Introduction

Diet with full of colorful fruits and vegetables is key of getting enough nutrients but lacks in vitamin D. Food which lacks in color also lacks in essential nutrients but in contrast, mushrooms commonly white in color contains abundance of essential nutrients. No other plant based foods produce vitamin D except mushrooms. Mushrooms are considered as vegetable but in actual they belongs to fungi kingdom instead of plant and also known as meat of vegetable world which is naturally low in fat, sodium and calories. Mushrooms are referred as functional food which provides basic nutrition and helps to prevent chronic diseases due to presence of beneficial dietary fibers (beta-glucans, chitin etc.) and antioxidants (Megan Ware 2017) [11]. Increasing consumption of whole, unprocessed foods, like mushrooms, appears to decrease the risk of obesity, diabetes, and heart disease. They also promote a healthy complexion and hair, increased energy, and overall lower weight. It is total diet or overall eating pattern that is most important in disease prevention and achieving good health. Mushrooms are also the only vegan, non-fortified dietary source of vitamin D. Dairy products are normally a good food source of vitamin D, but vegans do not consume any animal products, so mushrooms can offer an alternative source of this important vitamin (Food guide for health 2009) [5]. Ultraviolet light encompasses the 100-400 nm range of the electromagnetic spectrum and can be subdivided into three main regions. These include UV-A (315-400 nm), UV-B (280-315 nm) and UV-C (200-280 nm) (Koutchma 2009) [9]. While sunlight is a natural source of UV irradiation, there are several lamp technologies which emit artificial UV light. Ergosterol is precursor of vitamin D present in mushrooms (21-107mg/100g) which get enhanced and converted into ergocalciferols on exposure to sun rays or artificial UV rays either in growth phase or post-harvest period of mushroom (Roberts et al., 2008) [15]. Mathi is a rajasthani snack like flaky biscuit is now available at every sweet shop in India. It is made from flour, water, cumin seed (optional) etc. Mathi creation was influenced by need to have preserved food which stays edible for weeks in big jars at room temperature. It is popular snack mostly served in marriages, parties and poojas with pickles and even as tea-time snack. This days we see Mathi in different flavors like Masala Mathi, Cumin Mathi, Achari Mathi and Fenugreek leaves (methi) Mathi. Mushrooms inherent umami counter balances saltiness and allows for less salt to be used in recipes like Mathi. Vitamin D enriched mushroom based recipes are food based approach that would help to elevate the serum vitamin D levels of the deficient population which would have long term benefits with no side effects.

Formulation, sensory and nutritional evaluation of vitamin D enriched Mathi

Aparajita Bhasin, Sonika Sharma, Shammi Kapoor and Mudit Chandra

Abstract

The present study aimed to evaluate sensory properties, nutritional composition and shelf life of Mathi supplemented with vitamin D enriched button mushroom powder (produced by exposure of UV-B rays at 60cm distance for 30min time duration). Supplemented Mathi was highly acceptable at 10% level by panel members. Mathi supplemented with UV treated button mushroom powder contained high protein (p<0.05), ash (p<0.05) and fibre content (p=0.01) as well as high in vitro protein digestibility (p<0.01), total phenols (p<0.01) and high mineral content viz., iron, copper, phosphorus, potassium, zinc and selenium as compared to control Mathi (without button mushroom powder). After storage Mathi supplemented with vitamin D enriched button mushroom powder was acceptable up to 105 days of storage (3.5 months) and showed no microbial growth (bacterial and fungal). Air tight glass container was best considered best packaging material than other packaging materials.

Keywords: Nutritional composition, in-vitro protein digestibility, total phenols, mineral content, microbial growth.
Thus vitamin D enriched mushroom powder was incorporated in the tea-time snack (Mathi) to enhance its nutritional composition and provide health benefits.

Material and methods
PROCUREMENT OF RAW MATERIALS
Ingredients required to develop Mathi like refined wheat flour, carom seeds, ghee, oil were procured from local market of Ludhiana whereas fresh Button mushroom (Agaricus bisporus) was procured from mushroom farm, PAU, Ludhiana in a single lot.

PROCESSING OF BUTTON MUSHROOM TREATING WITH UV RAYS
Fresh button mushroom was cleaned, sliced longitudinally and exposed to varied UV rays such as UV-A, UV-B and UV-C using varied distance (30cm, 45cm, 60cm) at varied time durations (10min, 20min, 30min) for vitamin D enrichment followed by freeze drying at -40°C and pulverized in fine powder further used for vitamin D estimation. Button mushroom powder with maximum vitamin D content was further used in development of Mathi.

FORMULATION AND DEVELOPMENT OF MATHI
Indian snack Mathi was prepared with incorporation of vitamin D enriched button mushroom powder replacing main ingredient (refined flour) listed in the standard method. The standard method used for product development was as follows:

<table>
<thead>
<tr>
<th>Material Required</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refined wheat flour</td>
<td>90g</td>
</tr>
<tr>
<td>Button mushroom powder</td>
<td>10g</td>
</tr>
<tr>
<td>Ghee</td>
<td>20g</td>
</tr>
<tr>
<td>Carom seeds (Ajwain)</td>
<td>¼ tsp</td>
</tr>
<tr>
<td>Salt</td>
<td>¼ tsp</td>
</tr>
<tr>
<td>Refined oil</td>
<td>50ml</td>
</tr>
</tbody>
</table>

METHOD
Refined flour, vitamin D enriched button mushroom powder, salt and carom seeds were mixed well. Ghee was added in mixture for shortening and mixed thoroughly. It was kneaded into a stiff dough and further divided into small balls. The balls were rolled into shape of Mathi and pricked with knife so that it remained flat even after frying. Mathi was deep fried until turn golden brown in colour.

SENSORY EVALUATION
Mathi developed with vitamin D enriched button mushroom powder was evaluated for sensory attributes such as colour, appearance, aroma, texture, taste and overall acceptability by a panel of 10 trained members using 9 point hedonic scale. The judges were served each preparation with one control (without button mushroom powder) and three experimental samples (Ranganna 2002) [14].

NUTRITIONAL EVALUATION
Developed Mathi was further subjected to nutritional analysis for proximate and minerals using standard methods. In-vitro protein digestibility and total phenols were also analysed. Shelf life of Mathi was analyzed for 5 months using different packaging materials.

PROXIMATE ANALYSIS
Proximate composition such as Protein, Crude fat, Crude fibre, Crude ash, Carbohydrate and Energy were analyzed using standard methods suggested by AOAC (2000) [1].

**In-vitro protein digestibility**
The estimation was carried out by Macro kjeldahl method (Akesson and Stachman 1964) modified by (Singh et al 1989)

**Total phenols (Singleton et al 1999) [17]**

**Extraction of Bioactive compound- phenolic compounds**
The sample weighed as known quantity was taken in 100ml of the conical flask. Then add 15ml of 80% methanol acidified to pH 2.0 with 6N HCl (Hydrochloric acid) by vortex at room temperature for 30 minutes. The filtrate was decanted and re-extracted the residue for complete removal of phenolic compounds. This procedure was repeated for two times. The three supernatants were pooled, centrifuge at 6000rpm for 15min and filtered with the help of Whatman No.1 filter paper. Then the volume was made by solvent to 50ml. The sample was shifted to micro centrifuge tubes and stored at -20°C for total phenolic content (TPC) for which the known quantity of aliquot of sample was taken and volume up to 1.5ml with D/W was made. Then 0.5ml of FC reagent was added followed by adding 10ml of 7.5% NaCO3 and incubated at 37°C for 60 minutes. Resulting blue color complex was read at 750nm. Total phenol content was calculated in (mg/100g) using equation as follows:

\[
\text{Total phenol (mg GAE/100 g)} = \text{Std. Concentration/Std. O.D} \times \text{Sample taken} \times \frac{\text{Vol made up}}{\text{Sample taken}} \times 100/1000 \times \text{Dilution factor}
\]

**MINERAL ESTIMATION**
Minerals namely iron, copper, phosphorus, potassium, zinc and selenium were estimated by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method using ICP optical emission spectrophotometer (ICP-OES Optima 2100 DV) using wet digestion.

**Calculation**
Mineral concentration (mg/L) = Sample concentration (ppm) – Blank concentration (ppm) x dilution factor. Shelf life of Mathi using various packaging materials (Miles and Misra 1938) modified by (Thatcher and clark 1968) [18]

Different packaging materials such as zip lock polyethylene bags, glass container and plastic container were used for packing Mathi made by the incorporation of vitamin D enriched button mushroom powder with maximum overall acceptability and further evaluated for the bacterial and yeast/mold growth.

The original sample contains the Colony Forming Units (CFU) /ml is measured as:

\[
\text{CFU/ml}=\text{Average number of colonies for a dilution x } 50 \times \text{ dilution factor}
\]

**Statistical Estimation**
Independent sample t-test was applied for the comparison of nutritional parameters between control sample and experimental sample. The significant difference between organoleptic scores of samples were tested using One way ANOVA (Tukey’s test) to compare three or more products with control sample. For storage studies, factorial ANOVA was applied to test the interaction of packaging and storage time on microbial growth.

**RESULTS AND DISCUSSIONS**

**SENSORY EVALUATION OF MATHI**
The test samples were prepared with refined flour supplemented with vitamin D enriched button mushroom...
powder and three levels such as 5%, 10% and 15% were prepared, along with one control sample. The mean scores for various sensory attributes were given by panelists are shown in Table 1.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Colour</th>
<th>Appearance</th>
<th>Aroma</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>8.20±0.63</td>
<td>7.90±0.57</td>
<td>8.05±0.50</td>
<td>8.40±0.63</td>
<td>8.15±0.41</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>8.20±0.42</td>
<td>8.00±0.47</td>
<td>8.05±0.60</td>
<td>8.20±0.42</td>
<td>8.05±0.32</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>8.18±0.29</td>
<td>8.23±0.30</td>
<td>8.18±0.29</td>
<td>8.48±0.45</td>
<td>8.31±0.17</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>6.60±0.97</td>
<td>6.60±0.97</td>
<td>6.60±1.08</td>
<td>6.85±1.33</td>
<td>6.45±1.01</td>
<td></td>
</tr>
<tr>
<td>F Value</td>
<td>15.886</td>
<td>13.732</td>
<td>12.134</td>
<td>8.385</td>
<td>18.578</td>
<td></td>
</tr>
<tr>
<td>p-Value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Means with different notation as (a and b) indicates significant difference C – control
T1 – 5% treated button mushroom powder
T2 – 10% treated button mushroom powder
T3 – 15% treated button mushroom powder

The data in above table illustrated that the average scores of all sensory attributes obtained by T2 treatment supplemented with 10% treated button mushroom powder were higher than control and other treatments. Among all sensory attributes there was no significant difference observed within T2 treatment followed by T1 treatment (5%) and control samples. On the other hand, T3 treatment (15% supplementation) scored least ranges from (6.45–6.85) and significant difference was observed as compared to control and other treatments. The reason might be the more oil absorbance with increased button mushroom powder supplemented Mathi which adversely effected its overall appearance, colour, taste and flavor. The mean score of overall acceptability was recorded in T2 treatment (8.31), control (8.15) and T1 treatment (8.05). The products prepared with incorporation of different nutritious foods had obtained significantly high acceptability as compared to preparation with basic ingredients.

Chauhan et al (2017) reported that the Mathi prepared with the incorporation of 5% Beech mushroom (Hypszigus tessellatus) was observed highly acceptable than the other treatment levels. Verma and Jain (2012) prepared Mathi with the incorporation of dried powder of vegetables such as the mixture of spinach, mint, carrot and lotus stem respectively. The score for sensory attributes were found to be lower than Mathi prepared with the supplementation of fresh vegetables.

According to Chauhan et al. (2017) the proximate composition of different button mushroom powder supplemented Mathi was shown in Table 2. The data revealed that Mathi supplemented with vitamin D enriched button mushroom powder contains significantly (p<0.05) high protein content at 7.77% in comparison of control Mathi at 5.88%. On the other hand, there was no significant difference observed in the fat content of supplemented Mathi and control Mathi at 34.61±1.11 and 34.65±0.47 respectively. The ash content of treated button mushroom powder supplemented Mathi was found to be significantly higher 2.97% (p<0.05) as compared to control Mathi at 1.53%. In case of fibre content, 2.81% fibre analyzed in supplemented Mathi which was significantly higher than the control Mathi as 0.29% (p<0.0001). The calculated value of carbohydrate was seen 47.25% in supplemented Mathi which was significantly lower than control Mathi 52.58% carbohydrate content was observed. The energy content was found to be 531.57Kcals in supplemented Mathi with treated button mushroom powder instead of control Mathi i.e. 545.67 Kcals.

According to Chauhan et al (2017) Mathi was prepared with the supplementation of Beech mushroom (Hypszigus tessellatus) at the level of 5% and 10%. The protein content 15.23%, fat content 20.11%, ash content 2.44% followed by carbohydrate and energy content as 56.02% and 467.38 Kcals were observed at the level of 10% which were significantly higher than the control sample with 13.75% protein, 18.14% fat and 2.37% of ash whereas carbohydrate and energy were calculated at 63.18% and 470.98Kcals respectively.

The above data illustrates that the proximate composition of supplemented Mathi was enhanced with the incorporation of vitamin D enriched button mushroom powder which can help to improve the nutritional status of population.

### Nutritional analysis of Mathi

#### Table 1: Sensory evaluation of Mathi supplemented with vitamin D enriched button mushroom powder

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Colour</th>
<th>Appearance</th>
<th>Aroma</th>
<th>Texture</th>
<th>Taste</th>
<th>Overall Acceptability</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>8.20±0.63</td>
<td>7.90±0.57</td>
<td>8.05±0.50</td>
<td>8.40±0.63</td>
<td>8.15±0.41</td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>8.20±0.42</td>
<td>8.00±0.47</td>
<td>8.05±0.60</td>
<td>8.20±0.42</td>
<td>8.05±0.32</td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>8.18±0.29</td>
<td>8.23±0.30</td>
<td>8.18±0.29</td>
<td>8.48±0.45</td>
<td>8.31±0.17</td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>6.60±0.97</td>
<td>6.60±0.97</td>
<td>6.60±1.08</td>
<td>6.85±1.33</td>
<td>6.45±1.01</td>
<td></td>
</tr>
<tr>
<td>F Value</td>
<td>15.886</td>
<td>13.732</td>
<td>12.134</td>
<td>8.385</td>
<td>18.578</td>
<td></td>
</tr>
<tr>
<td>p-Value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Means with different notation as (a and b) indicates significant difference C – control
T1 – 5% treated button mushroom powder
T2 – 10% treated button mushroom powder
T3 – 15% treated button mushroom powder

#### Table 2: Proximate composition of Mathi supplemented with vitamin D enriched button mushroom powder (on dry weight basis)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Protein (%)</th>
<th>Fat (%)</th>
<th>Ash (%)</th>
<th>Fibre (%)</th>
<th>Carbohydrate (%)</th>
<th>Energy (Kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Mathi</td>
<td>5.88±0.19</td>
<td>34.65±0.47</td>
<td>1.53±0.06</td>
<td>0.29±0.08</td>
<td>52.58±0.32</td>
<td>545.67±4.95</td>
</tr>
<tr>
<td>Acceptable (10%TBMP)</td>
<td>7.77±0.11</td>
<td>34.61±1.11</td>
<td>2.97±0.62</td>
<td>2.81±0.04</td>
<td>47.25±1.79</td>
<td>531.57±4.76</td>
</tr>
<tr>
<td>T1 - Value</td>
<td>2.912</td>
<td>0.061</td>
<td>3.984</td>
<td>47.211</td>
<td>5.079</td>
<td>3.556</td>
</tr>
<tr>
<td>p-Value</td>
<td>0.044</td>
<td>0.954</td>
<td>0.016</td>
<td>0.000</td>
<td>0.000</td>
<td>0.024</td>
</tr>
</tbody>
</table>

TBMP- treated button mushroom powder at the distance of 60cm for 30min

The significant difference of proximate composition for treated button mushroom powder supplemented Mathi and control Mathi is shown in Table 2. The data revealed that Mathi supplemented with vitamin D enriched button mushroom powder contains significantly (p<0.05) high protein content at 7.77% in comparison of control Mathi at 5.88%. On the other hand, there was no significant difference observed in the fat content of supplemented Mathi and control Mathi at 34.61±1.11 and 34.65±0.47 respectively. The ash content of treated button mushroom powder supplemented Mathi was found to be significantly higher 2.97% (p<0.05) as compared to control Mathi at 1.53%. In case of fibre content, 2.81% fibre analyzed in supplemented Mathi which was significantly higher than the control Mathi as 0.29% (p<0.0001). The calculated value of carbohydrate was seen 47.25% in supplemented Mathi which was significantly lower than control Mathi 52.58% carbohydrate content was observed. The energy content was found to be 531.57Kcals in supplemented Mathi with treated button mushroom powder instead of control Mathi i.e. 545.67 Kcals.

### In-vitro protein digestibility and total phenol content

According to various studies, it was found that the processing of food enhance the digestibility of protein as well as phenolic content which improved the quality of food as compare to the raw food.
Results shown in Table 3 illustrated the in-vitro protein digestibility of Mathi prepared by adding vitamin D enriched button mushroom powder at 56.26% which was significantly higher than control Mathi at 48.41%. Dhaneshe et al (2018a) prepared Mathi with incorporation of 10% defatted peanut cake flour and 1% fenugreek leave powder was observed significantly higher content of in-vitro protein digestibility at 60.22% and lower in control Mathi at 42.97%.

Similarly total phenols of Mathi supplemented with vitamin D enriched button mushroom powder was observed at 190mg/100g which was significantly (p<0.0001) higher in comparison of control Mathi at 60mg/100g. Kaur and Aggrawal (2015) prepared potato–rice based Chkali by using three different varieties of potato and analyzed total phenols content. Significantly higher content of total phenols was observed in Chkali supplemented with boiled mashed potato (k.Pukhraj) at 80.51mg GAE/100g in comparison of other two varieties i.e. Chipsona-1 and Chandramukhi at 51.56 and 56.01mg GAE/100g and control Chkali at 41.00mg GAE/100g.

The above data revealed that the incorporation of vitamin D enriched button mushroom powder enhanced the total phenols content of Mathi as compared to the standard products as well as freeze drying process also improved the total phenols content in mushroom powder.

Mineral content of Mathi

From Table 4 it can be seen that the mineral content of Mathi supplemented with vitamin D enriched button mushroom powder was significantly higher than that in control Mathi. Further, it was seen that the iron content of Supplemented Mathi was 4.72 mg/100g which was significantly (P<0.01) higher than that in control Mathi at 2.99mg/100g. The copper content of supplemented Mathi was found significantly higher at 2.46 mg/100g as compared to 0.86mg/100g in control Mathi. Significant variations of phosphorus content were observed in supplemented and control Mathi i.e. 636.76 and 396.01mg/100g respectively. The potassium content of supplemented Mathi was observed at 673.47 mg/100g which was significantly (P<0.01) higher than control Mathi at 339.53 mg/100g. In case of zinc and selenium, supplemented Mathi contained 1.82mg/100g and 0.63 mg/100g respectively as compared to their presence in control Mathi at 1.4mg/100g and 0.21 mg/100g respectively.

Kaur and Brar (2017) prepared Mathi with supplementation of mango kernel seed flour at different levels i.e. 10%, 20%, 30% and 40% respectively where E1 treatment (10% supplementation) was found to be highly acceptable among other treatments and used for mineral estimation. Calcium content of E1 treatment was observed at 26mg/100g as compared to control at 25.42mg/100g. In case of iron content, significant variation was observed between E1 treatment and control at 3.34mg/100g and 2.08mg/100g respectively. Similarly, magnesium content of E1 treatment contained 35.33mg/100g which was significantly higher than control at 24.72mg/100g.

The present data in above table revealed that the supplemented Mathi with vitamin D enriched button mushroom powder contain enhanced mineral composition in comparison of control Mathi.

Shelf life of supplemented Mathi during storage for 5 months Microbial growth (bacteria/ yeast and mold) of Mathi supplemented with vitamin D enriched button mushroom powder on basis of packaging materials after storage for 5 months Factorial ANOVA was applied for find out the effect of packaging material and time duration on the stored Mathi on.

Table 3: In-vitro protein digestibility and total phenol content of Mathi supplemented with vitamin D enriched button mushroom powder (on dry weight basis)

<table>
<thead>
<tr>
<th>Products</th>
<th>In-vitro protein digestibility (%)</th>
<th>Total phenol content (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Mathi</td>
<td>48.41±0.97</td>
<td>60.00±0.64</td>
</tr>
<tr>
<td>Acceptable Mathi (10%TBMP)</td>
<td>56.26±0.81</td>
<td>190.00±0.64</td>
</tr>
<tr>
<td>t-Value</td>
<td>10.792</td>
<td>143.295</td>
</tr>
<tr>
<td>p-Value</td>
<td>&lt;0.0001</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

TBMP- treated button mushroom powder at the distance of 60cm for 30min

Kaur and Brar (2017) prepared Mathi with supplementation of mango kernel seed flour at different levels i.e. 10%, 20%, 30% and 40% respectively where E1 treatment (10% supplementation) was found to be highly acceptable among other treatments and used for mineral estimation. Calcium content of E1 treatment was observed at 26mg/100g as compared to control at 25.42mg/100g. In case of iron content, significant variation was observed between E1 treatment and control at 3.34mg/100g and 2.08mg/100g respectively. Similarly, magnesium content of E1 treatment contained 35.33mg/100g which was significantly higher than control at 24.72mg/100g.

The present data in above table revealed that the supplemented Mathi with vitamin D enriched button mushroom powder contain enhanced mineral composition in comparison of control Mathi.

Shelf life of supplemented Mathi during storage for 5 months Microbial growth (bacteria/ yeast and mold) of Mathi supplemented with vitamin D enriched button mushroom powder on basis of packaging materials after storage for 5 months Factorial ANOVA was applied for find out the effect of packaging material and time duration on the stored Mathi on.
microbial count (Table 5). The results described that there was no significant effect of packaging material on bacteria count, F(2,24)=3.204, p=0.058 and on fungi count, F(2,24)=2.418, p=0.110. There was a significant effect of time on bacteria count, F(3,24)=13.408, p<0.0001 as well as on fungi count, F(3,24)=12.527, p<0.0001. There was no significant effect of interaction between packaging and time on bacteria count, F(6,24)=1.000, p=0.448 and on fungi count, F(6,24)=0.891, p=0.517.

Our data observed the microbial growth (bacterial and yeast/mold) of Mathi prepared with vitamin D enriched button mushroom powder were in permissible limit till 5 months under good storage conditions. The increase in microbial growth is due to presence of moisture during storage period which break down fat and carbohydrate and increase microbial growth. For best results it is advisable to consume Mathi within 3 months of storage. On the basis of results we have concluded that the glass container is best packaging material as compared to other packaging materials such as zip lock polyethylene bags and plastic container. Nagi et al. (2012) studied the effect of storage period and packaging on the shelf life of cereal bran incorporated biscuits. The results revealed that the after 1 month of storage the microbial count was observed in defatted cereal based biscuits. In HDPE packaging the microbial count was higher at 16.96x10^4 cfu/g compared to laminated packed biscuits at 15.68x10^4 cfu/g after 3 months of storage period. The microbial count was in permissible limit. Lohekhar (2016) studied the total bacterial count of cereal pulse based value added nutritious instant mixes. Value added products were stored in different packaging materials i.e. polythene pouch and laminated aluminum pouch for 180 days. The results revealed the total bacterial count for Instant Sev Mix was below detectable level on 1^st day in both packaging materials whereas 5x10^3 cfu/g was recorded in polyethylene pouch which was quite higher than total bacterial count of sample packed in laminated aluminum pouch at 3x10^2 cfu/g after 180 days of storage period.

Sachan (2017) studied the yeast and mold growth of supplemented Mathi prepared with iron rich food supplements such as cauliflower leaves, garden cress seeds, rice flakes and lotus stem. The yeast and mold count was found nil on 0^th day whereas with the increase of storage period the yeast and mold count was also increased at 53x10^4 cfu/g on 30^th day, 95x10^4 cfu/g on 60^th day and 127x10^4 cfu/g on 90^th day of storage period.

Raja et al. (2014) observed the yeast and mold count in fish curls prepared with the incorporation of different flours (corn flour, black gram flour and peanut flour) during 28 days of storage period. In all stored samples yeast and mold growth was not detected from initial day till 14^th day of storage period. The yeast and mold count was found higher in black gram flour based sample at 2.70 log cfu/g on 21^st day and 3.78 log cfu/g followed by peanut flour based sample at 2.56 log cfu/g on 21^st day and 3.63 log cfu/g on 28^th day of storage period. Lower yeast and mold count was observed in corn flour based samples at 2.32 log cfu/g on 21^st day and 3.46 log cfu/g on 28^th day of storage period.

**Table 5: Microbial growth (bacterial/ yeast and mold) of Mathi supplemented with vitamin D enriched button mushroom powder on basis of packaging materials after storage for 5 months (10^4 cfu/g)**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Packaging Material</th>
<th>Bacterial count</th>
<th>Yeast/mold count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>105 Days</td>
<td>120 Days</td>
</tr>
<tr>
<td>Mathi  acceptable</td>
<td>zip lock polyethylene bag</td>
<td>2.00</td>
<td>2.67</td>
</tr>
<tr>
<td>(10%TBMP)</td>
<td>glass container</td>
<td>1.67</td>
<td>2.33</td>
</tr>
<tr>
<td></td>
<td>plastic container</td>
<td>1.67</td>
<td>3.33</td>
</tr>
</tbody>
</table>

TBMP- button mushroom powder treated with UV-B at the distance of 60cm for 30 minute Medium used: Nutrient Agar/Potato Dextrose Agar
Incubation Time: 24hrs
Incubation Temperature: 37°C

**Conclusion**

Incorporation of vitamin D enriched button mushroom powder has showed considerable effect on sensory properties of Indian snack Mathi. The results of our study conclude that incorporation of vitamin D enriched button mushroom powder up to 10% level enhanced sensory properties as well as high in-vitro protein digestibility, high total phenols, enhanced protein, ash, fibre and mineral content of developed Mathi. Thus, vitamin D enriched button mushroom powder could also use as a potential source for different snacks and functional food ingredients.

**References**