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RESEARCH ARTICLE

Moringa flower incorporated instant dip soups - market sustainable approach

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Abstract

India is a long way towards alleviating micronutrient deficiencies and developing functional foods for various chronic degenerative disorders. In developing countries, women's diets have inadequate micronutrients and are mostly non-heme foods. Intake of animal products, fruits, vegetables and fortified foods are recommended for micronutrient deficiencies. In the standardization of food products, food scientists and entrepreneurs face challenges in nutrition-suitable and market-value foods. However, the benefits of food-based strategies for preventing malnutrition are manifold nowadays and are focused on easily accessible, inexpensive green vegetables for micronutrient deficiencies. *Moringa oleifera* is a repository of nutrients for the creation of value-added food products. The leaves, pods, flowers and seeds of the plant are consumable and rich in various nutrients. *Moringa oleifera* is a miracle tree that has a very impressive range of medicinal and nutritional properties. In recent years phyto chemicals in *Moringa* flower have been studied extensively. In alleviating micronutrient deficiencies, it is the need of the hour to promote the *Moringa* flower as an incorporated diet. The objective of this study is to assess the potential use of *Moringa* flower in instant dip soups to enhance nutritional quality and storage stability. In this study, optimization process parameters via RSM Box-Behnken design were done and based on the same moringa dip drink was finalised. The findings of the current investigation demonstrated that the developed Moringa flower instant dip drink retains sufficient nutrients and can be utilized as a dietary supplement for various micronutrient deficits. The development of the Instant moringa dip drink has a market-sustainable approach to the generation of additional income for farmers, self-employment and export value in the food industry.

Keywords

food industry; food product; instant dip drink; micronutrient deficiencies; moringa flower

Introduction

Dietary methods emphasizing green vegetables are crucial for eliminating micronutrient deficiencies and present a challenge for food scientists in standardizing healthy and organoleptically acceptable food products available in the market. The deficiency of vitamins and minerals in food causes night blindness, iron-deficiency anemia and bone-related diseases. Women are at risk of micronutrient deficiencies due to low intakes of micronutrients in recommended values (1). This leads to deficiencies in vitamin A, iron and folic acid and has consequences in pregnancy outcomes and malnutrition in children and aged women (2). *Moringa oleifera*, native to India, is commonly known as the 'drumstick tree' and is widely cultivated across the world. *M. oleifera* tree differs in nutrient composition at different locations (3) and there is a slight difference in nutritional components of the tree grown in India to that grown in Nigeria. The nutritional differences in the leaves from two ecological locations, semi-deciduous and Savannah regions, were studied by Asante et al. (4).

Every part of *M. oleifera* is a storehouse of important phytoconstituents, with high nutritive value, suitable for nutritional and commercial purposes. *Moringa* has numerous elements vital for growth and development and it possesses a higher iron content than spinach (5). The leaves are rich in minerals calcium, potassium, zinc, magnesium, iron and copper (6), vitamins and other essential phytochemicals. *M. oleifera* leaves contain around 25.5-31.03 mg of zinc per kilogram, which meets the daily dietary need for zinc (7) and serves as a potential antioxidant, anticancer, anti-inflammatory, antidiabetic and antibacterial agent. *M.oleifera* seed, a natural coagulant, is extensively used in water treatment and flowers are an exceptionally good source of vitamins, minerals and amino acids such as methionine and cysteine (8). Bioactive substances including tannins, saponins, anthraquinones, alkaloids, terpenoids, flavonoids and phytosterols such as stigmasterol, sitosterol and campesterol, together with reducing sugars, are present in M. oleifera and are utilized to address malnutrition in children (9). Anti-cancerous agents like glucosinolates, isothiocyanates, glycoside compounds and glycerol-1-9-octadecanoate are also found in *Moringa* (10). *Moringa* leaves also have a low calorific value that can be used in the diet of obese people. The pods are fibrous, which is valuable for treating digestive problems and thwarting colon cancer (11). Research showed that immature pods contain around 46.78% fiber and around 20.66% protein content and are valuable in treating digestive problems and inhibit colon cancer (10). Pods have 30% of amino acid content, the leaves have 44% and flowers have 31%. The immature pods and flowers showed similar amounts of palmitic, linolenic, linoleic and oleic acids (12). Instant drink mixes are in the schemes presented by the Integrated Child Development Service of Tamilnadu (13) for school children of Tamilnadu.

The food industry uses the versatile portions of the *Moringa* tree to create a range of products with additional value. Significant findings were obtained in the physicochemical and functional content and storage studies of muffins containing *Moringa oleifera* powder (MOLP) at a concentration of 12% (9). Aloe vera (4%) enriched with *Moringa* (1%) resulted in a drink rich in color, flavor, taste overall acceptability (14). The addition of *M. oleifera* (MOLE) extract or oil is having a significant impact in enhancing microbial stability and improving the shelf-life of sour cream (8). Incorporating 10% Moringa leaf debris into cookies fulfills daily nutritional fiber requirements (15). Fortification of dry leaves of *M. oleifera* (2%) has a good effect in biological value (BV), true protein digestibility (TD) and net protein utilization (NPU) in Labneh cheese (16). *Moringa* leaf powder (10%) in *Moringa* idly resulted in sensory evaluation scores in the 8.0 range and higher nutritive value for supplementation (6). The addition of *M. oleifera* powder (15%) in durum wheat semolina enhanced nutritive and functional value without affecting the sensory acceptability of the pasta (17). The value addition of Lassi is increased by blending *Moringa* pod powder (1.63%), which has a high content of Vitamin C and fiber. As a natural functional additive, moringa flower extract in cooked chicken nuggets may be useful for improving quality and lowering lipid oxidation (18). One per cent *Moringa* seed flour addition enhances the nutritional and sensory qualities of mayonnaise (18,19). The scientific effort of this research provides insights into the use of *Moringa* as a cure for diabetes and cancer and the fortification of moringa in commercial products.

Moringa flower is a good source of nutraceuticals and has lots of bioactive compounds in flowers, seeds, leaves, oil and pods (20,22,28). The Flower of *Moringa* consists of essential phytocompounds, vitamins, omega oils, minerals and antioxidants. The dry *Moringa* flower contains calcium levels 17 times higher to those found in milk, vitamin C content 7 times greater than that of oranges, potassium levels 15 times higher than those in bananas, iron content 25 times higher than that in spinach, vitamin A levels 10 times greater than those in carrots, and protein content 9 times that of yogurt (7). The Moringa flower possesses medicinal properties that benefit the cardiovascular system, regulate blood glucose levels, neutralize free radicals, offer substantial anti-inflammatory support, elevate iron levels in the blood, and bolster the immune system. It is also effective in improving eyesight, mental abilities, bone strength, malnutrition and depression (21,22). *Moringa* flower provides a nutritional supplement around the world as a vegetable all over the world (23,28). Dried *Moringa* flowers are stored for many months under ambient conditions, and there is a minimum loss in nutritional value. As a food supplement, flower powder can be added to any dish to enrich the nutritional content of the products. The processing technology of *Moringa* flower powder is simple and can be easily stored. It is appropriate for many South Indian dishes, such as roti, chapati, biscuits, soup, rice and juice mixes and is significantly demanded in both national and international markets (24).

The Moringa flower belongs to the Moringaceae family and is well known for its nutritive value, and the twigs, stems and seeds contain high protein content (25,26). Lots of minerals essential for growth and development, i.e. calcium, zinc and iron, are present in *Moringa*. While leaves of *Moringa* provide 1000 mg (milk has 300-400 mg), and *Moringa* powder can offer more than 4000 mg (27). However, flowers have a large amount of calcium when compared to leaves. Moringa leaf powder has 28 mg more iron than spinach and can be used as a substitute for iron tablets for anemia treatment (28). *M. oleifera* leaves showed around 25.5-31.03 mg of zinc/kg, essential for synthesizing DNA and RNA (29). These studies would help the farmers to export *Moringa* value-added foods and youngsters to act as entrepreneurs. It is worth mentioning that *Moringa*-based soup dips are not available in the Indian market. Hence, an instant dip drink based on *Moringa* flower is developed in this study.

Materials and Methods

Fresh *Moringa oleifera* flowers were obtained from an organic moringa farm in the Tiruppur district, Tamilnadu. For initial range-finding trials, Moringa flowers were added in amounts ranging from 6 g to 25 g of fresh weight (FW) for every 30 g raw weight (RW) of the mix (i.e. one serving of each product) and three instant dip drink mixes were standardized (Fig.3b). Final evaluations were performed on product containing 20 g FW of blanched Moringa flower (MF) for every 30 g RW of instant drink mix in each. After harvest, young moringa flowers (T_1) and, mature moringa flowers (T_2), and flowers along with calyx and stalk (T_3) were stripped off, washed, blanched and dried in a solar drier. The dried flowers are made into fine powder, which can be stored in air-tight containers.

An index of overall acceptability for sensory evaluation provides appearance, flavor, taste, and texture after taste and it is based on 9-point hedonic scale. The modified products were evaluated to ensure their acceptability by composite scoring for the sensory qualities. All trials *Moringa* flowers (T1 -Immature flowers, T2- Matured flowers, T3 - Flowers along with calyx and stalk and T4- Flowers along with calyx and stalk grinded) were prepared fresh and presented to a panel of 15 trained judges. The characteristics of each formula, i.e., 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. Each of the 3 products developed was served to all sensory analysts who were the judges and then the recipes were modified and improved. Based upon their suggestions, final tests were conducted by incorporating 20 g of fresh Moringa flower into each serving since this addition level received the highest initial ratings from the judges.

Results and Discussion

The sensory characteristics of the Moringa flower dip drink from the range-finding trials indicated that the most acceptable formulation contained 20 mg of freshly blanched Moringa flowers or flower powder per serving of the soup mix. Evaluation of the nutritional and sensory qualities is done in the *M. oleifera* flower dips. The overall composite score for T2 was highest (Table 1) and this score was followed by T1 powder at 3.3 ± 0.2 and T3 at 3.1 ± 0.5. Scores for the three tested dip drink products from each of the individual attributes ranged from 3.2 to 3.4 (Table 2). Most of the panel preferred composite scores to evaluate the food products and dehydrated MF powder incorporated has been evaluated using composite scores (Table 3).

The nutritive value of the developed product was assessed for nutrients and sensory attributes such as taste and flavor. The nutritive values of trials supplemented with MF were calculated using RDA and the three products provided the same amounts of nutrients. Results indicated that despite nutrient losses, there is enough β-carotene retained in instant dip drinks to help eradicate several micronutrient deficiencies (30). When compared to RDA, the nutritional values for non-pregnant, pregnant and lactating women, it was recorded that the products studied had vitamin C-170-370% of ⅓ RDA, iron-12-15 % of ⅓ RDA and β-carotene-316-510% of ⅓ RDA. Twenty grams of Moringa flower provided 3810 µg of β-carotene, which is equal to 663 µg retinol equivalents (RE) (1 RE = 6 µg β-carotene) (Table 4). The three trials of fresh Moringa flower preparation had a β-carotene content from 3966 µg to 4200 µg per serving, which is equivalent to 661-669 µg RE (Fig.2). There may be 50% losses of the β-carotene content during cooking. According to the most recent studies on processing losses for β -carotene, even if the final recipes have 1980 µg or 330-333 RE, it meets 82.5% of RDA to adult women. To combat vitamin A deficiency, food-based approaches are generally considered for improving bioavailability (31). These results have an important implication that T1 (MF) had good sensory attributes compared to others for making the instant dip drink food product (Fig. 1, 2, 3a, 3b, 3c). Nutrients in food should prevent disease and disorders at the molecular level of the body. The deficiency of iron in the diet is considered the most important factor in nutritional anemia.

Several studies showed that *Moringa*-based food is used to treat malnutrition problems. However, due to its slightly bitter taste, children refuse to take in moringa (32). Similarly, *Moringa* incorporation in food increases the delicacy's nutrient value and has shown the potential for developing protein and minerals-rich chocolate (33). Moringa fortifications are possible to ensure intake of adequate nutrients in children and the *Moringa* flowers are used to make tea with low cholesterol properties. Moringa flowers are said to taste like mushrooms when fried (34) and the moringa flowers are great sources of nectar and are used by beekeepers. The root bark of Moringa has medicinal values and is used for dyspepsia, eye diseases and heart complaints (35). The taproot of *Moringa* is used as a spice, and the gum from the tree can be used in calico printing. The gum and roots also have antibacterial, antifungal and anti-inflammatory properties (36). Zeatin derived from leaves is an exceptional growth promoter that can enhance crop output by 25%-30% (12). Incorporation and fortification of moringa can significantly tackle nutrient deficiencies and malnutrition. Owusu et al. (37) also used *Moringa* as a fortificant and produced cream and butter crackers with moringa and *Ipomoea batatas* as fortificants, with the hope of adding additional nutrients to snacks. The sensory evaluation proved the cream crackers to be widely accepted. *M. oleifera* leaves can be incorporated into the diet of hens and layers, thereby providing an excellent protein source, substituting other expensive ingredients such as soybean meal and ground nut cake (38,39). Cereal gruels have also been fortified with moringa leaves to improve the protein content and energy. The cereal gruel with 65% popcorn and 35% moringa leaves is blanched and fermented and showed higher protein content.

Antioxidants in Moringa can reduce the reactive oxygen species, thereby protecting the brain (40,41). As a promoter of spatial memory, it is used to treat dementia (39) and is also useful to increase protein content and decrease urea and creatinine in blood to prevent renal dysfunction. Moringa decreased acidity in gastric ulcers that can be used as an antiulcer agent (42) *M. oleifera* has been proven as a good antimicrobial agent (43) to act against bacteria like *Bacillus*

Table 1: Experimental runs of Box-Behnken design

	F1	F2	F3	R1
RUN	A	B	C	A1
	ºCelcius	hours	%	µg/g
1	70	22	0.3	42
2	70	22	0.2	42
3	70	34	0.6	49
4	80	12	0.3	24
5	60	22	0.4	28
6	80	22	0.4	30
7	60	10	0.4	27
8	70	36	0.2	28
9	80	24	0.2	25
10	70	24	0.4	45
11	70	24	0.4	44
12	70	24	0.4	46
13	60	24	0.2	22
14	80	36	0.4	31
15	60	36	0.4	29
16	70	12	0.2	31
17	70	12	0.6	30

F1-Factor 1, F2-Factor 2, F3-Factor 3, R1-Response -1

A: Drying Temperature, B-Duration of drying, C-Citric acid, A1-Ascorbic acid

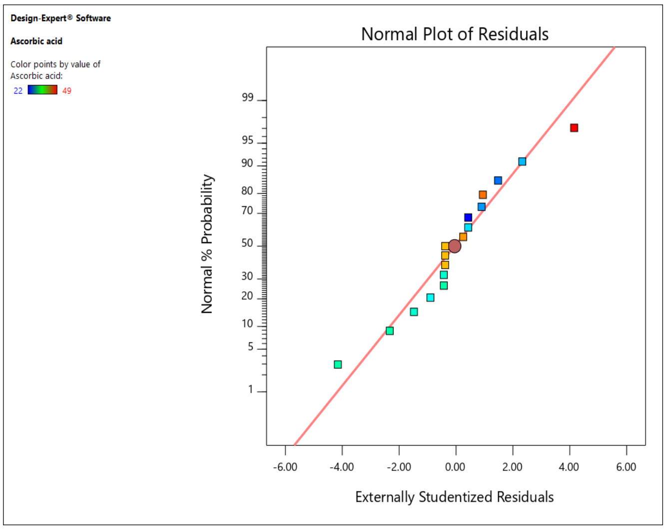

Fig. 1. Normal plot.

Table 2: ANOVA for quadratic model

	SUM OF SQUARES	DF	MEAN SQUARE	F	P	
MODEL	1228.11	9	136.46	50.41	< 0.0001	significant
A-DRYING TEMPERATURE	3.13	1	3.13	1.15	0.3183	
B-DURATION OF DRYING	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	
R	18.95	7	2.71			
LF	15.75	3	5.25	6.56	0.0504	not significant
PE	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

R-residual, L-lack of fit, PE-pure error, L-lack of fit

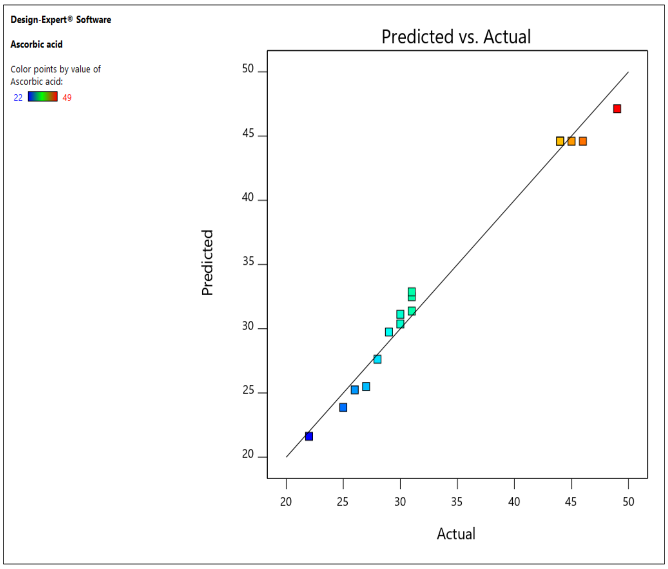

Fig. 2. Predicted vs. actual result.

Table 3: optimised process conditions

F	NAME	LEVEL
A	DT	65
B	D	28
C	C	0.55

For 43.58µg/g of ascorbic acid retention, the optimized process parameters are 0.55% of citric acid, 28 hours of drying at 65º C.

F- factor, DT-Drying Temperature; D-Duration of drying; C-Citric acid

Table 4: The nutritive values in developed products

Nutrients	Value
Energy	150 Kcal
Protein	6-10 g
Calcium	114-141 mg
Iron	1.5-1.9 mg
β-carotene	3888-3911 µg
Ascorbic acid	42-48 mg

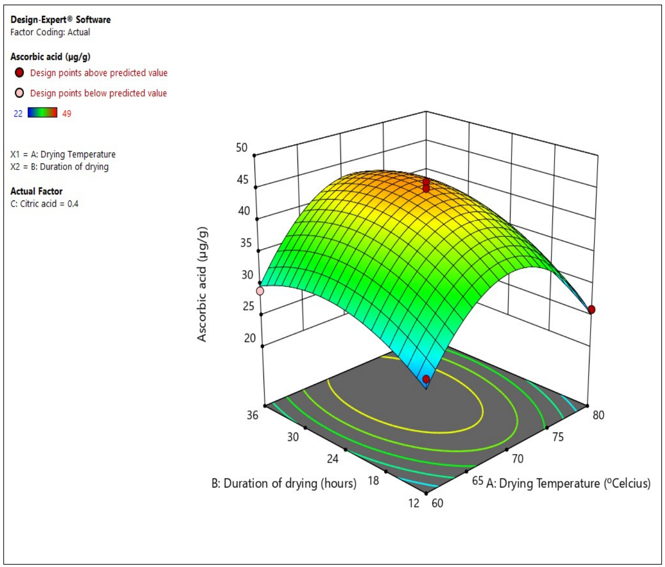

Fig. 3a. Comparison of the impact of drying temperature and duration of drying on ascorbic acid retention.

Fig. 3b. Instant dip from *M. oleifera* flowers.

subtilis, Staphylococcus aureus and Vibrio cholera. Compounds such as pterygospermin, moringine and benzyl isothiocyanate present in *M. oleifera* are responsible for the anti-bacterial activity. Beta-carotene-rich Moringa flower can be an important source of vitamin A that is used to release bound iron stores for reducing deficiency of anemia and vitamin A diseases. Hence, diet supplementation with *M. oleifera* increases iron and vitamin A content in blood. In the p44resent study, it is also worth mentioning that the developed dip drink is fully organic, does not have chemicals, and requires no extra effort to make the usual recipes. It reveals that the inclusion of the Moringa flower in dips leads to the development of natural nutritional recipes in modern foods. The inclusion of *Moringa* flower foods would help the development of good entrepreneurship and provide an additional source of income.

Conclusion

In this study, instant dip soups from *M. oleifera* flowers are standardized, and the formulated dip is fixed for further upscaling. Out of three dips standardized, 20mg/100ml of dip soups have more nutrients compared to other dips and it reveals that the processing technology of Moringa flower is simple and it has great demand in national and international markets. Moringa flower based instant dips may be combined with other herbals to enhance nutrients and to produce mixed instant dips for foreign exports.

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Authors' contributions

GGK has carried out the research work, MC drafted the manuscript for publication, MV participated in the study's design and SRP performed the statistical analysis. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues : None

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