



## NUTRITIONAL AND ORGANOLEPTIC EVALUATION OF BAKERY PRODUCTS FORTIFIED WITH DRIED *MORINGA OLEIFERA* LEAF POWDER

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In the current scenario, both consumers and food industry are in dilemma to meet the challenges in establishing a balance between taste and health. Various food experts give strong emphasis on a diet based on green leafy vegetables and advocate such a product strategy that supports inexpensive and accessible diet suiting to masses. Still, it is unfortunate for mankind that, yet we are not utilizing some of the nutritious rich green leafy vegetables, maybe due to our taste and preference. The purpose of the present study was to standardize and organoleptically evaluate dried leaves of the drumstick tree (*Moringa oleifera*) incorporated into two commonly consumed bakery products in India Biscuits and Rusk. In 100 gm serving of each of these recipes, 2 and 4 per cent dried *Moringa oleifera* leaf powder was incorporated. Both fortified products were found to be acceptable by the panel of 70 judges on a 9 point hedonic rating scale score ranging from liked moderately to liked extremely (on a scale of 1 to 9). The drumstick leaf recipes were rich in macro and micro nutrients, and 100 gm of biscuits could provide 1191.73kcal energy, 126.2 gm carbohydrate, 13.02 gm protein, 54.16 gm fat, and 3.02 gm fiber and 100 gm serving of rusk could provide 830.47 kcal energy, 113.87gm carbohydrate, 20.82gm protein, 30.94gm fat, and 3.04gm fiber. The recipes were also micronutrient rich 21.41-25.84 µg β-carotene, 0.2 mg ascorbic acid, 194.14- 392.14mg calcium, and 3.03-3.25 mg iron. The fortified products cost only Rs. 21.63 and Rs. 31.28/ 100 gm respectively. The analysis based on the above facts also suggests that industrial production of foods which is ready to eat incorporating drumstick leaves prove to be a great endeavor.

**Key words:** Dried *Moringa oleifera* Leaf Powder (DMOLP), Fortification Organoleptic evaluation.

### Introduction

The development of nutritious and organoleptically acceptable recipes with locally available foods is a challenge for food scientist. However, the benefits of such food-based strategies to prevent micronutrient malnutrition are manifold. They: (a) are preventive, (b) are cost-effective, (c) are sustainable, (d) are income-generating, (e) is culturally acceptable and feasible to implement, (f) promote self-reliance and community

participation, and (g) foster the development of environmentally sound food production systems<sup>1</sup>*Moringaoleifera Lam.*, from the Moringaceae family is of importance to the food and medical industries and is widely grown in tropics and sub-tropics. Its root, bark, pods, leaves are used in traditional medicine for the treatment of human diseases whereas pods and young leaves are used as vegetables<sup>2</sup>. The leaves are highly nutritious, being a significant source of β-

carotene, Vitamin A, C, protein, iron, calcium, and potassium. The leaves are cooked and used like spinach. Gram for gram, *Moringa* leaves contains seven times the vitamin C found in oranges, four times the calcium and two times the protein found in milk, four times the vitamin A found in carrots, and three times the potassium found in bananas<sup>3</sup>.

In many parts of the world including Africa, the use of *M. oleifera* as a food fortificant is on the increase. For instance, both fresh and dried *Moringa* leaves are included in meals in African countries such as Ghana, Nigeria, Ethiopia, East Africa, and Malawi<sup>4</sup>. Many studies have shown the potential use of different parts of *M. oleifera* in food applications such as in making soups<sup>5</sup>, weaning foods<sup>6</sup>, amala, a stiff dough made from yam and plantain flour<sup>7</sup>, herbal biscuits<sup>8</sup>, bread<sup>9</sup>, cake<sup>10</sup> and yogurt<sup>11</sup>. The use of this nutrient-rich plant in fortifying foods is getting much attention.

According to Claughton and Pearce<sup>12</sup>, baked snacks such as biscuits are widely consumed in many parts of the world. They are used for feeding and nutrition improvement programs especially among low-income groups<sup>13</sup>. Most bakery products can easily be enriched and fortified to meet the specific needs of the target groups and vulnerable sections of the population who are undernourished. Bakery products can also be formulated in such a way to meet the specific therapeutic needs of consumers. Thus, biscuits and rusks can be regarded as food vehicles for carrying desired nutrients to the target individuals.

The present study aims to fortify two bakery products with the inclusion of dried *Moringa oleifera* leaf powder and to organoleptically evaluate those recipes using a test panel composed of randomly selected college students.

#### **Material and Methods**

The fresh leaves of drumstick were collected from trees around the city and were meticulously sorted, thoroughly

rinsed with clean water, and dried in shade for 2-4 days on muslin cloth. After leaves are dried under aseptic conditions, the leaves are finely ground, sieved, and kept in a dry airtight container for further use in the development of food products. During the present study, baked products biscuits, and rusks which are consumed in day-to-day life by the majority of people were developed with the addition of dried *M. oleifera* leaf powder in concentrations of 2 and 4 percent.

#### **Standardization of Recipes:**

Standardization of recipes was done by repeated trial method, using the same procedure to prepare the products each time. Adjustment of the quantity of dried *Moringa oleifera* leaf powder was done to obtain the maximum acceptable taste.

#### **Method of preparation of Biscuit:**

Refined wheat flour and baking powder mixed and sieved thrice. DMOLP required in biscuit variety (B and C) was also sieved along with the above mixture. Hydrogenated fat and sugar were mixed together and creamed till well light creamy texture is obtained. And little milk at a time was added to the creamed mixture to improve the consistency. The flour mixture was mixed well with the creamed mixture and vanilla essence was also added at the same time. Milk was added to prepare the dough. The dough was rolled into one-fourth inch thickness. Cumin seeds were sprinkled on the rolled surface. The biscuits were cut using a biscuit cutter and on a baking tray. The biscuits were baked at 175 ° C for approximately 10 minutes till the golden brown color appears. Biscuits are cooled and served.

#### **Method of preparation of Rusk:**

Combine the yeast, sugar, and 2 tbsp of warm water in a bowl and mix well. Cover it with a lid and keep it aside for 10 minutes. Combine all the remaining ingredients in a deep bowl along with the yeast-sugar mixture and knead into soft dough using enough water. Dried *Moringa oleifera* leaf powder was also added to the

dry mixture at this stage. Cover it with a damp muslin cloth and keep it aside in a warm place for 1 hour. Knead the dough again and put the dough into a greased rectangular aluminum tin and press well. Bake in a pre-heated oven at 180 °C for 30 minutes. Cool it completely and cut into vertical halves and then cut it horizontally. Place all the slices in a baking tray and bake them in a pre-heated oven at 180 °C for 30 minutes, while turning it once in 15 minutes. Cool the rusks completely and serve them

**Sensory evaluation of products:**

Sensory evaluation provides an index of the overall acceptability of foodstuffs, which depends on its appearance, flavor, taste, texture, aftertaste, and overall acceptability. To ensure the acceptability of the modified recipes, they were subjected to evaluation by 9 points Hedonic scale for their sensory qualities. All recipes were prepared fresh and presented to a panel of 70 untrained college students

Specific sensory characteristics of each recipe (color, appearance, texture, odor and taste) were rated separately on a scale of 1 to 9. Scores were defined as follows: 1 - disliked extremely, 2 –disliked very much, 3 –disliked moderately, 4 – disliked slightly, 5 – neither liked nor, 6- liked slightly, 7- disliked moderately, 8- disliked very much, 9- liked extremely. Overall acceptability was calculated as a cumulative of all five properties and then divided by 9.

**Nutritive Value and Cost of DMOLP added Products:**

The products developed were analyzed for the proximate compositions using the Indian Food Composition Table, 2017<sup>14</sup> and the cost of products was also calculated.

**Statistical analysis:**

Sensory evaluation was analyzed using SPSS software. An ANOVA was used in order to calculate the mean, standard deviation and to test the overall significance.

## **Results and Discussion:**

Hedonic mean acceptability scores of the biscuits (Table 1, Figure 1) revealed that biscuits were well accepted by the panel members as the mean scores for overall acceptability of the standard biscuits and biscuits developed from two different concentrations of DMOLP ranged from 7.01±1.44 to 8.26±.80, thus fall between the category of liked moderately to liked extremely. The standard biscuits were liked most with a mean score of 8.26±.80 falling in the category of liked very much to liked extremely, followed by biscuits with 2 percent DMOLP with a score of 7.34±1.24 falling in the category of liked moderately to liked very much and 4 percent biscuits with a mean score of 7.01±1.44 falling in the category of liked moderately.

Discussing the various attributes of organoleptic evaluation separately, it was noted that standard biscuits scored maximum in all the attributes color (8.35±.88), appearance (8.22 ±1.10), taste (8.22±1.02), odor (8.18 ±1.02), and texture (8.14±1.12) falling in the range of liked very much to liked extremely.

Biscuits with 2 percent DMOLP scored highest in appearance (7.62 ± 1.29) followed by texture (7.51±1.33), color (7.30±1.36), odor (7.20 ±,1.48) and taste (7.18±1.69) falling the in the category of liked moderately to liked very much. Whereas biscuits 4 per cent DMOLP scored highest in texture (7.40±1.44) followed by appearance (7.25±1.43), color(7.11±1.46), odor (6.87±1.76), and least in taste i.e. (6.64±2.01) falling in the category liked slightly to liked moderately.

The results of the organoleptic evaluation of rusks (Table 2, Figure 2 ) showed that same as biscuits standard rusks had the highest mean overall acceptability score (8.24±.94) and were liked extremely. Next was rusk with 2 percent DMOLP (7.05±1.61) and was liked very much and rusk with 4 percent DMOLP scored 6.67±1.88 and was liked moderately.

The scores of individual sensory attributes revealed that standard rusk was liked extremely by panel members and scored

highest for all sensory attributes ranging from 8.12±1.2 to 8.37 ±.90 whereas rusk 2 percent DMOLP scored between

Food Products	Sensory Attributes											
	Color		Appearance		Odor		Texture		Taste		Overall Acceptability	
	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD
Biscuit (Standard)	5.00-9.00	8.35 ±.88	3.00-9.00	8.22 ± 1.10	5.00 - 9.00	8.18±1.02	5.00-9.00	8.14 ±1.12	2.00-9.00	8.22 ±1.02	5.80-9.00	8.26 ±.80
Biscuit (2%DMOLP)	3.00-9.00	7.30 ±1.36	3.00-9.00	7.62 ± 1.29	3.00-9.00	7.20 ± 1.48	3.00-9.00	7.51 ±1.33	5.00-9.00	7.18 ±1.69	4.00-9.00	7.34 ±1.24
Biscuit (4%DMOLP)	3.00-9.00	7.11 ±1.46	4.00-9.00	7.25 ± 1.43	1.00-9.00	6.87 ± 1.76	2.00-9.00	7.40 ±1.44	2.00-9.00	6.64 ±2.01	2.80-9.00	7.01 ±1.44

**Table 1** Mean Scores for Organoleptic characteristics of Biscuits developed with different concentrations of dried *Moringa oleifera* leaf powder

Food Product	Sensory Attributes											
	Color		Appearance		Odor		Texture		Taste		Overall Acceptability	
	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD	Range	Mean ±SD
Rusk (Standard)	6.00-9.00	8.37 ±.90	6.00-9.00	8.32 ±.97	5.00-9.00	8.14 ±1.15	4.00-9.00	8.12 ±1.2	4.00-9.00	8.30 ±1.10	5.20-9.00	8.24 ±.94
Rusk (2 %DMOLP)	1.00-9.00	7.11 ±1.76	1.00-9.00	7.32 ±1.70	1.00-9.00	6.91 ±1.71	1.00-9.00	7.08 ±1.76	1.00-9.00	6.74 ±1.87	1.00-9.00	7.05 ±1.61
Rusk (4% DMOLP)	1.00-9.00	6.68 ±1.98	1.00-9.00	6.85 ±1.92	1.00-9.00	6.72 ±1.97	1.00-9.00	6.85 ±1.95	1.00-9.00	6.04 ±2.17	1.00-9.00	6.67 ±1.88

**Table 2** Mean Scores for Organoleptic characteristics of Rusks developed with different concentrations of dried *Moringa oleifera* leaf powder

6.74±1.87 to 7.32±1.70 for various sensory characteristics, falling in the category of liked moderately to liked very much. And the rusk 4 percent DMOLP scored least from 6.04±2.17 to 6.85±1.92 falling in the category of liked slightly to like moderately.

The results of Table 3 revealed that there was a significant difference between standard biscuits and biscuits made with incorporation of 2 and 4 percent DMOLP in all sensory attributes. Whereas no significant difference was observed in any sensory attribute of biscuits fortified with 2 and 4 percent that means both are equally acceptable.

Sensory Characteristics	Standard v/s 2 % Mean	Standard v/s 4% Mean	2% v/s 4 % Mean
Colour	1.05 *	1.24 *	.18
Appearance	.60 *	.97*	.37
Odor	.98 *	1.31*	.32
Texture	.62 *	.74 *	.11
Taste	1.04 *	1.58 *	.54
Overall Acceptability	.91 *	1.24 *	.33

**Table 3:** Level of Significance in Sensory Characteristics of Standard and DMOLP incorporated Biscuits

\*The mean difference is significant at the .05 level

Same as the biscuits significant difference was observed between standard rusks and rusks made with incorporation of 2 and 4 percent DMOLP in all sensory attributes. Whereas no significant difference was observed in any sensory attribute of rusks fortified with 2 and 4 percent that means both are equally acceptable (Table 4).

The nutrient content of standard and DMOLP fortified biscuits is given in Table 5, which showed that energy content of standard biscuits was 1191.91 Kcal and biscuits with 2 and 4 percent DMOLP contend 1192.56 and 1192.73kcal energy respectively. The protein content was highest in biscuits with 4 per cent DMOLP (13.02 gm) followed by biscuits with 2 percent DMOLP (12.56gm) and lowest in standard biscuits (12.31 gm.) Same as protein biscuits with 4 per cent DMOLP had highest content of fiber (3.02 gm), calcium (194.14mg), iron(3.03 mg) and β carotene (25.84 μg) followed by biscuits with 2 percent DMOLP (fiber 2.89 gm, calcium 145.2 mg, iron 2.43 mg and β carotene 18.95 μg) and standard

Sensory Characteristics	Standard v/s 2% Mean	Standard v/s 4% Mean	2% v/s 4% Mean
Colour	1.25(*)	1.68 (*)	.42
Appearance	1.00 (*)	1.47 (*)	.47
Odor	1.22 (*)	1.41 (*)	.18
Texture	1.04 (*)	1.27 (*)	.22
Taste	1.55 (*)	2.25 (*)	.70
Overall Acceptability	1.18 (*)	1.56 (*)	.38

**Table 4:** Level of Significance in Sensory Characteristics of Standard and DMOLP incorporated Rusk  
\*The mean difference is significant at the .05 level.

Nutrients (per 100 gm)	Standard Biscuits	Biscuits 2% DMOLP	Biscuits 4% DMOLP
Energy (Kcal)	1191.91	1192.56	1191.73
Carbohydrate (gm)	127.23	126.71	126.2
Protein (gm)	12.31	12.56	13.02
Fat (gm)	54.02	54.09	54.16
Fiber (gm)	2.76	2.89	3.02
Iron (mg)	1.84	2.43	3.03
Calcium (mg)	96.4	145.2	194.14
Beta carotene (µg)	10.17	18.95	25.84
Vitamin C (mg)	-	0.1	0.2

**Table 5:** Nutrient Content of Standard Biscuits and Dried *Moringa oleifera* leaf powder incorporated Biscuits

biscuits (fiber 2.76 gm, calcium 96.4 mg , iron 1.84 mg and β carotene 10.17µg).

The nutrient content of standard and DMOLP fortified rusks in Table 6 revealed that energy content of standard rusk was 830.65 kcal, 831.3 kcal in rusk with 2 percent DMOLP and 830.47 kcal in 4 per cent DMOLP rusk. The protein content of standard rusk was 20.11 gm and protein content was increased with DMOLP fortification i.e. 20.26 gm in rusk with 2 per cent DMOLP and 20.82 gm in rusks with 4 per cent DMOLP. The fiber content was increased from 2.76 gm in standard rusks to 3.02 gm in rusks with 4 percent DMOLP. Similarly the content of iron from 2.06 mg to 3.25 mg, calcium 94.4 mg to 392.14 mg and β carotene 1.97 µg to 21.41µg was increased with the addition of DMOLP.

The value-added bakery products act as a good source of, fibre, calcium, and iron as moringa leaves are a good source of these nutrients. Table 5 and 6 revealed that the percentage of nutrients in biscuits and rusk was increased with the increase in the incorporation of DMOLP. The DMOLP

Nutrients (per 100 gm )	Standard Rusk	Rusk 2% DMOLP	Rusk 4% DMOLP
Energy (Kcal)	830.65	831.30	830.47
Carbohydrate (gm)	114.9	114.38	113.87
Protein (gm)	20.11	20.46	20.82
Fat (gm)	30.8	30.87	30.94
Fiber (gm)	2.76	2.89	3.02
Iron (mg)	2.06	2.65	3.25
Calcium (mg)	294.4	343.2	392.14
Beta carotene (µg)	1.97	10.75	21.41
Vitamin C (mg)	-	0.1	0.2

**Table 6:** Nutrient Content of Standard Biscuits and Dried *Moringa oleifera* leaf powder incorporated Rusk

incorporation increases fiber, calcium, iron and β carotene

Biscuits and rusk fortified with 4 percent DMOLP would cost Rs. 21.63/100gm and Rs.31.28/ 100 gm respectively in the retail market and standard biscuits and rusk cost Rs. 18.83/100 gm and Rs. 28.48/100 gm respectively, which means there is only a marginal increase in cost i.e. of Rs. 2.8/- only but the incorporation of DMOLP would certainly increase the nutritive value of these bakery products (Table 7 and 8).

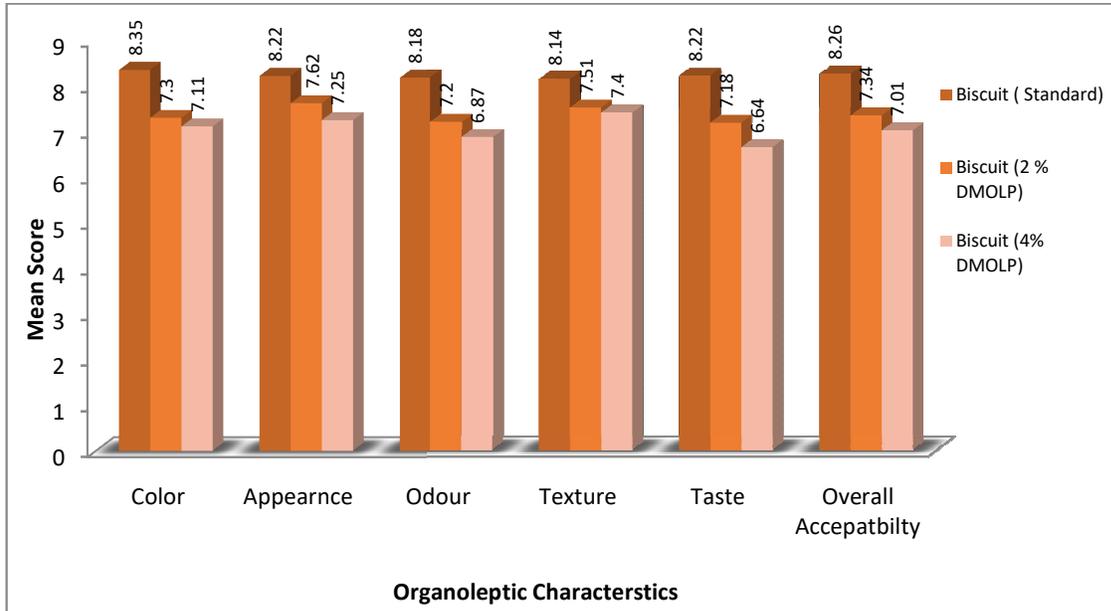
S.No.	Type of Biscuit	Rs./100 gm
1	Standard Biscuits	18.83/-
2	4 percent DMOLP Biscuits	21.63/-

**Table 7:** Cost of Standard Biscuits and Dried *Moringa oleifera* leaf powder incorporated Biscuits

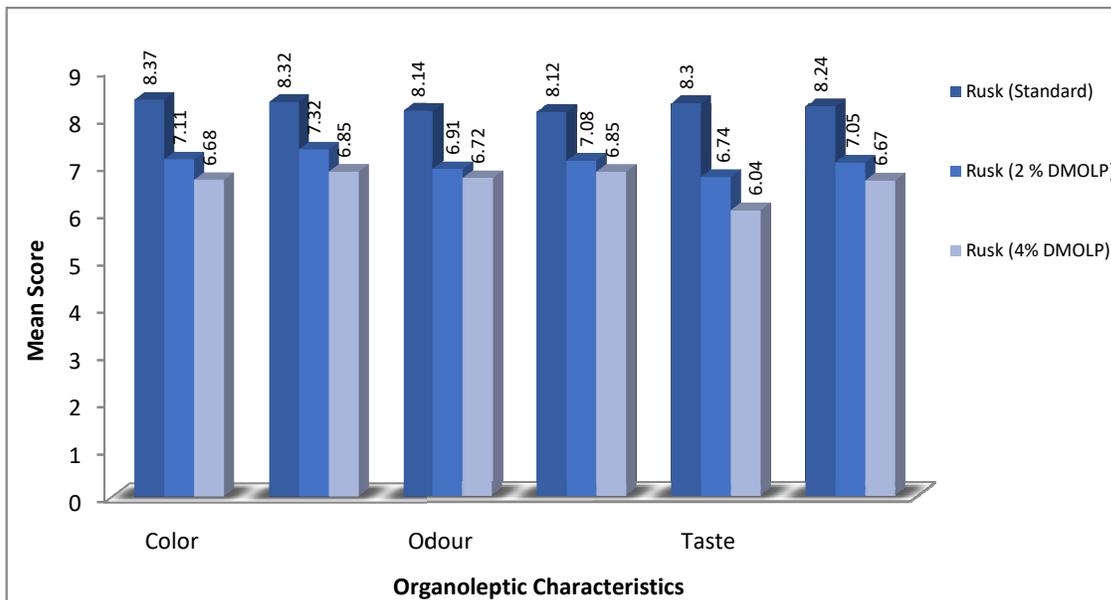
S.No.	Type of Rusk	Rs./100 gm
1	Standard Rusk	28.48/-
2	4 percent DMOLP Rusk	31.28/-

**Table 8:** Cost of Standard Biscuits and Dried *Moringa oleifera* leaf powder incorporated Rusk

The results of the present study are supported by the findings of Abilgos as cited by Manaois<sup>15</sup>, that supplementation with nutrient-rich green leafy vegetables, such as moringa leaves, foods have been shown to effectively enhance the nutrient profile of the foods without compromising quality and consumer acceptability. Dachanaet al<sup>16</sup>. made cookies by adding DMOLP at a level of 5, 10 and 15 percent



**Figure 1 :** Mean Scores for Organoleptic characteristics of Biscuits developed with different concentration of Dried *Moringa oleifera* Leaf Powder



**Figure 2:** Mean Scores for Organoleptic characteristics of Rusks developed with different concentration of Dried *Moringa oleifera* Leaf Powder

showed that addition of DMOLP up to 10 percent did not change the acceptability of cookies and it significantly increased the content of the protein, iron, calcium and  $\beta$ -carotene contents of cookies. Karet.al.<sup>17</sup> found that Moringa leaf enriched biscuits were acceptable in sensory evaluation but the typical leafy flavor and slight bitter taste of the product decreases its consumer acceptance with increasing concentration of DMOLP leading to further modifications like addition of strong flavor and taste enhancing agent. The results of study done by Abilgos<sup>15</sup>, revealed that the 5 percent fortification with DMOLP in flat noodles was preferred by the panel members. So it is clear from the above discussion that fortification with DMOLP increased the nutrient content of the developed food products but with increasing the concentration sensory attributes e.g. color and flavor were less preferred by the consumers.

#### Conclusion:

In order to explore rich nutritional contents of moringa leaves, dried *Moringa oleifera* leaf powder was mixed in biscuits and rusks at the level of 2, and 4 per cent. To attenuate the buildup of oxidative stress in the body, more emphasis needs to be given to plant based foods, especially those which are not eaten commonly but can improve health tremendously. It will enhance food security also. The consumption of such fortified bakery products should be encouraged to maintain the balance between demand of taste and health. Addition of 4 per cent DMOLP considerably increased the protein, fiber, iron, calcium and  $\beta$ -carotene contents of biscuits and rusks, and both products were accepted well by all the panel members. Hence, DMOLP biscuits and rusks have the potential to serve as inexpensive valuable sources of protein, fiber, iron, calcium and  $\beta$ -carotene in the diets of the undernourished people in developing countries like India and on the other hand

these fortified bakery products can be nutritious option for those who eat biscuits and rusks for taste.

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