Innovations

Nutritional Analysis and Sensory Evaluation of Wheat Based Snack Bar Enriched with Moringa Oleifera Leaf Flour

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Abstract

The study aims to assess the sensual, textural, and nutritional quality of Moringa Energy Bar to improve health promotion among the adolescent population. Moringa, which is gaining a neutraceutical perspective out of various pieces of research, is incorporated into food product development. Moringa leaves from the "Miracle Tree, "a habitat of origin from South Asia, are enriched with macro and micronutrients that combats both malnutrition and Hidden Hunger (Micronutrient Deficiency). The phytochemical properties like anti-diabetic, anticancer, antiulcer, antimicrobial, and antioxidant nature of Moringa leaves make it a superfood. Moringa Leaves were processed using the conventional method to obtain unsieved coarse Moringa Leaf Flour. Moringa Energy Bars are prepared using 50%, 70%and 80% concentrations. Organoleptic evaluation of M_3, M_2, and M_1 by 24 semi-trained personnel identified M3 with 50% concentration to be more acceptable. The Nutritionally analyzed M3 Moringa Energy Bar contained (12.1g) Fibre (9.8g), Iron (10.1g), Magnesium (112mg), Calcium (345mg), Zinc (19.4mg), and a good source of energy (447Kcal) as well. The Nutritionally analyzed M_3 Moringa Energy Bar contained (12.1g) Fibre (9.8g), Iron (10.1g), Magnesium (112mg), Calcium (345mg), Zinc (19.4mg), and a good source of energy (447Kcal) as well. Moringa as a nutraceutical agent, in addition to average dietary value utilized in nutritional snack bar development, aids in health promotion and disease prevention among adolescents with unhealthy food habits like junking. The Moringa energy bar supplies the recommended dietary allowance of micro and macronutrients and contains antioxidants like flavonoids.

Keywords: *Moringa, Adolescent health, Micronutrient, Iron deficiency*

1. Introduction

The sustainable development goals of the 2030 agenda set worldwide call for sustainability in every human action, individually and collectively, as a living community of our planet earth. In recent years[i], Moringa has gained popularity as a superfood in the western world and has been a common vegetable for centuries in Indian households. Moringa Tree is fast-growing, deciduous resistant to draughts, and requires less agricultural care. Belonging to the family of Moringacea, 13 species of Moringa are the habitat of Africa, Asia, islands in the Pacific and the Caribbean, and South America. And three species, namely M.Peregrina, M.Stenopetala, and M.Olifera, are cultivated widely in India, the Philippines, and Pakistan. The "never die tree, "as it is termed due to its drought-resistant quality, is also known by other names such as "Horse Radish Tree, Drumstick Tree, Mothers friendly tree, "and "Ben oil tree. " Some research studies claim that the moringa tree grown in different geographical locations differs in its nutritional composition. These differences may be attributed to soil characteristics, climate, and environmental factors. Moringa grown in Savannah are less nutritious than those in deciduous regions. Moringa Tree is often known as the " Miracle Tree "because the plant parts like leaves, flowers, seeds, roots, and barks have more nutritional and health benefits (Patil et al., 2022). Moringa as a diet has both nutritional and pharmaceutical values. These foods are termed a nutraceutical, a term coined by Stephen DeFelice in 1989, since these foods are helpful in health promotion and disease prevention. Almost all parts of the Moringa Tree have been used in preparing indigenous medicinal preparations for various ailments2. Moringa root with quercitin is hepatoprotective and antispasmodic. The seeds possess anti-cancerous properties. The moringa pods are enriched with vitamin A that treat and prevents night blindness. However, most of the supply of micro and macronutrients and phytochemicals with anti-cancerous, antimicrobial, antioxidant, anti-diabetic, and growth-promoting factors are in Moringa leaves with an additional feature that its safe among all other parts of the plant. The Moringa leaves are low caloric, high protein low cost green leafy vegetable. used in southern part of India. Moringa as a diet has both nutritional and pharmaceutical values. These foods are termed nutraceuticals, a term coined by Stephen DeFelice in 1989, since these foods are helpful in health promotion and disease prevention.

1.1.1 Benefits of Moringa Leaves:

The utilization of Moringa leaves in developing food products and its research in recent years is advancing. Some food products produced with dried moringa leaves include cookies, jam, energy drinks, etc. These food products can be used as healthy snacks for people of all ages. Children and teens prefer snacking, and their poor food habits make them prone to unhealthy snacking. The adolescent

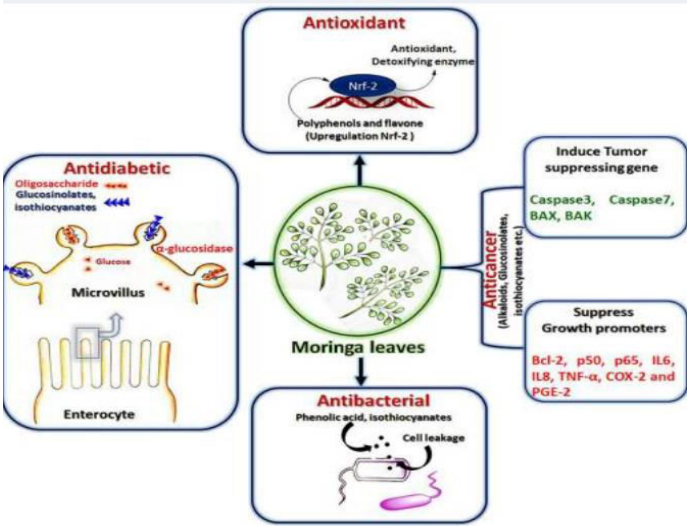
population needs to grow into healthier adults and make their adolescence active with a good supply of macro and micronutrients.(Sivagurunathan, 2015). Healthy snacks are prepared from vegetables and fruit sources with cereals and legumes. The unhealthy snacks contain most of the "added sugar "and excess salt for more extended storage. Also, it has fewer protein and micronutrients than healthy snacks as per the WHO guidelines on marketing foods and nonalcoholic beverages for children. Moringa leaves, being a sustainable source of energy when incorporated into producing a snack bar, may be an ideal source of rich nutrients for adolescent health promotion and disease prevention. This study aims to develop Moringa Energy Bar and evaluate the Bar's sensory attributes that will suit the adolescents snacking preferences.

Table 1: Nutritive Value of Moringa Leaves Dry Versus Fresh

Mineral & Vitamin Contents	**Fresh leaves**	**Leaf powder**	**Vitamin & Amino acids Contents**	**Fresh leaves**	**Leaf powder**
Fiber (g)	0.9	19.2	Methionine (g/16g N)	2	0.35%
Minerals (g)	2.3	nil	Threonine (g/16g N)	4.9	1.19%
Ca (mg)	440	2003	Leucine (g/16 g N)	9.3	1.95%
Mg (mg)	24	365	Isoleucine (g/16g N)	6.3	0.83%
P (mg)	70	204	Valine (g/16 g N)	7.1	1.06%
K (mg)	259	1324	Arginine (g/16 g N)	6	1.33%
Cu (mg)	1.1	0.6	Histidine (g/16g N)	2.1	0.61%
Fe (mg)	0.7	28,2	Lysine (g/16g N)	4.3	1.32%
S (mg)	137	870	Tryptophan (g/16g N)	1.9	0.43%
Oxalic acid (mg)	101	1.60%	Phenylalanine (g/16g N)	6.4	1.39%
Vitamin A - β carotene (mg)	6.8	16.3	Vitamin B2 - riboflavin (mg)	0.05	20.5
Vitamin B -choline (mg)	423	nil	Vitamin B3 - nicotinic acid (mg)	0.8	8.2
Vitamin B1 - thiamine (mg)	0.21	2.64	Vitamin C -ascorbic acid (mg)	220	17.3

Source: Moringa oleifera: Natural nutrition for the tropics by Fuglie (1999)..,("Study on Moringa Tree (Moringa Oleifera Lam.) Leaf Extract in Organic Vegetable Production," 2020)

Figure 1: Phytochemical Properties of Moringa Leaves



Source: Pharmacological activities of Moringa with the mechanism of action(Patil et al., 2022)

2.1.1 Materials and Methods

Moringa Leaves were procured from a local farm at Ayapakkam. The wheat flour is prepared by washing and drying whole wheat in sunlight and grinding it in mil. Sesame seeds, granulated sugar, and ground nut were all purchased from the local market. The sesame seeds, ground nuts, and wheat flour are roasted dry on low flame for a few minutes before changing color and until crispy. After removing the skin, the scorched ground nut is crushed, and the sesame seeds are added whole.

2.1.2 Processing of Moringa Leaves

Moringa leaves were destalked, and leaf petals were carefully removed by hand, washed, and placed on a tray for drying not directly under sunlight but in the shade under 30-40 degree Celsius for three days. The leaves were turned several times during drying. After 5 days of complete drying, the leaves were milled using a conventional mixer grinder. The un-sieved flour is stored in a container as Moringa Leaf Powder.

2.1.2 Preparation of Energy Bar

The ingredients are weighed well in advance of the preparation. The roasted whole wheat flour, skinned roasted and crushed ground nut, roasted

sesame seeds, and moringa leaf powder are mixed thoroughly to get a uniform flour. Meanwhile, the sugar is melted with water, and butter added to it is cooked until the sugar syrup makes a ball consistency upon dripping on cold water. In this stage, the sugar syrup is mixed thoroughly with prepared uniform flour and spread on a tray greased with butter. While the mixture is still warm, the bars are cut and set to room temperature. Three blends of Moringa flour were used, namely 80%, (M_1) 60%, (M_2) and 50% ,(M_3)in preparing the Bar. The bars were later stored in an airtight container.

Weighing the ingredients

Dry Roasting the Ground Nut, Sesame Seeds, Wheat Flour

Melting butter and sugar on a pan

Wheat flour, crushed ground nuts, sesame seeds and Moringa flour added to caramelized sugar

Stirred on low flame for a few seconds

Cut into bars while still hot.

The mixture is spread on a tray greased with butter and left to cool.

Ready to Eat storage-friendly, nutrient-rich Moringa Energy Bar

Table 2: **Recipe - Moringa Energy Bar – Standardisation**

Ingredients	**The ratio in Grams %**			
	Standard	50:50 M_3	70:30 M_2	80-:20 M_1
Wheat Flour	50	25	15	10
Moringa flour	Nil	25	35	40
Sesame Seeds	10	10	10	10

Ground Nut	10	10	10	10
Sugar	25	25	25	25
Butter	5	5	5	5
Total	100	100	100	100

2.2.1 Sensory Evaluation

24 panelists were selected for sensory evaluation of the Moringa Energy Bar. The panelists were teaching and non-teaching working personnel from SRM College of Nursing who were oriented to testing terminologies before the sensory evaluation and about using a 7-point hedonic scale. The hedonic Scale was equivalent to "Like extremely" as 7 to "Dislike extremely" as 1, as described by Ihekoronye and Ngoddy (1985). The samples were well packed with aluminum foils and were coded with alphabets "A, B, C." Samples were provided for analysis at the ease of the panelist. After tasting, water was given to rinse the mouth before tasting the next sample. Necessary precautions are taken to avoid bias. The sensory evaluation data were analyzed using one-way ANOVA.

2.2.2 Nutrient evaluation

Nutrient testing was done at the Chennai testing lab. The details of techniques used for micro and macronutrients can be inferred from given Table .3

Table 3: Micro and Macro Nutrients of Moringa Energy Bar

S.No.	**Parameters**	**Method**	**Units**	**Results**
1	Energy	FAO method	Kcal/100g	445
2	Carbohydrates	CTL/SOP/FOOD 262-2014	g/100g	62.0
3	Total Fat	AOAC20th Edn. 2016,920.39	g/100g	16.5
4	Protein	AOAC20th Edn. 2016,986.25	g/100g	12.1
5	Dietary Fibre	AOAC20th Edn. 2016, 986.29	g/100g	9.18
6	Calcium	IS5959: 1990 (RA2003)	mg/100 g	345

7	Magnesium		mg/`100g	112
8	Iron	AOAC20th Edn. 2016, 999.11	mg/100g	10.1
9	Moisture	IS12711:1989	g/100g	7.0
10	Total Ash		g/100g	2.37
11	Zinc	AOAC20th Edn. 2016, 999.11	mg/100g	19.2

3 Results and Discussion

Three samples, M1, M2, and M3, enriched with Moringa Leaf Powder, were evaluated for sensory properties. Statistical analysis (Table 5) shows that the p-value is less than 0.01 and is significant at a 1% level. It is inferred that there is a highly significant difference between the overall mean sensory scores of all three samples, M1, M2, and M3. The Games-Howell, multiple comparison tests show a considerable difference between each pair of three samples. M3, with a high mean score, indicates higher sensory attributes than the other two samples. (Table 6).

Table 5 : Comparison between the overall mean sensory scores of three samples (One way ANOVA)

S. No.	Sample	N	Mean	SD	F Value	P value
1	M_1	24	21.1	6.573	18.421	0.000**
2	M_2	24	27.3	5.677		
3	M_3	24	31.5	5.657		

** - Significant at 1% level

Table 6 Games – Howell multiple comparison test

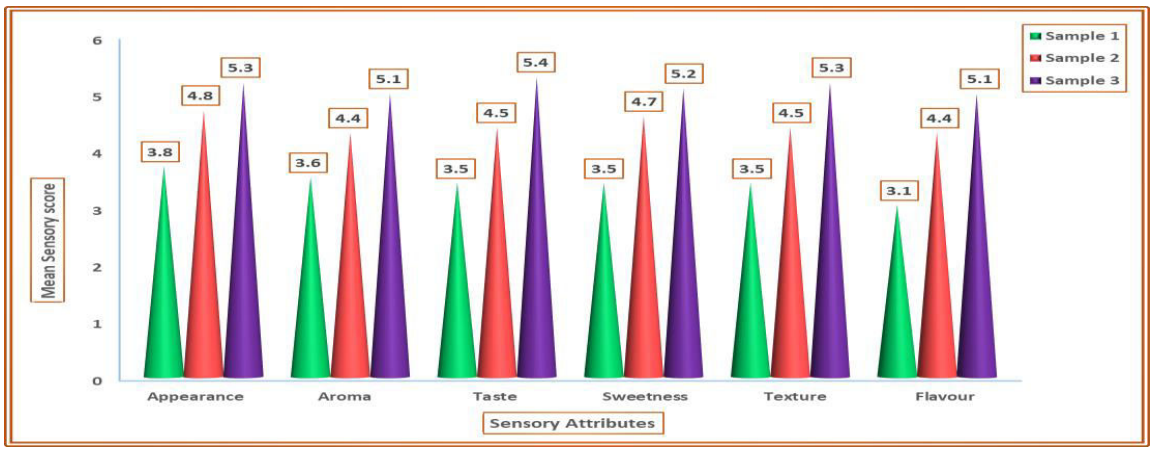
S. No.	Sample (I)	Sample (J)	Mean difference (I - J)	SE	P value
1	M_1	M_2	-6.250	1.773	0.003**
		M_3	-10.417	1.770	0.000**

2	M_2	M_1	6.250	1.773	0.003**
		M_3	-4.167	1.636	0.037*
3	M_3	M_1	10.417	1.770	0.000**
		M_2	4.167	1.636	0.037*

** - Significant at 1% level * - Significant at 5% level

Table 7 Mean score of sensory attributes

S. No.	Category	Mean Sensory attributes		
		M_1	M_2	M_3
1	Appearance	3.8	4.8	5.3
2	Aroma	3.6	4.4	5.1
3	Taste	3.5	4.5	5.4
4	Sweetness	3.5	4.7	5.2
5	Texture	3.5	4.5	5.3
6	Flavor	3.1	4.4	5.1



4. Conclusion

The results from the study conclude that the acceptability of the Moring Energy Bar depended on the ratio of the Moringa Leaf Powder to Wheat Flour. The lower the percentage of Moringa leaf powder, the higher the acceptability. The nutrient evaluation identifies that the moringa energy bars can be a better replacement as a healthy snack for adolescents combating their micro and macronutrient deficiency facilitating their health promotion and illness prevention..

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