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Formulation of moringa flowers dessert for unique food entrepreneurship

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Abstract
Moringa flowers contain many medicinal properties. The objective of this study was to assess the potential use of Moringa flower (*M. oleifera*) as functional ingredients in instant dessert to enhance the nutritional quality, storage stability and acceptability of unique food products. Three instant dessert mixes from fresh *Moringa oleifera* flowers were standardized and then the formulated dessert was fixed for further upscaling. For initial range-finding trials, moringa flowers were added in amounts ranging from 6 g to 25 g fresh weight (FW) for every 30 g raw weight (RW) of dessert mix (i.e. one serving of each product). Final evaluations were performed on product containing 20 g FW of blanched moringa flowers for every 30 g RW of instant dessert mix in each. All trials Moringa flowers (T1:T2:T3) were done. T1 sample with moringa flowers had good sensory attribute than the pod and leaves for instant dessert product. The product provided energy (200 Kcal), protein (10 g), calcium (140 mg), Vitamin C (48 mg), iron (1.9 mg) and β-carotene (3911 µg). Results indicated that in spite of traces of nutrient losses, there is enough β-carotene and iron retained in dessert mix which will help in the eradication of several micronutrient deficiencies.

Keywords: Moringa, flower, dessert, instant food, iron rich food

Introduction
Moringa flowers contain many medicinal properties. Moringa flowers are edible, nutritious. This flower is consumed after minimal processing. Moringa flowers find their taste closer to that of mushrooms. They contain calcium & potassium. Many researchers have proved that moringa flowers helps in the increased milk production in nursing mothers. The extracts from seeds, leaves, bark and kernel of moringa flowers are generally known and proven to contain the bioactive agents, which reduce the inflammatory reactions in humans. The Moringa flower has been shown to suppress the inflammation by a process, which is different from other parts of plant. The extract of moringa flower reacts with the principal components which is produced by the outer membrane of bacteria & inhibits their ability to breach body defense. The extract of moringa, especially from the flower have a significant ability to protect liver against acute chemically-induced injuries. The extracts of flowers of *M. concanensis* (fresh or dried) contain a great amount of ascorbic acid, polyphenols, tannins and flavonoids with high scavenging activity. Standardization of nutritious and organoleptically suitable food products with market available foods is a challenge for any food scientist. However, the benefits of such food-based strategies to prevent micronutrient malnutrition are manifold. Indian diets provide mostly non-heme iron, which is very poorly absorbed. Thus it has been suggested that vegetarians may be at a greater risk of iron deficiency than non-vegetarians. Women in developing countries often consume inadequate amounts of micronutrients because of their limited intake of animal products, fruits, vegetables, and fortified foods. Intakes of micronutrients less than the recommended values increase a woman's risk of having micronutrient deficiencies. The adverse effects of deficiencies in vitamin A, iron, and folic acid, including night-blindness in pregnant and lactating women and iron-deficiency anemia, are well known. Low intakes of these and other nutrients, including zinc, calcium, riboflavin, vitamin B6, and vitamin B12, also have consequences for women's health, pregnancy outcome, and the health and nutritional status of breastfed children. Multiple deficiencies coexist, so the benefit of multiple micronutrient supplements is becoming increasingly apparent.

These issues need to be discussed, and guidance be provided on the selection of appropriate food for women of reproductive age in developing countries.

Considering the benefits of both dietary fibre and antioxidants in a moringa flowers, the objective of this study was to assess the potential use of Moringa flower (*M. oleifera*) as functional ingredients in instant desserts to enhance the nutritional quality, storage stability and acceptability of unique food products.

Methods and Materials

Fresh *Moringa oleifera* flowers were obtained from moringa trees around the Tiruppur district. Three instant dessert mixes were standardized which can be consumed frequently. Different amounts of freshly blanched moringa flowers were added in instant dessert mix was standardized. For initial range-finding trials, moringa flowers were added in amounts ranging from 6 g to 25 g fresh weight (FW) for every 30 g raw weight (RW) of dessert mix (i.e. one serving of each product). Final evaluations were performed on product containing 20 g FW of blanched moringa flowers for every 30 g RW of instant dessert mix in each.

Value addition in Moringa flowers

Moringa oleifera belonging to the monogeneric family, Moringaceae is well known for its nutritive value in flowers. It contains high protein content in the leaves, twigs, stems and seeds. They are an exceptionally good source of provitamin A, vitamins B and C, minerals (particularly Iron) and sulphur containing amino acids methionine and cysteine. It is commonly said that moringa flowers 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 of Moringa flowers rivals that of milk and eggs. However, the flowers of *M. oleifera* are known to have large amounts of their calcium bound in calcium oxalate crystals.

Moringa flowers powder

The flowers (T1:T2:T3) after harvest should be stripped off, washed, blanched and dried in solar drier (sunlight can destroy essential nutrients). The dried flowers are made into fine powder which can be stored in air-tight containers. Vitamin A retention is enhanced if the flowers are blanched before drying. As a nutritional additive, 50 gms spoonful of the powder can be added to soups or sauces. Moringa flowers powder can be stored for up to 6 months when protected from light and humidity.

Fresh moringa flowers were crushed and pounded in a mortar with a small amount of water. For larger production, hammer mill is used to pound young moringa (not more than 40 days old) together with little water (about one liter per 10 kg fresh material).Then it is filtered and diluted with water and sugar is added for taste. Alternatively, spoonful of more moringa flowers powder can be added to a litre of water. Then it is stirred together, strained and sugar is added. Juice or juice concentrate is stored in a refrigerator.

Sensory evaluation of the products

Sensory evaluation provides an index of overall acceptability which depends on its appearance, flavor, taste, texture, aftertaste, and overall acceptability based on 9 point hedonic scale. To ensure the acceptability of the modified products, they were subjected to evaluation by composite scoring for their sensory qualities. All trials Moringa flowers (T1:T2:T3) were prepared fresh and presented to a panel of 15 untrained judges. Specific sensory characteristics of each recipe (appearance, color, flavor, taste, texture and overall acceptability) were rated separately on a scale of 1 to 5. Scores were defined as 1 - dislike extremely, bad; 2 - like only slightly, tolerable; 3 - like, good; 4 - like very much, very good; 5 - like extremely, excellent. Numerical averages were then calculated for a composite test score. For the range-finding trials, all judges were served each of the 3 products developed and then the recipes were modified and improved based upon their suggestions. The final tests were conducted by incorporating 20 g of fresh moringa flowers into each serving, since this level of addition received the highest initial ratings from the judges.

Optimization of process parameters via RSM Box-Behnken design in moringa flower product

Table 1: Box-Behnken design experimental runs

	Factor 1	Factor 2	Factor 3	Response 1
Run	**A:Drying Temperature**	**B:Duration of drying**	**C:Citric acid**	**Ascorbic acid**
	°Celcius	**hours**	**%**	**µg/g**
1	75	24	0.4	44
2	75	24	0.4	44
3	75	36	0.6	49
4	85	12	0.4	26
5	65	24	0.6	30
6	85	24	0.6	31
7	65	12	0.4	27
8	75	36	0.2	28
9	85	24	0.2	25
10	75	24	0.4	45
11	75	24	0.4	44
12	75	24	0.4	46
13	65	24	0.2	22
14	85	36	0.4	31
15	65	36	0.4	29
16	75	12	0.2	31
17	75	12	0.6	30

Table 2: Summary

Source	Sequential p-value	p-value	R^2value
Linear	0.4692	0.0001	-0.0198
2FI	0.7192	< 0.0001	-0.1663
Quadratic	< 0.0001	0.0504	0.9653
Cubic	0.0504		0.9897

Quadratic equation has the best regression value hence this is a apt suitable RSM

Table 3: ANOVA for quadratic model

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1228.11	9	136.46	50.41	< 0.0001	significant
A-Dehydration	3.13	1	3.13	1.15	0.3183	
B-Duration	66.13	1	66.13	24.43	0.0017	
C-Citric acid	144.50	1	144.50	53.38	0.0002	
AB	2.25	1	2.25	0.8311	0.3923	
AC	1.0000	1	1.0000	0.3694	0.5625	
BC	121.00	1	121.00	44.70	0.0003	
A^2	598.76	1	598.76	221.18	< 0.0001	
B^2	82.44	1	82.44	30.45	0.0009	
C^2	135.60	1	135.60	50.09	0.0002	
Residual	18.95	7	2.71			
Lack of Fit	15.75	3	5.25	6.56	0.0504	not significant
Pure Error	3.20	4	0.8000			
Cor Total	1247.06	16				

Response = 44.6 + 0.625 * A + 2.875 * B + 4.25 * C + 0.75 * AB + -0.5 * AC + 5.5 * BC + -11.925 * A^2 + -4.425 * B^2 + -5.675 * C^2

Results and Discussion

Sensory Attributes of the moringa flowers dessert mix

The products which were determined to be the most acceptable in the range-finding trials utilized 20 g of freshly blanched moringa flowers per serving of the soup mix. The overall composite score for moringa flowers was highest at 2.3±0.7. This score was followed by moringa flowers at 2.2±0.4 and moringa pods at 2.0±0.6. Scores for each of the individual attributes for the three test dip soup products ranged from 2.0 to 2.3. Majority of the panel have reported to prefer composite scores to evaluate foods products. Dehydrated moringa flowers powder incorporated has been evaluated using composite scores. The methodology used to evaluate the incorporation of other green leafy vegetables, such as coriander leaves, curry leaves, tomato powder and pulses mixture into a variety of food products.

Nutritive value of the developed product

The nutritive value of the trials supplemented with moringa flowers was calculated using standard values by Recommended Dietary Allowances. The three products provided similar amounts of energy (200 Kcal), protein (10 g), calcium (140 mg), Vitamin C (48 mg), iron (1.9 mg) and β-carotene (3911 µg). When the nutritive values were compared with the common meal-planning benchmark of ⅓ RDA for non-pregnant, pregnant and lactating women, it was found that these products meet 20-24% of ⅓ RDA for energy, 28-51% of ⅓ RDA for protein, 37-112% of ⅓ RDA for calcium, 170-370% of ⅓ RDA for vitamin C, 12-15% of ⅓ RDA for iron and 316-510% of ⅓ RDA for β-carotene. Twenty grams of moringa flowers provided 3810 µg of β-carotene, which is equivalent to 663 µg retinol equivalents (RE) [1 RE = 6 µg β-carotene]. The three trials prepared from fresh moringa flowers had a β-carotene content ranging from 3966 µg to 4200 µg per serving, which is equivalent to 661-669 µg RE (Figure 2). According to the most recent consensus on bioavailability and processing losses for β-carotene, even if there are 50% losses during cooking the β-carotene content of the final recipes would be 1980 µg or 330-333 RE, which meets 82.5% of the RDA for adult women. These results have an important implication, as food-based approaches to combat vitamin A deficiency have generally considered green leafy vegetables to be poor sources of vitamin A due to low bioavailability. Hence T1 sample with moringa flowers had good sensory attribute than the pod and flowers for instant dip soup food product. The nutrient and phytochemical constituents in moringa flowers have been studied extensively in recent years. Although deficiency of iron in the diet is regarded as the most important factor in the etiology of nutritional anemia, certain human and animal studies have shown that supplementation of diets with both iron and vitamin A may increase the iron status as measured by hematological indices like hemoglobin. Beta-carotene-rich moringa flowers can thus be an important source of vitamin A, can be used for releasing the bound iron stores and can thus help in reducing anemia as well as prevalence of vitamin A deficiency in vulnerable sections of the society.

Conclusion

The nutritional and sensory qualities of dehydrated moringa flowers incorporated into instant dip soup or instant soup mixes shall be in the schemes presented by the Integrated Child Development Service. Results indicated that in spite of nutrient losses, there is enough β-carotene retained in instant dip soup to help in the eradication of several micronutrient deficiencies. The primary function of any food is to provide nutrients and its secondary functions are sensory attributes such as taste and flavor. The tertiary function is completely independent of the primary and secondary is to prevent disease and disorders at the molecular level. The recipes developed in the present study require no extra effort or modification of the usual, traditional recipes beyond simple inclusion of the moringa flowers. The present study recommends the prospect of more aggressive introduction and utilization of moringa flowers by the food sectors. It is worthwhile for industry to take up the production of moringa flowers based instant food products. It is need of the hour to promote moringa incorporation into the diet in India for a long way towards not only in alleviating micronutrient deficiencies, but also towards the development of functional foods for various chronic degenerative disorders. These efforts could also be an additional source of income generation, employment and export opportunities.

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