FORTIFICATION OF “MATHRI” WITH MALTED NUTRI FLOUR AND LEAF POWDER MIX AND ASSESSMENT OF ORGANOLEPTIC AND NUTRITIONAL ATTRIBUTES

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ABSTRACT

India, being glorified with variety of natural climates and seasons, has a number of edible green leafy vegetables (GLVs) some of which are locally grown and consumed. Greens are affluent sources of micronutrients like iron, calcium, phosphorus, vitamin C, beta-carotene and folic acid. Traditional preparations when modified like mathri when incorporated with vegetables could serve a means of enhancing nutritive value of food. The study was undertaken with three objectives (i) to standardize the method of mathri developed using malted nutri flour and leaf powder mix (ii) to assess the organoleptic quality of fortified mathri (iii) to determine its nutritional composition. Organoleptic evaluation of mathri was done by a panel of ten judges using 9 point hedonic scale. Levels of incorporation of leaf powder mix in mathri were 5-20 per cent whereas nutri flour was replaced at 80,85,90,95 percent. Result showed that mathri with the levels of nutri flour at 95 percent and leaf powder mix at 5 percent had highest overall acceptability (7.15±0.05) attributes and the score was in the range of like very much. Nutritional analysis shows that protein and iron content of fortified mathri i.e. 16.71 g and 14.59 mg was higher as compared to control mathri. Thus, it can be concluded that nutri flour and leaf powder mix being good source of proteins and iron may be incorporated in the daily diets of vulnerable sections of population.

KEYWORDS: Mathri, Leaf Powder Mix, Nutri Flour, Iron and Protein.
INTRODUCTION
Delving into the occurrence of iron deficiency anaemia among the liable sections of developing countries, the need for scrutinizing the underutilized green leafy vegetables is necessary to overcome the diseases like iron deficiency anaemia. Plant based foods contain significant amounts of micronutrients which provide desirable health benefits. Vegetables of *Brassica* family are very nutritive and contain rich amounts of minerals like iron and vitamins like folate. Cauliflower is a cruciferous vegetable, the leaves of which are propagated through seeds. It consists of white coloured curd, thick stalks and green coloured leaves that surrounds the flower (*Bhuvaneswari and Ramya, 2014*). The cauliflower leaves are rich in iron, vitamin C, beta-carotene and other important nutrients like indole-3-carbinol and phytonutrients sulforaphane (*Antosiewicz et al. 2008*). In rural India, generally flower curd is consumed and leaves are removed and thrown as waste. But leaves of cauliflower are rich in iron and folate that may prove very effective in treating symptoms of anaemia (*Brittenham 2009*). Turnip is one of the oldest cultivated vegetables used for human consumption since prehistoric times (*Liang et al. 2006*). Increasing the utilization of underutilized green leafy vegetables like cauliflower greens and turnip greens in our diet, known to be wealthy sources of micronutrients can be a food-based approach for increasing their intake and treating deficiency diseases like anaemia.

Nowadays millets are considered as potential replacement for staple crops to tackle with the scarcity of Food. Pearl millet is an important source of some minerals particularly iron and zinc. It has high levels of lipids, high quality and well-balanced proteins (*Elyas et al. 2002*) and diverse health promoting phenolic compounds. It has health promoting properties, particularly its antioxidant activity and its use as nutraceuticals and in functional foods (*Dykes and Roony, 2006*). Pearl millet is particularly rich in iron and zinc and antioxidants which altogether may prove beneficial for treating deficiency diseases like anaemia. Barnyard millet (*Echinochloa frumantacea*) is important millet having ample amount of protein coupled with carbohydrate content. This millet has great potential to blend with other cereals without giving any off flavour and aftertaste. Thus this millet can be added in traditional food preparations to add value in peculiar food uses (*Veena, 2003*). Thus, there is a need to pinpoint the untapped green leafy vegetables and millets, preserve them and utilize them. For green leafy vegetables, drying or dehydration is one of the commonest methods of preservation even at household levels.
**Mathri** is a Rajasthani snack. It is a kind of flaky biscuit from north-west region of India. It is made from flour, water, and cumin seeds (optional). The creation of this snack was influenced by the need to have preserved food that will stay edible for days and the finished products are often stored in big jars at room temperature. Thus the present study has been undertaken with the objective to prepare and standardize iron rich mathri by incorporating leaf powder mix to nutri-flour and to evaluate their sensory attributes and nutritional composition.

**MATERIALS AND METHODS**

Malted nutri flour {Malted Wheat Flour (40 g): Malted Pearl Millet Flour (30 g): Malted Barnyard Millet Flour (30 g)} and Leaf Powder Mix {Brassica oleracea (cauliflower leaves – 50g) and Brassica rapa (turnip leaves-50 g)} was developed using standard procedure and incorporated in development of Mathri.

The nutri-flour and leaf powder mix were incorporated in the mathri at 100, 95, 90, 85, 80 percent and 0, 5,10,15,20 percent respectively. Control was developed using refined wheat flour. All the variations of mathri and control were replicated 3 times.

**Details of Control and Treatment Combinations**

- **Control** ($T_0$) = Mathri prepared from 100g refined wheat flour.
- **Variation I** ($T_1$) = Mathri prepared from 95 g Nutri-flour and 5 g Leaf Powder Mix.
- **Variation II** ($T_2$) = Mathri prepared from 90 g Nutri-flour and 10 g Leaf Powder Mix.
- **Variation III** ($T_3$) = Mathri prepared from 85 g Nutri-flour and 15 g Leaf Powder Mix.
- **Variation IV** ($T_4$) = Mathri prepared from 80 g Nutri-flour and 20 Leaf Powder mix.

**Organoleptic Evaluation of Mathri**

For sensory evaluation, a panel of ten judges was formed and panellists were provided with the prepared foods an hour after any normal meal (mid-morning or mid-afternoon), when the judges were neither too well fed nor too hungry. Organoleptic evaluation was done for different sensory attributes such as colour and appearance, flavour, body and texture, taste and overall acceptability using nine-point hedonic scale.

**Nutritional Analysis**

Standard methods as prescribed by **AOAC (2007)** were used for determination of nutritional components of mathri.
RESULTS AND DISCUSSION

Organoleptic Attributes of Developed Mathri

Colour and Appearance of ‘Mathri’

Results regarding colour and appearance of ‘mathri’ have been presented in Table 1. It was revealed that T₀ (8.4) had the highest score followed by T₁ (6.86), T₃ (6.33), T₀ (5.86) and T₄ (5.4) respectively. Scores indicated that treatment T₀ was liked very much while treatments T₁, T₂, T₃ and T₄ were moderately liked by the sensory panel. Addition of different proportions of nutri-flour and leaf powder mix affected the colour and appearance of developed ‘mathri’. As the amount of leaf powder mix was increased, the scores for colour and appearance got decreased because of darkness of developed ‘mathri’.

Body and Texture of ‘Mathri’

Results regarding body and texture of ‘mathri’ have revealed that T₀ (8.6) had the highest score followed by T₁ (7.4), T₂ (6.8), T₃ (6.33) and T₄ (5.93) respectively. Scores indicated that treatment T₀ was liked very much while treatments T₁, T₂, T₃ and T₄ were moderately liked by the sensory panel. As the amount of leaf powder mix was increased, the scores for body and texture got decreased because of hardness and cracks of developed ‘mathri’.

Flavour of ‘Mathri’

Results regarding flavour of ‘mathri’ have revealed that T₀ (8.33) had the highest score followed by T₁ (7.2), T₂ (6.73), T₃ (6.13) and T₄ (5.8) respectively. Scores indicated that treatment T₀ was liked very much while treatments T₁, T₂, T₃ and T₄ were moderately liked by the sensory panel. As the amount of leaf powder mix was increased, the scores for flavour got decreased because of bitterness of developed ‘mathri’.

Taste of ‘Mathri’

Results regarding taste of ‘mathri’ have revealed that T₀ (8.53) had the highest score followed by T₁ (7.13), T₂ (6.33), T₃ (5.4) and T₄ (4.86) respectively. Scores indicated that treatment T₀ was liked very much while treatments T₁, T₂, T₃ and T₄ were moderately liked by the sensory panel. As the amount of leaf powder mix was increased, the scores for taste got decreased because of bitterness of developed ‘mathri’.

Overall Acceptability of ‘Mathri’

Results regarding overall acceptability of ‘mathri’ have revealed that T₀ (8.22) had the highest score followed by T₁ (7.15), T₂ (6.55), T₃ (5.93) and T₄ (5.5) respectively. Scores
indicated that treatment $T_0$ was liked very much while treatments $T_1$, $T_2$, $T_3$ and $T_4$ were moderately liked by the sensory panel. As the amount of leaf powder mix was increased, the scores for overall acceptability of developed ‘mathri’ got decreased.

**Table 1: Average Sensory Score of Different Parameters in Samples of Leaf Powder Mix Incorporated Nutri-Flour Based “Mathri”**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Colour and Appearance</th>
<th>Body and Texture</th>
<th>Flavour</th>
<th>Taste</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control ($T_0$)</td>
<td>8.4±0.1</td>
<td>8.6±0.05</td>
<td>8.33±0.08</td>
<td>8.53±0.06</td>
<td>8.22±0.11</td>
</tr>
<tr>
<td>$T_1$</td>
<td>6.86±0.06</td>
<td>7.4±0.2</td>
<td>7.2±0.11</td>
<td>7.13±0.17</td>
<td>7.15±0.05</td>
</tr>
<tr>
<td>$T_2$</td>
<td>6.33±0.17</td>
<td>6.8±0.11</td>
<td>6.73±0.13</td>
<td>6.33±0.17</td>
<td>6.55±0.13</td>
</tr>
<tr>
<td>$T_3$</td>
<td>5.86±0.06</td>
<td>6.33±0.17</td>
<td>6.13±0.17</td>
<td>5.4±0.23</td>
<td>5.93±0.10</td>
</tr>
<tr>
<td>$T_4$</td>
<td>5.4±0.11</td>
<td>5.93±0.06</td>
<td>5.8±0.11</td>
<td>4.86±0.29</td>
<td>5.5±0.1</td>
</tr>
<tr>
<td>$F_{cal}$ (5 %)</td>
<td>88.61</td>
<td>88</td>
<td>55.92</td>
<td>52.39</td>
<td>88.66</td>
</tr>
<tr>
<td>SE</td>
<td>0.17</td>
<td>0.15</td>
<td>0.18</td>
<td>0.28</td>
<td>0.15</td>
</tr>
<tr>
<td>CD (p≤0.05)</td>
<td>0.40*</td>
<td>0.36*</td>
<td>0.43*</td>
<td>0.65*</td>
<td>0.36*</td>
</tr>
</tbody>
</table>

*Significant (p≤0.05)

Values are mean ± SE of three independent determinations.

Results are in agreement with the study conducted by Verma and Jain (2012) that developed Mathri using carrot, spinach and mint leaves in fresh as well as dehydrated form. Result shows that the fresh vegetables mathri showed the highest overall acceptability (7.8±0.199) attributes and the score fell in the range of like very much. Mathri prepared using 5 percent amaranth leaves powder was found to be ‘liked moderately’ by the judges as reported by Singh et al. 2007. Gupta and Prakash (2011) also formulated micronutrient rich products with dried greens; keerai and shepu. Dehydrated greens were incorporated into ‘Mathri’ and ‘Thaliepeeth’ at 4, 8 and 12 percent levels. Results of sensory analysis revealed that products incorporated with 4 percent dehydrated greens were similar to control in texture, taste and overall acceptability. However, acceptability scores reduced with increasing concentration of greens. A study was also undertaken for the development and sensory evaluation of beta carotene rich food preparations using underexploited carrot greens by Kaur & Kochar, (2009). Dry leaf powder was added in Mathri at 8 percent, 9 percent and 10 percent levels. Best acceptable level of incorporation of dry carrot powder was 9 percent and the scores for overall acceptability were 6.05.

**Nutritional Composition of Developed ‘Mathri’**

All the treatments of developed ‘mathri’ were subjected to routine nutrient analysis using the standard procedures and the values are presented in table 2.
Moisture
Of the five treatments that were analysed; treatment (T₄) had the highest moisture content (3.48±0.12 g per 100 g) followed by T₃ (3.01±0.07 g per 100 g), T₂ (2.35±0.25 g per 100 g), T₁ (2.32±0.08 g per 100 g) whereas treatment T₀ contained the least (2.16±0.04 g per 100 g).

Protein
The protein content was found highest in T₄ (23.42±0.05 g per 100 g) followed by T₃ (21.42±0.20 g per 100 g), T₂ (19.52±0.17 g per 100 g), T₁ (16.71±0.12 g per 100 g) and lowest in control (T₀) (12.72±0.42 g per 100 g).

Fat
Being deeply fried with ‘refined oil’, the mathri’ had relatively larger amount of fat despite the ingredients used were low in fat being highest in T₄ (16.3±0.07 g per 100 g) followed by T₃ (15.47±0.08 g per 100 g), T₂ (14.50±0.16 g per 100 g), T₁ (14.24±0.23 g per 100 g) and lowest in T₀ (13.10±0.73 g per 100 g).

Fibre
The fibre content was found to be highest in treatment T₄ (9.33±0.04 g per 100 g) followed by T₃ (8.77±0.05 g per 100 g0), T₂ (7.81±0.18 g per 100 g), T₁ (5.29±0.08 g per 100 g) and lowest in T₀ (2.43±0.14 g per 100 g) as the amount of leaf powder mix was increased in treatments being least in T₀ and highest in T₄.

Ash
The ash content of the treatment T₄ was found to be highest (8.69±0.02 g per 100 g) followed by T₃ (7.37±0.12 g per 100 g), T₂ (5.35±0.25 g per 100 g), T₁ (3.70±0.10 g per 100 g) and least in T₀ (2.18±0.05 g per 100 g).

Table 2: Nutritional Composition of Developed ‘Mathri’

<table>
<thead>
<tr>
<th>Nutrients</th>
<th>T₀</th>
<th>T₁</th>
<th>T₂</th>
<th>T₃</th>
<th>T₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture (g)</td>
<td>2.16±0.04</td>
<td>2.32±0.08</td>
<td>2.35±0.25</td>
<td>3.01±0.07</td>
<td>3.48±0.12</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>12.72±0.42</td>
<td>16.71±0.12</td>
<td>19.52±0.17</td>
<td>21.42±0.20</td>
<td>23.42±0.05</td>
</tr>
<tr>
<td>Crude Fat (g)</td>
<td>13.10±0.73</td>
<td>14.24±0.23</td>
<td>14.50±0.16</td>
<td>15.47±0.08</td>
<td>16.3±0.07</td>
</tr>
<tr>
<td>Crude Fibre (g)</td>
<td>2.43±0.14</td>
<td>5.29±0.08</td>
<td>7.81±0.18</td>
<td>8.77±0.05</td>
<td>9.33±0.04</td>
</tr>
<tr>
<td>Ash (g)</td>
<td>2.18±0.05</td>
<td>3.70±0.10</td>
<td>5.35±0.25</td>
<td>7.37±0.12</td>
<td>8.69±0.02</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>72.01±0.98</td>
<td>66.73±0.28</td>
<td>63.62±0.38</td>
<td>60.09±0.18</td>
<td>56.81±0.20</td>
</tr>
<tr>
<td>Energy (Kcal)</td>
<td>456.86±1.67</td>
<td>461.93±0.85</td>
<td>463.07±1.40</td>
<td>465.31±0.70</td>
<td>467.59±0.57</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>10.83±0.03</td>
<td>14.59±0.20</td>
<td>17.77±0.09</td>
<td>19.47±0.14</td>
<td>21.48±0.24</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>164.14±0.88</td>
<td>261.96±0.96</td>
<td>278.67±0.28</td>
<td>286.46±0.21</td>
<td>297.93±0.52</td>
</tr>
</tbody>
</table>
Carbohydrates

The highest carbohydrates content was recorded in \( T_0 \) (72.01±0.98 g per 100 g) followed by \( T_1 \) (66.73±0.28 g per 100g), \( T_2 \) (63.62±0.38 g per 100 g), \( T_3 \) (60.09±0.18 g per 100g) and least carbohydrates were found in \( T_4 \) (56.81±0.20 g per 100 g). The obvious reason behind decreasing carbohydrates with increasing ratio of leaf powder mix is that later contains lesser amount of carbohydrates.

Energy

The calorie content of treatment \( T_4 \) was the top most (467.59±0.57 Kcal per 100 g) followed by \( T_3 \) (465.31±0.70 Kcal per 100 g), \( T_2 \) (463.07±1.40 Kcal per 100 g), \( T_1 \) (461.93±0.85 Kcal per 100 g) and least in \( T_0 \) (456.86±1.67 Kcal per 100 g). This may be attributed to higher content of the carbohydrates, fat and protein in the treatment \( T_5 \).

Iron

As far as micronutrients are concerned, the treatment \( T_4 \) (21.48±0.24 mg per 100 g) was found to have highest iron content followed by \( T_3 \) (19.47±0.14 mg per 100 g), \( T_2 \) (17.77±0.09 mg per 100 g), \( T_1 \) (14.59±0.20 mg per 100 g) and least in \( T_0 \) (10.83±0.03 mg per 100 g).

CALCIUM

Calcium content was found highest in treatment \( T_4 \) (297.93±0.52 mg per 100 g) followed by \( T_3 \) (286.46±0.21 mg per 100 g), \( T_2 \) (278.67±0.28 mg per 100 g), \( T_1 \) (261.96±0.96 mg per 100g) and least in \( T_0 \) (164.14±0.88 mg per 100 g). Again the reason behind this is the increased ratio of leaf powder mix in treatments which is rich in iron and calcium as well.

Results reported in present study are in agreement with the study conducted by Singh and Kawatra (2006) that developed and evaluated nutritional composition of products like pakora, vada, namakpare, biscuits and cakes incorporated with dried amaranthus leaves powder. Total iron content ranged from 7.9 mg to 12.4 mg in all the products. Begum et al. (2000) also reported cauliflower leaf powders to be a good source of protein and other micronutrients. Therefore, it can be concluded that the value addition enriched the nutritive value of traditional recipe appreciably. There was a substantial increase in the nutritional value of all the products developed by incorporating dried greens. Beta carotene and Iron content in all food preparations increased significantly (P<0.05) with incorporation of dried greens in comparison to their control recipes with 0 percent incorporation. Verma and Jain
(2012) fortified mathri with fresh and dehydrated vegetables and assessment of nutritional quality. Levels of incorporation of fresh greens (spinach, mint and carrot) in mathri were 8 per cent whereas powder of dry green vegetables (spinach, mint, carrot and lotus stem) was added in mathri at 7 per cent. Nutritional analysis showed that protein and iron content of dried vegetables mathri i.e. 7.44g and 5.37mg was higher as compared to fresh vegetables mathri.

CONCLUSION
The value addition enriched the nutritive value of mathri appreciably. There was a substantial increase in the nutritional value of mathri enriched by green vegetable. Iron content in all treatments increased significantly (P<0.01) with incorporation of nutri flour and leaf powder mix. It may be concluded that mathri developed using malted nutri flour and leaf powder mix being good source of proteins and iron may be incorporated in the daily diets of vulnerable sections of population.

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