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Research Article

EVALUATION OF PROXIMATE AND MINERAL COMPOSITION OF RAW AND BOILED STORAGE SCALE LEAF SAMPLES OF *BORASSUS FLABELLIFER* L.

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ABSTRACT
Borassus flabellifer L. is a dioecious palm. Every part of the plant has been used by the people for various purposes, right from as a source of food, medicine to handicrafts made from palm leaves. The edible part of the seedling is scale leaf or cataphyll which is enclosed by cotyledonous sheath (seed shoot). The present study aimed at analysing the storage scale leaf for understanding its comparative proximate and mineral values of raw and boiled scale leaf for establishing its nutritive use. The crude protein content is lower in the raw scale leaf sample (5.84%) than the boiled scale leaf (6.40%). The boiled sample had higher crude carbohydrate content (16.53%) than the raw scale leaf sample (11.59%), which shows that the boiled scale leaf is a good source of carbohydrates. The crude lipid content of raw scale leaf (1.72%) is significantly lower than the boiled scale leaf (4.39%). Crude fibre content ranged from 1.98% in raw scale leaf to 2.11% in the boiled scale leaf. The moisture content lowered in the boiled scale leaf (57.31%) than the raw scale leaf (58.93%). The calorific value was higher in the boiled scale leaf sample (131.23 cal/100g) than the raw scale leaf sample (85.2 cal/100g). The amount of minerals were also analysed and compared between the boiled and raw samples (g/100g), viz; Magnesium (raw 0.202 and boiled 0.163), Potassium (raw 1.336 and boiled 1.203), Calcium (raw 0.709 and boiled 0.667), Iron (raw 0.101 and boiled 0.106) and Zinc (raw 0.006 and boiled 0.034). Significant differences ($P < 0.05$) between the raw and roasted samples are seen in the statistical analysis.

Keywords: *Minerals, Palmyra Palm, Proximate Analysis, Scale Leaf*

INTRODUCTION
Palmyra palm (*Borassus flabellifer* L.) is a well-known widely distributed tropical palm belonging to the family Arecaceae. *Borassus* in Greek means “leathery covering of fruit”; *flabellifer* means “fan-bearer” (Small, 2011). The tree was named so because for the resemblance of the leaf to the palm of the hand. The other local names of the palm includes Toddy palm, wine palm, Cambodian Palm, Panai maram, Pana, Taalimara, Tal, Tad and it is the state tree of Tamil Nadu (The Wealth of India, 1988). It is the national fruit of Cambodia and it is well distributed in the Indian subcontinent and South East Asian countries as it requires dry, tropical weather (Alamelumangai *et al.*, 2014). It is a dioecious palm which grows slowly and the sex of the tree cannot be identified until it starts to produce flowers. It usually flowers only after 12-15 years of growth. Fruits start to appear from May to August. The tender fruits contain a soft, sweet, jelly-like endosperm with sap and embryo. These fruits are relished during summer and they are a cooling, delicious and filling food, the gelatinous light golden fibrous, luscious, semi-saccharine, farinaceous matter known as Palmyra pulp. Seed germination is of remotive tubular type. The cotyledonary sheath encompasses the plumule and the radicle at its tip growing downwards into the soil. The cotyledonary sheath develops into a solid cylindrical structure, often marked externally by pneumathodes. The seedling produces a single scale leaf or cataphyll which contains abundant storage starch. The cotyledon and scale leaf become firm and hard and the latter grows to a thickness of about 1 cm by the growth and enlargement of its cells. The fully grown scale leaf has enlarged to a size of about 30-40 cm in length and about 3-4 cm in breadth at its broadest part. This scale leaf is the edible part of the seedling, locally known as "Panam kizhangu". This edible part (scale leaf) is removed and eaten as favourite seasonal food when it is 2-4 months old (Mitra, 1988, Dassanayake and Sivakadachchan, 1973).

The Palmyra scale leaf flour has been consumed by the locals in Sri Lanka for many centuries and toxic effects have been reported by them, viz; neurotoxicity, hepatotoxicity, immunosuppression, clastogenic and mutagenic effects (Jansz *et al*., 2002). The toxicity is due to the presence of flabelliferins (Wickeramasekara and Jansz, 2001). The present study is carried out to investigate the comparative proximate analysis and mineral analysis of raw and boiled scale leaf, since the palmyra scale leaf flour is used for various food preparations and consumed in both raw and boiled states.

MATERIALS AND METHODS

The raw scale leaf of *B. flabellifer* were procured from the local market of Tambaram West, Tamil Nadu, India. A known quantity (100g) of raw and boiled scale leaf samples were made into a paste and both the pastes were stored in two different air tight containers, labelled separately subjected to further analysis.

Proximate Analysis

The following proximate analysis (crude protein, crude carbohydrate, crude lipid, crude fibre, moisture content and calorific value) were performed in the raw and boiled scale leafs and the results were determined by using standard methods (AOAC, 2003, Greenfield and Southgate, 2003).

Mineral Analysis

Minerals were determined by digesting the scale leaf paste of both raw and boiled sample separately in 3M hydrochloric acid. The five inorganic elements; Magnesium, Potassium, Calcium, Iron and Zinc were determined using the atomic absorption spectrophotometer (AAS) method outlined in (AOAC, 2003).

Data Analysis

Results obtained in all tests have been subjected to Independent Sample T-test Analysis using SPSS version 15 to ascertain the significant values. P-values of less than 0.05 ($P < 0.05$) showed significant difference among raw and boiled scale leaf samples.

RESULTS AND DISCUSSION

Proximate Analysis

The proximate analysis of food is done mainly to analyse moisture, ash, lipid, protein and carbohydrate contents. These parameters play an important role in the food industry for product development, quality control (QC) or regulatory purposes (Thangaraj, 2016). Proximate analysis can also help the common people outside the food industry to know about the nutritional aspects and the quality of the food they are eating. The scale leaf samples were subjected for proximate analysis and the values were analysed (Table 1).

Table 1: Proximate Analysis of Raw and Boiled Scale Leaf of *B. Flabellifer*

Nutritive Composition	Raw Sample (g/100g)	Boiled Sample (g/100g)	P Value
Crude Protein	5.84%	6.40%	0.000
Crude Carbohydrate	11.59%	16.53%	0.000
Crude Lipid	1.72%	4.39%	0.000
Crude Fibre	1.98%	2.11%	0.001
Moisture Content	58.93%	57.31%	0.000
Calorific value[1]	85.2	131.23	0.005

[1]cal/100g

The crude protein was analysed for the raw and boiled sample, the boiled sample had 6.40% of crude protein and the raw sample had 5.84% of crude protein. From the results, it is clearly shown that the protein level is more in the boiled sample. In another study, conducted on the palmyra scale leaf flour it was found that the protein content of the flour was lower than that of cereals but higher than that of other tuber samples (Jansz *et al*., 2002). The crude protein content of *Borassus aethiopum* scale leaf flour is 0.017 ± 0.00 g/100 g dry matter (Ali *et al*., 2010), comparing this value with the present study *B. flabellifer* scale leaf flour has more crude protein content. Protein in the diet contributes for the growth and repair of worn-out tissues (Ayoola *et al*., 2012).

The crude carbohydrate value for boiled sample is 16.53% and for raw sample is 11.59%. The result shows that crude carbohydrate content has increased after boiling the raw scale leaf sample. In another report, the carbohydrate content of *B. flabellifer* sample is 25.53g/100g of dry matter (Sahni *et al*., 2014), showing variation in the crude carbohydrate content. Starch is the main carbohydrate content of the scale leaf, it has low gelatinization temperature and viscosity but has a good setting property due to which it exhibits as a good source of food starch (Balasubramanium *et al.*, 1999). It was also found that the starch of the scale leaf flour is devoid of bitterness (Jansz *et al.*, 1992).

The crude lipid content of boiled sample is 4.39% and that of raw sample is 1.72% which shows that crude lipid content has increased after boiling the raw sample. The result of the present study showed higher crude lipid content compared to the previous analysis (Sahni *et al*., 2014). However, the flour of *B. aethiopum* has even more lipid content (10.73 ± 0.00g/100g) than the crude lipid content of *B. flabellifer* (Ali *et al*., 2010). The crude lipid is composed of triglycerides of palmitate, oleate and linolinate. The crude lipid content of samples is comparatively less than that of lipids of cereals and tubers (Jeyarartnam, 1986). Lipids also play an important role in human diet because it helps in absorption of lipid soluble vitamins (Atasie *et al.,* 2009).

The crude fibre content in the boiled sample is 2.11% and in raw sample is 1.98%, this shows that the crude fibre content has increased after boiling the sample. Since there is a considerable amount of fibre it may have low glycaemic index (Jansz *et al.,* 2002). The crude fibre content of *B. flabellifer* flour is 7.29g/100g in another study, which indicates that the scale leaf is a rich source of dietary crude fibre (Sahni *et al.,* 2014). Low fibre content in diet may also lead to constipation, cancer and piles (Atasie *et al.,* 2009).

The moisture content of raw sample is 58.93% and for the boiled sample is 57.31%. The results reveal that both raw and boiled samples have significant increase in moisture content.

The moisture content has lowered down slightly in the boiled sample due to boiling. The moisture content in previous study also showed higher value (Sahani *et al.,* 2014).

The calorific value has increased drastically (131.23 cal/100g) in the boiled sample than that of the raw sample (85.2 cal/100g). In previous report on the dried scale leaf flour of *B. flabellifer*, the calorific value is also higher (Sahani *et al.,* 2014). In another study on the scale leaf flour, it was found that the calorific value content is similar to that of cereals and grains (Jansz *et al.,* 2002). From the above results for proximate analysis it is clear that all the values in proximate composition has increased in the scale leaf after boiling except for moisture content.

Mineral Analysis

The raw and boiled samples were analysed for five inorganic nutrients viz; Magnesium, Potassium, Calcium, Iron and Zinc. Generally, mineral analysis were performed in the below ground storage organs that display wide reserves of carbohydrates, vitamins including rich mineral contents as they are in direct contact with the soil (Subramanian *et al.,* 2011). The results are tabulated in table 2.

Table 2: Mineral Analysis of Raw and Boiled Scale Leaf of *B. Flabellifer*

Minerals	Raw Sample(g/100g)	Boiled Sample(g/100g)	P Value
Magnesium	0.202	0.163	0.000
Potassium	1.336	1.203	0.001
Calcium	0.709	0.667	0.000
Iron	0.013	0.106	0.002
Zinc	0.064	0.034	0.000

The amount of magnesium present in the raw sample is 0.202g/100g and that of boiled sample is 0.163g/100g, which indicates that raw sample is high in magnesium than the boiled sample. The amount of potassium present in the raw sample is 1.336g/100g and the boiled sample is 1.203g/100g, and this indicates that raw sample is rich in potassium. The amount of calcium present in the raw sample is

0.709g/100g whereas the boiled sample show 0.667g/100g and this proves that raw sample is a good source of calcium. Calcium maintains the bone health of humans. Increased levels of calcium in important agricultural crops can reduce osteoporosis significantly (Park *et al.*, 2005). The iron content of raw sample is 0.101g/100g and that of boiled sample is 0.106g/100g, which shows that Iron is more in the boiled sample. The amount of zinc was also analysed and in raw sample it is 0.064g/100g and in boiled sample is 0.034g/100g, raw sample is rich in zinc content.

The mineral analysis results of *B. flabellifer* were compared with the mineral content of another related species *B. aethiopum.* The results showed less quantity magnesium and calcium and more quantity of iron and zinc in *B. flabellifer* (Ali *et al.*, 2010). Previous report on nutrient analysis has revealed that the three wild edible tubers *Brachystelma edulis* Coll. & Helmsl., *Ceropegia bulbosa* var.*bulbosa* Roxb. and *Ceropegia hirsuta* Weight & Arn. shows the presence of minerals such as Magnesium, Calcium, Manganese, Iron, Copper and Zinc; the mineral contents of *B. flabellifer* scale leaf sample seem to be comparatively high than the three wild tubers (Deshmukh and Rathod, 2013).

Conclusion

Raw and boiled scale leaf samples of *B. flabellifer* have different proximate and mineral characteristics. The results suggested that the boiled Palmyra scale leaf sample have a good proximate percentage than the raw sample, as boiling might have enhanced the proximate content in this study. From the results of mineral analysis, it is found that the raw sample is rich in minerals than the boiled sample, which may be due to the effect of boiling the sample. It may be concluded from the results of the present study that the Palmyra scale leaf shows more quantity of storage food substance in boiled condition and more quantity of nutrients in the raw condition.

Hence, this edible part serves as a good source of food both in boiled and raw condition. However, the people of Tamil Nadu have been consuming this edible Palmyra scale leaf mostly in the boiled condition as a seasonal and nutritious food.

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