxburghii: (A) Bar graph showing changes in ODHP content and (B) line graph showing degree of loss out of the total content in different stages of the pod.

Tab. 1. Effect of cooking methods on major element content in different developmental stages of P. roxburghii pod (mg/100 g)

<table>
<thead>
<tr>
<th>Major Element</th>
<th>Cooking methods</th>
<th>Stages</th>
<th>Mean Stages</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Raw</td>
<td>Immature</td>
<td>Mature</td>
</tr>
<tr>
<td>Ca</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ordinary Cooking</td>
<td>174.02b</td>
<td>288.01b</td>
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<tr>
<td></td>
<td>Pressure Cooking</td>
<td>177.92b</td>
<td>328.52b</td>
</tr>
<tr>
<td></td>
<td>Mean (Methods)</td>
<td>196.65</td>
<td>340.18</td>
</tr>
<tr>
<td>Mg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ordinary Cooking</td>
<td>156.20b</td>
<td>188.65b</td>
</tr>
<tr>
<td></td>
<td>Pressure Cooking</td>
<td>150.0b</td>
<td>205.70b</td>
</tr>
<tr>
<td></td>
<td>Mean (Methods)</td>
<td>177.47</td>
<td>232.18</td>
</tr>
<tr>
<td>K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ordinary Cooking</td>
<td>2760.00</td>
<td>2740.0</td>
</tr>
<tr>
<td></td>
<td>Pressure Cooking</td>
<td>2400.00</td>
<td>2450.0b</td>
</tr>
<tr>
<td></td>
<td>Mean (Methods)</td>
<td>2533.3</td>
<td>2550.0</td>
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<tr>
<td>S</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>Ordinary Cooking</td>
<td>85.37</td>
<td>78.97</td>
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<td>Pressure Cooking</td>
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<tr>
<td></td>
<td>Mean (Methods)</td>
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<tr>
<td>P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ordinary Cooking</td>
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<td>203.7</td>
</tr>
<tr>
<td></td>
<td>Pressure Cooking</td>
<td>188.9</td>
<td>190.3</td>
</tr>
<tr>
<td></td>
<td>Mean (Methods)</td>
<td>197.03</td>
<td>199.70</td>
</tr>
</tbody>
</table>

Note: NS=Non-significant; Different letters in a column indicate significance at 5% level
and mature stages of the pod. Ca, Mg and K in different stages were found to be affected significantly by different methods of cooking, while no such changes were observed in case of S and P. Tab. 2 indicates the changes of minor elements in different stages of the pod. Cooking methods did not affect any significant changes in respect of Fe, Mn and Cu, however, significant changes were observed in case of Zn. Zn content in tender (10.05), immature (10.15) and mature (6.18 mg/100 g) raw pods decreased to 6.10, 6.12 and 3.12 mg/100 in ordinary cooking and to 7.50, 7.13 and 6.0 mg/100 g in pressure cooking. The degree of minerals loss due to different processing methods is indicated at Fig. 6(A-I). Percent removal of Ca was 26.88% to 37.27% by OC, while it was 25.51% to 37.57% in Mg and 3.95% to 13.04% in K (Fig. 6A-C). Processing methods seemed to be less effected on S, P and Fe content of the pods (Fig. 6D-F). S and Fe content even increased due to processing methods recording a gain of 6.58% and 12.33% in OC and 5.38% and 20.54% in PC. However, the degree of loss was higher in case of Zn, Mn and Cu, recording up to 49.51%, 66.67% and 40% by OC and up to 29.75%, 33.33% and 10% by PC, respectively, in different stages of the pod (Fig. 6G-I).

![Fig. 6(A-I). Bar graph showing per cent loss/gain out of the respective total element content due to different processing methods in different stages of P. roxburghii pods.](image-url)
Among the elements tested, Ca and Zn were the only ones differed significantly in various stages of the pod (Tab. 1 and 2). K was found to be the most abundant mineral found in the pods, recording up to 2760 mg/100 g in the tender stage of the pod, which is followed by Ca (404.01 mg/100 g), Mg (302.20 mg/100 g) and P (211 mg/100 g), respectively (Tab. 1).

Among the micro elements, Fe (51 mg/100 g) recorded to be the most abundant element, which is followed by Zn (10.15 mg/100 g), Mn (9 mg/100 g) and Cu (6 mg/100 g) (Tab. 2). This might be of nutritional importance, especially in the part of the world where anemia and iron deficiency is relatively rampant as in the case of P. thonningii (Jimoh and Oladiji, 2005). Iron, zinc and manganese are antioxidant micronutrients and their high presence in P. roxburghii could therefore boost the immune system (Talwar et al., 1989). Though, both cooking methods did not differ significantly, the degree of loss was often found to be higher in case of ordinary cooking (Fig. 6A-I). Similar findings were also reported by other researchers, which may be due to leaching of minerals on account of the enhanced permeability of the seed coat by the process of cooking (Kingsley, 1995; Meiners et al., 1976). However, S and Fe increased due to processing methods, recording a gain of 6.58% and 12.33% in OC and 5.38% and 20.54% in PC (Fig. 6D and F). These results were in agreement with the findings of Sinha and Kawatra (2003).

**Discussion**

DM and TS increased with the advancement of the pod (Fig. 2A and 3A), while TP and ODHP decreased (Fig. 4A and 5A). Processing methods reduced DM, TSS, TP and ODHP content in all the stages, the degree of loss in DM, TP and ODHP being higher before the pod matured (Fig. 2B, 4B and 5B). This may be due to the reason that as the pod advances, more and more cell walls are lignified thereby inhibiting loss due to leaching. However, contrary to this, higher loss of TSS was recorded in the mature stage of the pod indicating accumulation of water soluble sugars when the pod matured (Fig. 3B). Out of the two processes, pressure cooking increased loss of dry matter, as well as soluble sugar, which may be due to the fact that boiling at higher pressure rendered complex substances broken down into simpler units, increasing loss due to leaching. Cooking as well as autoclaving brought about slight decrease in glucose, fructose and sucrose levels and increased oligosaccharide content of all the varieties of lima bean (Ologhobo and Fetuga, 1988). Processing methods also influenced total phenolics in selected dry beans (Boateng et al., 2008). Significant reductions in case of phenolics and phytic acids, due to different processing methods, were also reported (Sinha and Kawatra, 2003).


Conclusion

Parkia roxburghii was a good source of Ca, K, P, Fe, Zn, Mn and Cu. In spite of being a leguminous plant, which was generally prone to many anti-nutritional and toxic factors, especially more, so in the case of non-conventional legumes, parkia contains less amounts of anti-nutrients (Salam et al., 2010). Due to its wide adaptability in different soils, in varied altitudes as well as due to its nutritious pods and prolong availability for use, P. roxburghii, if properly exploited may be a nutritious vegetable supplement for the human consumption at large.

References


