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Development of 'ready to use' value added products from *Moringa* Leaves

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Abstract
The leaves, pods, flowers and many parts of *Moringa oleifera*, is replete with a wide range of phytochemicals and have been traditionally used as food and medicine. The leaves are inexpensive and abundantly available, but are largely underutilized and are often discarded. This study aimed at evaluating the composition of *Moringa oleifera leaves* and on formulating value added instant products that can be easily consumed. Fresh leaves were procured, shade dried (moisture below 10%) and ground to a homogenous mixture and then stored in air tight container. The resultant Moringa Leaf Powder (MLP) was studied for proximate composition, minerals (Ca, Fe, K, P) and antioxidant scavenging activity. In total, six different instant value-added products were formulated by adding the developed MLP, which were then evaluated in comparison to the control samples. Sensory analysis was carried with 50 semi-trained panellists, using a 5 point hedonic scale. The protein content was about 23% in MLP. The MLP was a rich source of calcium, iron (8616 mg and 659 mg), including other micronutrients. The products prepared with addition of MLP were well accepted sensorily. The study indicates that the abundantly available and highly nutritious but largely underutilized *Moringa oleifera*, can be used in various food formulations to enhance the nutritional value and wider acceptance and consumption.

Keywords: *Moringa, Moringa* leaf powder, nutrition, value addition

1. Introduction

Moringa oleifera is widely considered as the tree of miracles as its leaves, roots, flowers, pods and seeds have been consumed by people traditionally as food and medicine. Native to South Asia, it is grown as an agriculture crop in India, Ethiopia, Philippines, Sudan. It is also grown in places like east, west and South Africa, tropical Asia, Latin America, Caribbean, Florida and the Pacific Islands (FAO). This tropical monogeneric plant belongs to *Moringaceae* family, commonly grown on the Himalayan ranges of northern India, Pakistan, Bangladesh and Afghanistan (Fahey, 2005).

Moringa oleifera, commonly known as drumstick and *murungai* in Tamil is a common vegetable well utilised by most Indians, who consume many of its parts in curries and accompaniments to the main course. The high nutritious value and its varied use as food and medicine is well known, with leaves also used as forage, trunk used for manufacturing gums, flower nectar as honey and powdered seeds for water purification (Fuglie, 1999).

The leaves of *Moringa oleifera* contains high amount of micro-nutrients which improves both physiological and metabolic activities of human health. The nutritive value of drumstick leaves when compared to other food is impressive, as can be gauged by the fact that it has 7 times the Vitamin C in oranges, 10 times the vitamin A in carrots, 17 times the calcium in milk, 9 times the protein in yoghurt, 15 times the potassium in bananas and 25 times the iron in spinach (Gopalan *et al.*, 1998). The leaves also are a fair source of phytochemicals like carotenoids, tocopherols and ascorbic acid (Saini *et al.*, 2014). Further, they are rich in natural antioxidants, which help in improving the shelf-life of fatty foods due to the presence of different varieties of compounds like ascorbic acid, flavonoids, phenolics and carotenoids (Siddhuraju and Becker, 2003). Thus, the leaves could be used to improve the nutritional properties of food as well as overcome malnutrition that is common in developing countries.

The main purpose of the study was to explore possibilities of using dehydrated *moringa* leaf powder to enrich variety of instant food products which can increase its nutritional profile. The current research was undertaken with objectives of studying the properties of *Moringa oleifera* to assess the feasibility of incorporating it in new food formulations.

2. Materials and Methods

Fresh leaves were procured, thoroughly cleaned to manually remove stem, dirt and other extraneous matter to produce high quality dehydrated powder. The leaf samples were shade dried till they turned crisp with the moisture level

reduced up-to 10%. The dried leaves were ground to a homogenous mixture for particle reduction of 100$^{\mu}$ and stored in air tight container till further processing.

Fig 1: Preparation of Moringa leaf powder (MLP)

2.1 Preparation of value added products

Instant value added products such as Moringa peanut chutney powder, Moringa chutney powder, Moringa rice powder, Moringa sambar powder, Moringa plain spread and Moringa spread with seasoning were prepared by mixing the dehydrated Moringa leaf powder (MLP) with suitable combination of spice powders and salt. Other ingredients used in the value added products were procured from the local market. The recipe used for the preparation of these value added products were standardized in several trials by varying the quantities of prepared leaf powder and other ingredients in various proportions in order to yield palatable products.

Fig 2

2.2 Chemical analysis

The composition as moisture content, crude protein, crude fibre, crude fat, carbohydrate and ash of the dried leaves were analysed using standard methods of the Association of Official Analytical Chemists (AOAC, 2000). Protein was analysed using kjeldhal method (N x 6.25). The iron, potassium, phosphorous and calcium levels were analysed by using Atomic Absorption Spectrophotometer for antioxidant scavenging activity and storage stability.

2.3 Sensory Evaluation

All six instant products containing dried Moringa leaf powder as an ingredient were presented to a team of 50 semi-trained panellist between the age group of 18 to 42. The samples were rated for its colour, aroma, texture, taste and after taste. Scoring was done on the basis of 5- point hedonic scale (Excellent 5, Very good 4, Good 3, Average 2 and Poor 1).

2.4 Statistical analysis

All analyses were done in triplicate and the average values were computed with standard deviation (SD).

3. Results and Discussion

The analysis of MLP indicated that it contains higher concentration of nutrients like calcium, iron and protein etc. as given in Table 1. The abundantly available inexpensive leaves of *Moringa* are extremely nutritious but is mostly an underutilized tropical crop. *Moringa* leaves can be used in diet to improve the nutritional quality of food as well as to overcome micronutrient deficiency. Dehydration of the leaves makes it a concentrated source of nutrients, which can be used as a functional ingredient in various products.

The incorporation of MLP was found to improve the nutrient content like protein, calcium, phosphorous, potassium, iron etc., (Table 1). The proximate composition of MLP showed higher protein content (23%). The calcium and iron contents were also higher at 8616 and 659 mg/100 mg respectively. This makes *Moringa* leaves a good potential source of supplementary protein and other essential nutrients in the diet. The results are in accordance with other research studies.

Table 1: Proximate, mineral composition of Moringa leaf powder (MLP)

Parameters	Values per 100 g powder
Moisture(g)	8.04±0.01
Protein (g)	23.73±0.05
Fat (g)	8.98±0.07
Ash (g)	11.10±0.01
Carbohydrate(g)	44.54±0.03
Crude fibre (g)	4.65±0.01
Iron (mg)	659.23±0.28
Calcium (mg)	8616.14±0.04
Potassium (mg)	17.81±0.02
Phosphorous (mg)	3163.7±0.01

Subsequent to establishing the high nutritive content of MLP, various food products were formulated and the final MLP incorporated recipes were tested against the control products which did not have MLP. The MLP incorporated products like the Moringa sambar powder and the control sambar power, the Moringa chutney powder and control chutney powder were tested for its sensory and nutritional content.

The developed products had higher percentage of protein and lower fat content against the control as seen in Table **2.**

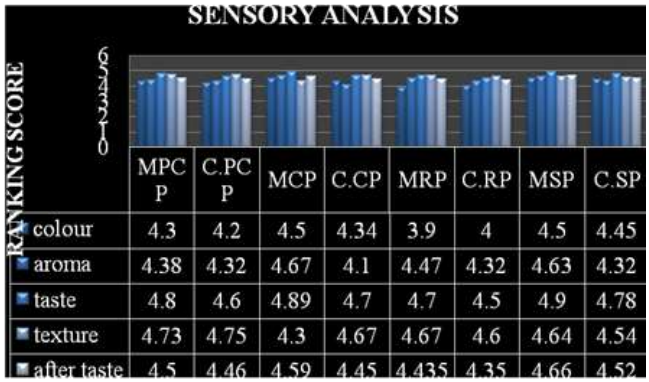
Table 2: Nutritional composition of developed valued products and control

Nutritional information	Moringa Sambar powder	Control Sambar powder	Moringa Chutney powder	Control Chutney powder
Energy (Kcal)	1076.08	438	1142.32	409
Protein (g)	36.35	15.1	50.585	17.9
Carbohydrate(g)	79.41	62.7	89.75	62.4
Fat(g)	11.68	14.1	9.478	9.8

The proximate composition of Moringa spread with and without seasoning were studied and the results tabulated in Table 3.

Table 3: Proximate composition of moringa spread and moringa spread with seasoning

Nutritional information	Moringa Spread	
	Without seasoning	With seasoning
Energy (K.Cal)	744.5	716.28
Protein (g)	37.52	33.58
Carbohydrate(g)	42.28	35.57
Fat(g)	55.51	53.84



1. MPCP – Moringa peanut chutney powder, 2. C.PCP- Control peanut chutney powder, 3. MCP – Moringa chutney powder, 4. C.CP – Control chutney powder, 5. MRP – Moringa Rice powder 6. C.RP – Control Rice powder, 7. MSP – Moringa Sambar Powder, 8. C.SP – Control sambar powder

Fig 3

Sensory analysis shows the acceptability of all the eight products including the controls in terms of colour, aroma, texture, taste and after taste in the range 3.9 to 4.8.

4. Conclusion

Though consumption of *Moringa* leaves, fruit and flowers are common in India, the use of such traditional food items has gone down which could be for many reasons including replacement of diet with new and different food including fast food, not valuing the traditional food items, not too much culinary experimentation to make dishes from *moringa* that could be attractive and which retains or even increase the nutritional value and also maybe the time spent to process the leaves for consumption.

The idea behind this research study was the creation of innovative valued added products that would be easily acceptable to the consumers. The high levels of vegetarian diet in the Indian population, which may not provide necessary protein and micronutrients, if not selected appropriately and also the high malnutrition level of both the rural and urban population drives such research, wherein an inexpensive abundantly available, highly nutritious and ethnic food like the *moringa* leaves can address gaps in the nutritional needs.

These products can be consumed by all age groups and can be eaten as accompaniment to the main course. Hence, such value added and innovative nutritious dishes can support people to eat healthy and also continue to eat traditional and local food that has not consumed large carbon footprints.

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