Nutrient composition and sensory evaluation of drumstick (*Moringa oleifera* Lam.) leaf products

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ABSTRACT

Drumstick (*Moringa oleifera* Lam.), an indigenous underexploited tree, is now valued for health care. It provides pods and leaves for vegetables, and has various nutraceutical values. Nutrient composition of pods and leaves of drumstick KDM-01 (Bhagya, a recently released variety from University of Horticultural Sciences, Bagalkot during 2012) and S-6/4 (Dhanraj) and sensory evaluation of products that contained dehydrated drumstick leaf powder at different levels was carried out at College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India.

There was no significant difference observed between the varieties with respect to proximate composition of pods and leaves. In micronutrient composition, pods showed significant difference between the varieties in ascorbic acid, phosphorus, potassium and magnesium contents. The pods of variety KDM-01 were significantly higher in ascorbic acid (138.54 mg/100 g), phosphorus (109.70 mg/100 g) and magnesium (24.50 mg/100 g) content. Whereas, the pods of the variety S-6/4 was significantly higher in potassium (265.28 mg/100 g) content. In leaf micronutrient composition, KDM-01 variety showed significantly higher ascorbic acid (17.48 mg/100 g), calcium (2399.11 mg/100 g) and copper (0.081 mg) contents than variety S-6/4 (15.82 mg/100 g, 2081.77 mg/100 g and 0.073 mg/100 g, respectively). Whereas, the leaf of S-6/4 was significantly higher in iron (28.56 mg/100 g) than KDM-01 (27.36 mg/100 g).

With regard to sensory evaluation studies, the acceptability of *Thalipattu* incorporated with 5% fresh leaves was accepted highly, followed by 5% dehydrated leaf powder. Rice *Kichadi* prepared by incorporation of 7.5% dehydrated drumstick was accepted most, followed by control (without incorporation of drumstick leaves). Products incorporated with drumstick leaves at different levels showed corresponding elevation in micronutrient composition. Drumstick leaves are an outstanding indigenous source of highly digestible protein, calcium, iron, ascorbic acid and vitamin A, and can be exploited either in fresh or in dehydrated form in traditional food items. This would help in alleviating micronutrient deficiencies in a cheaper and most affordable way.

INTRODUCTION

Micronutrient deficiencies are more common in developing countries and the cause for their high prevalence is low dietary intake by populations and poor availability of micronutrients. Iron deficiency is the most common nutritional problem worldwide and contributes to maternal deaths in pregnancy and parturition. In India 79% of

children between 6 to 35 months and women between 15 to 49 years of age are anaemic (Krishnaswamy 2009). Vitamin A deficiencies are estimated to cause 600,000 deaths whereas zinc deficiencies cause 400,000 deaths annually. The most sustainable approaches to increasing the micronutrient status of populations are food-based strategies, which include food production, dietary diversification and food fortification. Food-based intervention focus on natural, processed, or fortified foods alone or in combination as the primary tool for improving the quality of diets and for overcoming and preventing malnutrition and nutritional deficiencies.

Green leafy vegetables are rich sources of iron and other essential micronutrients, but they are discarded and are not used for human consumption. Drumstick leaf (*Moringa oleifera* L.) is one of them, which is available at no cost. The leaves are micronutrient-dense and provide more vitamins per mouthful than any other leaves. It is commonly said that drumstick leaves contain more vitamin A than carrots, more calcium than milk, more iron than spinach, more vitamin C than oranges and more potassium than bananas and that the protein quality rivals that of milk and eggs.

Drumstick leaves can be utilized in multiple ways by incorporating them into existing products and formulations of health foods using techniques of dehydration. Devising several simple and acceptable micronutrient-rich recipes containing drumstick leaves would not only bring variety to the diet but also help in combating micronutrient deficiencies. Therefore, we studied nutrient composition and sensory evaluation by utilizing the dehydrated drumstick leaf powder to enhance the nutritional quality of traditional products.

METHOD

Two varieties of drumstick (kdm-01 and s-6/4) pods and leaves were procured from the Research Field Unit, Department of Vegetable Science, College of Horticulture, University of Horticultural Sciences, Bagalkot. The other ingredients used for the preparation of formulations were procured from the local market.

Proximate composition (protein, fat, crude fibre, carbohydrate and moisture), vitamin A and ascorbic acid content of pods leaves and incorporated products were analyzed by using the standard procedure of AOAC (2004). Mineral estimation of the samples was carried out by the method of Ranganna (1986).

Preparation of drumstick leaves for drying

Fresh, green, undamaged, non-insect infested leaves were sorted out and the stalks of the leaves were cut from the main branches. Leaves were washed thoroughly three to four times under running water to remove the adhering dust and dirt particles. Washed leaves were spread on cotton cloths on the working table for shade drying in a well-ventilated room until the leaves were dried completely and became crisp and brittle to touch. The dried leaves were powdered, stored in airtight containers in a refrigerator and used for incorporation in traditional products *Thalipattu* and *Kichadi*.

Product formulation

Two products, *Thalipattu* and *Kichadi,* were selected for incorporating dehydrated drumstick leaves powder. *Thalipattu* is a mixed cereal and legume pancake-like product consumed for breakfast. Bengal gram flour (25 g), rice flour (25 g), fine semolina (25 g) and whole wheat flour (25g) were mixed together. Onion (40 g), tomatoes (20 g), half green chili (finely chopped), ajwain (1 g), cumin seed powder (1 g) and salt (3 g) were added to flour mixture and made into a stiff dough with water. The dough was rolled with roller and pin to have a diameter of about 5 inches and

roasted by using oil (5 ml) on a nonstick tawa. Then it was turned upside down so that it was roasted on both sides. The dehydrated drumstick leaf powder at 2, 5, 7.5, 10% levels and 5% fresh drumstick leaves were incorporated into the flour mixture. The dough without addition of drumstick leaves served as control.

Kichadi is a pressure-cooked product prepared by using rice (70 g) and a legume, green gram dhal (30 g). Onion, chili, salt, mustard seeds, cumin seeds, oil and curry leaves were added for the product preparation. Rice and green gram dhal were washed thoroughly and cooked in a pressure cooker until soft. Seasoning was given with a little oil, mustard, cumin, chopped onion, chilli and curry leaves and mixed together with the cooked rice and green gram dhal mixture. During cooking the *Kichadi* was prepared by incorporating dehydrated drumstick lead powder at 2, 5, 7.5 and 10% levels and 5% fresh drumstick leaves. The *Kichadi* without incorporation of drumstick leaf served as control.

Sensory evaluation

The formulated products were subjected to sensory evaluation with the help of panel of 20 members using 9-point hedonic ranking scale for appearance, colour, texture, taste and overall acceptability (Swaminathan 1987). The product without dehydrated drumstick leaf powder and fresh leaves served as control. The data was compiled and analyzed statistically.

Statistical analysis

Statistical analysis for nutrient and micronutrient composition of drumstick pods and leaves was carried out by Student's 't' test. The sensory evaluation data was subjected to ANOVA (Panse and Sukathme 1967) and 'F' test was carried out to know the significant difference among the products that were developed.

RESULTS AND DISCUSSION

Proximate composition of drumstick pods and leaves

Proximate composition of drumstick pods and leaves are presented in Figures 1 and 2. The moisture content of the pods of Dhanraj and Bhagya was 87.95 and 87.41%, respectively, whereas, leaves contain 76.22 and 75.83%, respectively and there was no significant difference between the varieties. Protein content was slightly higher in the pods (3.50%) and leaves (6.11%) of Bhagya than Dhanraj (3.43% and 5.87%, respectively) though there was no significant difference between the varieties. Fat content was higher in Dhanraj pods (0.12%) and leaves (1.83%) than Bhagya (0.10 % and 1.71%, respectively). Crude fibre content was more (4.93%) in Bhagya pods than Dhanraj (4.66%) whereas, leaves of Dhanraj (2.50%) was higher amount than Bhagya (2.46%). The pods and leaves of Bhagya (4.06% and 13.89%) variety was higher carbohydrate than Dhanraj (3.84% and 13.58 %, respectively). The difference between the pods and leaves of two varieties with regard to proximate composition were found to be statistically insignificant.

Vitamin and mineral composition of drumstick pods and leaves

Vitamin and mineral composition of drumstick pods and leaves are depicted in Table 1 and Table2. In pods of Bhagya the ascorbic acid content was 138.54 mg/100 g and it was significantly different than the pods of Dhanraj (121.43 mg/100 g). The same trend was also observed in ascorbic acid content of leaves, where in the leaves of

variety Bhagya was higher (17.48 mg/100 g) ascorbic acid than the variety Dhanraj (15.82 mg/100 g). Vitamin A content of both varieties was on par with each other in both the pods and leaves. However, the leaves of Bhagya (18.12 mg/100 g) was higher in Vitamin A than Dhanraj (16.46 mg/100 g).

In mineral composition there was significant difference between the pods of two varieties with respect to phosphorus, potassium and magnesium content. Phosphorus and magnesium content of pods of variety Bhagya (109.70 and 24.50 mg/100 g) was higher than Dhanraj (104.92 mg/100 g and 23.37 mg/100 g, respectively).

In leaves, significant difference was observed in calcium, iron and copper content. The leaves of variety Bhagya was higher in calcium (2399.11 mg/100 g) than Dhanraj (2018.77 mg/100 g), whereas, the iron content was higher in variety Dhanraj (28.56 mg/100 g) than Bhagya (27.36 mg/100 g). The leaves of Bhagya (0.0187 mg/100 g) was higher content of copper than Dhanraj (0.073 mg/100 g). There was no significant difference in phosphorus, potassium and magnesium content in the leaves of two drumstick varieties.

Incorporation of drumstick leaf powder in product and sensory evaluation

Blanched and dehydrated drumstick leaf powder was incorporated in to *Thalipattu* as noted above. Products were evaluated for sensory quality by a panel of judges. Results of sensory analysis are presented in Table 3. The control sample was given scores ranging from 6.523 to 7.364 for different quality attributes. Addition of 5% fresh drumstick leaves enhanced the quality attributes *viz.,* colour, flavour, taste, texture and overall acceptability over the control. Incorporation of dehydrated drumstick leaf powder at 7.5% and 10% levels lowered the scores of all the attributes of the product. However, there was no significant difference observed with taste and texture of the product at all levels of incorporation of dehydrated drumstick leaf powder. Overall acceptability of *Thalipattu* with 5%, 7.5% drumstick leaf powder and 5% fresh leaves were on par with the control. Significant differences were found in colour, flavour and overall acceptability. Addition of dehydrated drumstick leaf powder brought down the scores of colour and flavour of *Thalipattu.*

Sensory analysis scores of *Kichadi* are presented in Table 4. Colour of the *Kichadi* prepared by incorporation of dehydrated drumstick leaf powder at 5%, 7.5% and 5 % fresh leaves were on par with the control, however, the scores of 5% fresh leaves incorporation was higher than control. Scores for the colour of the *Kichadi* was significantly brought down by the incorporation of 10% dehydrated drumstick leaf powder. In all the other quality attributes also 10% incorporation of drumstick leaf powder showed significant difference with lowest scores except in texture. However, the incorporation of drumstick leaf powder at levels of 5% and 7.5% improved all the quality attributes *viz.,* taste, texture and over all acceptability. No significant difference was observed in texture of *Kichadi* at all levels of incorporation.

Products incorporated with dehydrated drumstick leaf powder showed a remarkable increase in all their micronutrient content (Table 5 and Table 6). The iron content of *Thalipattu* was found to significantly increase from 7.12 mg in control to 9.85 mg/100 g for the 10% dehydrated drumstick leaf powder incorporated product. Vitamin A content also increased extraordinarily. A serving size of two *Thalipattu* (100 g) can provide the daily requirement of Vitamin A for an individual.

Iron, calcium, vitamin A and vitamin C content of *Thalipattu* increased from 7.12 mg, 74.70 mg, 121.71 mcg, 17.62 mg, respectively in control to 9.85 mg, 314.65 mg, 1767.32 mcg and 18.34 mg, respectively for the 10% dehydrated drumstick leaf

powder incorporated product. Significant difference was also found in all the micronutrients by the incorporation of dehydrated drumstick leaf powder at 5% and 7.5%. A similar trend was observed in the *Kichadi.* The incorporation of dehydrated drumstick leaf powder at 10% enhanced the iron (8.17 mg), calcium (302.33 mg), vitamin A (1776.63 mcg) and vitamin C (12.94 mg) when compared to control (5.43 mg, 62.18 mg, 37.46 mcg and 11.44 mg, respectively).

Similar observations have been reported by Kaveri et al. (2004) who incorporated dehydrated *Peucedanum graveolens* in wheat papads. Mineral, vitamin and fiber content of greens incorporated into papads increases remarkably. Addition of dehydrated greens (*Amaranthus paniculatus* and *Peucedanum graveolens*) increased nutrient density of *Mathri* and *Thalipattu* (Gupta and Prakash, 2011). Ingestion of meals containing provitamin A rich carotenoids from yellow and green leafy vegetables improved the total body vitamin A pool size and Hb concentration and decreased anaemia rates in Filipino school children (Maramag et al. 2010).

From the above observations, it can be concluded that drumstick leaves and pods are rich source of nutrients. Sensory evaluation of products incorporated with different levels of dehydrated drumstick leaf powder revealed that they could be incorporated in traditional products *Thalipattu* and *Kichadi* at levels of 7.5% with no detrimental effects on sensory quality. Addition of dehydrated drumstick leaf powder increased the nutrient density of all products. Value addition of traditional products with dehydrated drumstick leaf powder can be advocated as a feasible food- based approach to combat micronutrient malnutrition.

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Table 1. Vitamin content in drumstick pods and leaves (per 100 g)

Vitamins	Pods		't' value	Leaves		't' value
	Bhagya	Dhanraj		Bhagya	Dhanraj	
Ascorbic acid (mg)	138.54	121.43	7.061**	17.48	15.82	4.648**
Vitamin A (mg)	0.136	0.14	NS	18.12	16.46	NS

**Significant at 1 % level
NS: Non Significant

Table 2. Mineral composition of drumstick pods and leaves

Minerals	Pods			Leaves		
	Bhagya	Dhanaraj	't' value	Bhagya	Dhanaraj	't' value
Calcium (mg)	30.28	31.49	NS	2399.11	2018.77	4.90**
Phosphorus (mg)	109.70	104.92	6.101**	207.68	207.55	NS
Iron (mg)	5.29	5.91	NS	27.36	28.56	6.296**
Potassium (mg)	260.18	265.28	6.944**	1347.40	1362.25	NS
Magnesium (mg)	24.50	23.37	10.336**	364.62	371.58	NS
Copper (mg)	0.073	0.076	NS	0.081	0.073	8.50**

**Significant at 1 % level
NS: Non Significant

Table 3. Sensory analysis of *Thalipattu* by incorporation of drumstick leaf powder and fresh leaves

Level of incorporation of drumstick	Quality characteristics				
	Colour	Flavour	Taste	Texture	Overall acceptability
5% DDP	6.102	6.579	7.215	6.523	7.056
7.5% DDP	5.897	6.102	6.841	6.682	6.635
10% DDP	4.897	5.635	6.364	5.841	6.000
5% DFL	8.056	7.317	7.476	7.158	7.635
Control	7.364	6.523	6.579	6.635	6.738
CD± SEm	1.273±0.54	1.118±0.47	NS	NS	1.002±0.43

DDP: Dehydrated drumstick powder
DFL: Drumstick fresh leaves

Table 4. Sensory analysis of *Kichadi* by incorporation of drumstick leaf powder and fresh leaves

Level of incorporation of drumstick	Quality characteristics				
	Colour	Flavour	Taste	Texture	Overall acceptability
5% DDP	6.943	6.023	7.056	6.761	7.158
7.5% DDP	6.284	5.579	6.125	6.364	6.341
10% DDP	5.476	4.658	5.079	5.635	5.102
5% DFL	7.364	6.158	6.579	6.500	6.784
Control	7.215	6.420	6.602	6.341	6.841
CD± SEm	1.069±0.45	1.318±0.56	1.122±0.48	NS	1.049±0.44

DDP: Dehydrated drumstick powder
DFL: Drumstick fresh leaves

Table 5. Nutrient composition (per 100 g) of *Thalipattu* by the incorporation of drumstick leaves

Treatments	Protein (g)	Fat (g)	Crude Fibre (g)	Ash (g)	Iron (mg)	Calcium (mg)	Vit-A (mcg)	Vit-C (mg)
Control	13.40	12.45	2.07	1.93	7.12	74.70	121.71	17.62
5% DDP	13.82	12.54	2.19	2.02	8.49	195.10	1025.99	16.47
7.5%DDP	14.15	12.57	2.25	2.04	9.16	254.42	1355.89	16.85
10%DDP	14.27	12.63	2.32	2.10	9.85	314.65	1767.32	18.34
5g DFL	14.09	12.53	2.14	2.03	7.46	96.72	472.57	27.29
CD (1%)	0.510	0.047	0.036	0.021	0.020	0.742	2.849	0.353
SEm±	0.116	0.011	0.010	0.008	0.014	0.166	0.634	0.078

DDP: Dehydrated drumstick powder
DFL: Drumstick fresh leaves

Table 6. Nutrient composition (per 100 g) of *Kichadi* by the incorporation of drumstick leaves

Treatments	Protein (g)	Fat (g)	Crude Fibre (g)	Ash (g)	Iron (mg)	Calcium (mg)	Vit-A (mcg)	Vit-C (mg)
Control	13.17	10.96	1.43	1.78	5.43	62.18	37.46	11.44
5% DDP	13.39	11.05	1.55	1.88	6.79.	182.45	929.95	12.14
7.5%DDP	13.55	11.09	1.60	1.91	7.49	242.77	1356.97	12.60
10%DDP	13.68	11.15	1.67	1.96	8.17	302.23	1776.63	12.94
5g DFL	13.15	11.06	1.46	1.90	5.78	84.62	365.92	23.07
CD (1%)	0.127	0.033	0.021	0.016	0.025	1.903	75.105	0.420
SEm±	0.031	0.005	0.014	0.011	0.005	0.420	16.75	0.093

DDP: Dehydrated drumstick powder
DFL: Drumstick fresh leaves

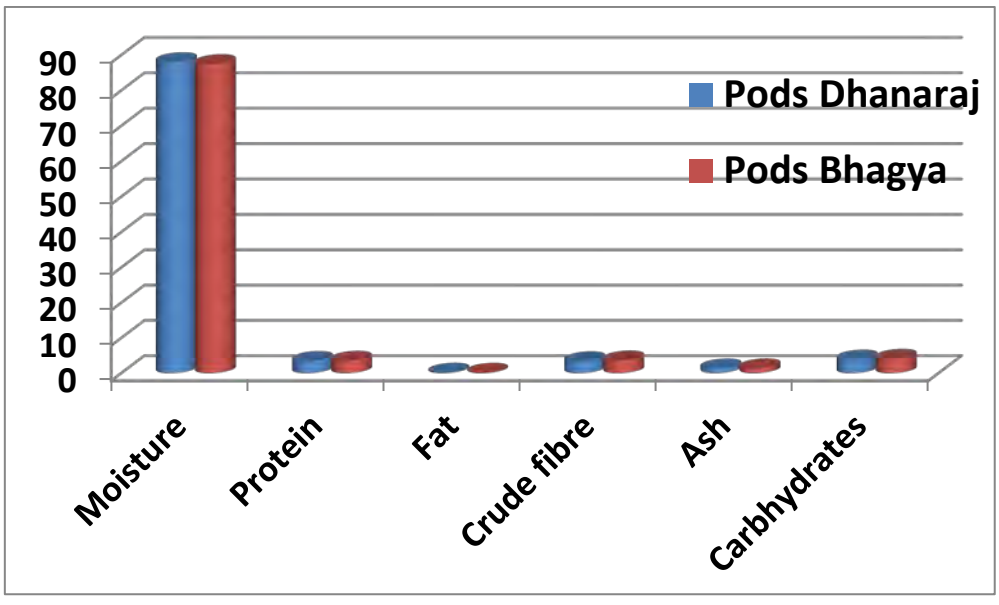

Figure 1. Proximate composition of drumstick pods

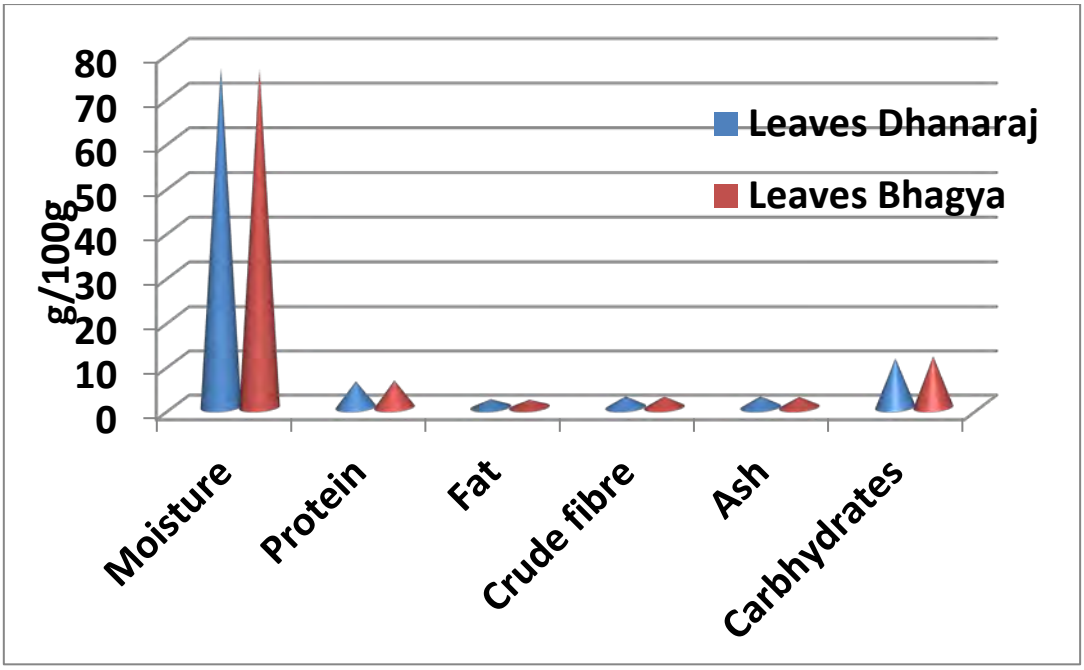

Figure 2. Proximate composition of drumstick leaves