Development and Quality Evaluation of Supplementary Food (Panjiri) Incorporating Processed B. juncea Meal

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A B S T R A C T

The present study was aimed towards investigating the food application of processed mustard meal (PMM), which was obtained through a microwave-assisted processing for reduction of selected anti-nutrients, in a supplementary food (panjiri). During formulation of panjiri, the whole wheat flour was progressively replaced (0-20%) with PMM and the panjiri samples were then evaluated for color, nutritional and sensory acceptability. Panjiri sample with whole wheat flour only was considered as control. Incorporation of PMM decreased the L*, a* and b* value of panjiri from 70.58, 7.43 and 25.32 to 59.74, 5.36 and 17.63, respectively. The total color difference (ΔE) was in the range of 4.13 to 13.46 indicating obvious color changes. The hue and chroma also decreased from 73.65 and 26.39 to 73.09 and 18.43, respectively with increasing PMM level. The sensory evaluation revealed that PMM based panjiri with 5% replacement only was statistically similar to control in overall acceptability. However, the product was acceptable up to 10% incorporation level (OAA score 7.55) also. Nutritional analysis of most accepted PMM (10%) based panjiri sample indicated 1.44% moisture, 14.64% crude fat, 1.20% total minerals, 9.23% crude protein and 73.48% total carbohydrates. The glucosinolates content was 2.20 μmoles/g defatted sample.

Keywords
Mustard meal, Supplementary food, Panjiri, Glucosinolates, Color value

Introduction

Mustard (Brassica juncea) meal is the by-product produced after extraction of seed oil by physical or chemical processes or a combination thereof. About 60 per cent of residue is left as cake after oil extraction from the seed which is rich source of excellent nutritional quality protein (28-36 per cent) (Das et al., 2009). This potential alternative source of food protein generally finds its applications in animal and poultry feed only. Presence of certain anti-nutritional components such as glucosinolates (Tripathi
and Mishra, 2007), phytates (Rutkowski and Kozlowska, 1979) and polyphenolics such as tannins (Sosulki, 1979) limit its food uses. However, the mustard meal can be diversified to food uses after microwave-assisted processing that is aimed towards reduction of certain anti-nutritional components (Goswami et al., 2020).

Panjiri is a traditional food product prepared from locally available flours of cereal grains such as wheat, rice or maize and legumes, sugar, ghee, and various dry fruits using household technologies like blending and roasting (Salve et al., 2011). The type and quantity of the ingredients may vary from place to place. It is usually consumed as a supplementary food for improvement of nutritional status by pregnant and lactating women (Sonkar and Singh, 2010; Satter Miah et al., 2016) because pregnancy and lactation are the most nourishment demanding stages of women’s life. During these stages, the nutritional status of women is not only important for their health but is closely linked to the well being of the child also. The cereals although are good source of energy (350 calories per 100g), but are relatively poor source of protein. Hence, various studies have been aimed towards enhancing nutritional value of panjiri by incorporating other ingredients also (Gurwara et al., 2016; Kajale et al., 2014). The prevailing malnutrition among mothers and children of low socio-economic groups has led Food and Agricultural Organization (FAO) to suggest development of supplementary foods based on locally available food crops also (Baskaran et al., 2001). In recent years, food utilization of by-products of food crops has also been emphasized and studied by many.

Hence, the present study was aimed towards investigating the effect of incorporation of B. juncea meal, obtained after microwave-assisted processing for reduction of selected anti-nutritional components, on nutritional and sensory acceptability of panjiri, a supplementary food.

Materials and Methods

Preparation of PMM and panjiri

Indian mustard seeds (cv PBR 91) were procured from Department of Plant Breeding and Genetics, PAU, Ludhiana (India). After cleaning and conditioning (10 per cent moisture) the oil expelling was done using Mini oil mill (Komet, CA59G, Germany). The cake left was repeatedly extracted with n-hexane to obtain defatted mustard meal (≈1 % fat) which was further subjected to microwave-assisted processing according to Goswami et al., (2020) to obtain processed mustard meal (PMM) which contained 9.53 µmoles glucosinolates/g defatted meal.

Panjiri samples were prepared after progressive replacement of whole wheat flour (0-20%) with PMM in the formulation. Panjiri containing whole wheat flour only was taken as control. The formulation used for preparation of panjiri is given in Table 1. Whole wheat flour (atta) or the blend was roasted in ghee till proper browning (8-10 min) and then cooled to room temperature. The powdered sugar was then added and mixed properly. The panjiri samples were then packed in polypropylene bags for further analyses to assess the effect of incorporation of B. juncea meal.

Color attributes

The panjiri samples were evaluated for their color characteristics by using the HunterLab miniScan XE Plus colorimeter (Model 45/0-L, HAL, USA). The samples were placed in petri dishes and data were recorded (n=8) for L* value (lightness, range 0-100), a* value (redness/greenness) and b* value...
(yellowness/blueness). The $L^*$, $a^*$ and $b^*$
values were further used to compute the total
color difference ($\Delta E^*$), hue ($h^o$) and chroma
($C$) as follows:

$$\Delta E^* = \left[ (\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2 \right]^{1/2}$$

$$h^o = \tan^{-1}(b^*/a^*)$$

$$C = [a^*^2 + b^*^2]^{1/2}$$

**Sensory acceptability**

The sensory acceptability of *panjiri* samples
was evaluated in terms of appearance, texture,
flavour, taste and overall acceptability. The
samples coded in random 3 digit numbers
were evaluated by sensory panel comprising
of 10 semi trained persons aged between 25
and 50. The panel rinsed their mouth with
water in between the evaluation of different
samples. The panellists were asked to score
the sensory attributes on a Nine point Hedonic
scale (1-dislike extremely to 9-like extremely).

**Determination of chemical constituents**

The proximate composition of control and
10% PMM based *panjiri* sample (OAA score
7.55) was determined with the standard
AACC (2000) methods. The glucosinolates
content was determined according to the
method of Kumar *et al.*, (2004) with little
modification as described by Goswami *et al.*, (2020). Briefly, sample (0.2 g) along with 0.3
ml of 60% methanol was heated in a water
bath (80°C, 5 min) till complete evaporation
of alcohol. After addition of distilled water (4
ml), the content was subjected to heating
again and centrifugation (4000 rpm, 20 min).
After mixing of 40μl of supernatant and 4 ml
of 0.2 mM sodium tetrachloropalladate
solution, the absorbance was recorded 1 h
later at 405 nm. The glucosinolates content
was expressed as μmoles/g defatted sample
against the standard of sinigrin. Minimum
three replicates were assayed.

**Statistical analysis**

The analysis was performed at least in
triple and results were expressed as means
along with standard deviation. The significant
difference between the samples ($P < 0.05$)
was determined with the help of analysis of
variance (ANOVA) test using SPSS, Version
20 statistical software. In case of significant
differences Tukey’s Multiple Comparison
Test was applied to determine mean values
which differ significantly ($P < 0.05$) from
others.

**Results and Discussion**

**Color attributes of panjiri**

The color attributes of the *panjiri* samples in
terms of $L^*$, $a^*$ and $b^*$ value, total color
difference, Chroma and Hue are shown in
Table 2. The $L^*$, $a^*$ and $b^*$ value of PMM
was 47.11, 4.71 and 15.66, respectively. The
processed mustard meal incorporation caused
darkening of the product as evident by the
decrease in $L^*$ value of control (70.58) to
59.74 at 20 per cent PMM incorporation level
and which may be attributed to the $L^*$ value
of the PMM itself. Similar effect of processed
mustard meal incorporation on $L^*$ value of
cookies has been reported (Goswami *et al.*, 2020).

The mustard meal, during the processing
treatment, may have undergone some
chemical changes such as Maillard browning
leading to darkening of the meal which
affected the lightness of the products also.
There was observed decrease in redness with
increasing level of PMM and is indicated by
the decreased $a^*$ value from control (7.43) to
20 per cent PMM sample (5.36). There was
greater yellowness in control *panjiri* sample
($b^*$ value 25.32) than the sample with
maximum PMM level in the present
investigation ($b^*$ value 17.63).
Table 1: Panjiri formulation

| Ingredient                         | Quantity (g/100g) |
|------------------------------------|-------------------|
| Wheat flour (Atta) / blend         | 65                |
| Powdered sugar                     | 22                |
| Ghee                               | 13                |

Table 2: Effect of PMM on color attributes of Panjiri

| PMM (%) | L*       | a*       | b*       | ΔE       | Chroma  | Hue (°)   |
|---------|----------|----------|----------|----------|---------|-----------|
| 0       | 70.58 ± 0.92<sup>d</sup> | 7.43 ± 0.21<sup>c</sup> | 25.32 ± 0.89<sup>c</sup> | 0        | 26.39 ± 0.88<sup>e</sup> | 73.65 ± 0.50<sup>b</sup> |
| 5       | 68.79 ± 0.80<sup>c</sup> | 6.32 ± 0.16<sup>b</sup> | 21.84 ± 0.44<sup>a</sup> | 4.13 ± 0.47<sup>a</sup> | 22.74 ± 0.42<sup>d</sup> | 73.86 ± 0.51<sup>b</sup> |
| 10      | 67.45 ± 0.68<sup>b</sup> | 6.28 ± 0.23<sup>b</sup> | 19.43 ± 0.23<sup>c</sup> | 6.79 ± 0.39<sup>b</sup> | 20.43 ± 0.24<sup>c</sup> | 72.08 ± 0.63<sup>a</sup> |
| 15      | 59.92 ± 0.37<sup>a</sup> | 5.45 ± 0.34<sup>a</sup> | 18.76 ± 0.26<sup>b</sup> | 12.68 ± 0.34<sup>b</sup> | 19.54 ± 0.28<sup>b</sup> | 73.80 ± 0.96<sup>b</sup> |
| 20      | 59.74 ± 0.60<sup>a</sup> | 5.36 ± 0.39<sup>a</sup> | 17.63 ± 0.34<sup>a</sup> | 13.46 ± 0.42<sup>d</sup> | 20.43 ± 0.24<sup>c</sup> | 73.09 ± 1.12<sup>b</sup> |

PMM- Processed mustard meal
Data represent mean values ± standard deviation (n=8) for each sample. Mean values followed by different lowercase superscript letters within a column are significantly different (P < 0.05 using Tukey’s test)

Table 3: Effect of PMM on sensory acceptability of Panjiri

| PMM (%) | Appearance | Texture | Aroma | Taste | OAA* |
|---------|------------|---------|-------|-------|------|
| 0       | 8.10 ± 0.57<sup>b</sup> | 8.30 ± 0.71<sup>c</sup> | 8.10 ± 0.74<sup>b</sup> | 8.15 ± 0.71<sup>d</sup> | 8.30 ± 0.54<sup>c</sup> |
| 5       | 8.15 ± 0.41<sup>b</sup> | 7.70 ± 0.54<sup>c</sup> | 7.95 ± 0.80<sup>b</sup> | 8.00 ± 0.53<sup>d</sup> | 8.05 ± 0.44<sup>bc</sup> |
| 10      | 7.80 ± 0.59<sup>b</sup> | 7.45 ± 0.69<sup>bc</sup> | 7.30 ± 0.63<sup>ab</sup> | 7.20 ± 0.67<sup>c</sup> | 7.55 ± 0.50<sup>b</sup> |
| 15      | 6.75 ± 0.98<sup>a</sup> | 6.65 ± 1.06<sup>ab</sup> | 6.85 ± 0.67<sup>a</sup> | 6.25 ± 0.72<sup>b</sup> | 6.75 ± 0.54<sup>a</sup> |
| 20      | 6.35 ± 1.20<sup>a</sup> | 6.30 ± 1.09<sup>a</sup> | 6.70 ± 0.54<sup>a</sup> | 5.30 ± 0.82<sup>a</sup> | 6.20 ± 0.54<sup>a</sup> |

(PMM- Processed mustard meal; OAA- Overall acceptability)
Data represent mean values ± standard deviation (n=10) for each sample. Mean values followed by different lowercase superscript letters within a column are significantly different (P < 0.05 using Tukey’s test)

Table 4: Nutritional composition of Panjiri

| Components                          | Control Panjiri | 10 per cent PMM Panjiri |
|-------------------------------------|-----------------|-------------------------|
| Moisture (%)                        | 0.28            | 1.45                    |
| Moisture (%)                        | 0.28            | 1.44                    |
| Protein (%)                         | 7.66            | 9.23                    |
| Crude fat (%)                       | 14.56           | 14.64                   |
| Ash (%)                             | 1.04            | 1.20                    |
| Carbohydrates (%)                   | 76.46           | 73.48                   |
| Glucosinolates (μmoles/g defatted sample) | 0.00            | 2.20                    |
Progressive replacement of whole wheat flour with PMM even at 5 per cent level caused significant color difference as indicated by ΔE value of 4.13. Further replacement linearly caused greater difference at each level of PMM incorporation with maximum ΔE value of 13.46 at 20 per cent PMM level. The Hue and Chroma values also decreased with increasing level of PMM in the formulation.

**Sensory acceptability**

Sensory acceptability of the prepared panjiri samples was also determined using 9 Point Hedonic Scale for parameters such as appearance, texture, aroma, taste and overall acceptability (Table 3). Results of appearance and overall acceptability showed that there was no significant difference (p > 0.05) between panjiri made by incorporating PMM. The addition of PMM decreased the mean score of appearance from 8.10 to 6.35. Panjiri prepared by incorporating 5 per cent PMM was ranked the most acceptable with an overall acceptability of 8.05, whereas panjiri prepared by incorporating 20 per cent PMM ranked minimum with score of 6.20. The values for the score of taste of the panjiri samples ranged from 8.15 to 5.30. The presence of phenolic compounds in PMM that impart bitterness may be held responsible for the decreasing score for taste with increasing level of PMM.

**Nutritional analysis**

The control panjiri and panjiri prepared with maximum accepted PMM level (10%) was analyzed for proximate composition and glucosinolates content. The observations are presented in Table 4. The panjiri samples exhibited protein content in the range of 7.66 to 9.23 and the higher value was for 10 per cent PMM based panjiri. Goswami et al., (2020) also reported increase in protein content of cookies upon incorporation of processed mustard meal. The ash content was 1.04 per cent in control and 1.20 per cent in the 10 per cent PMM panjiri. The glucosinolates were present in 10 per cent PMM panjiri (2.20 μmoles/g defatted sample) but the level was too low.

The health benefiting effects of glucosinolates have been established in literature as anti-carcinogenic etc. but only when present in small quantity.

In conclusion the present study was carried out to diversify the use of B. juncea meal, a by-product of oil milling industry, in supplementary foods due to its greater protein content. Mustard meal application in food is generally limited by the presence of certain anti-nutritional components. This study established that B. juncea meal which is generally moved towards feed applications, could be used as an acceptable ingredient of panjiri after microwave-assisted processing that was aimed towards reduction of certain anti-nutritional components.

The incorporation of PMM affected the color attributes of panjiri and made it to appear darker. There was significant increase in total color difference with increasing level of PMM. The product made with maximum 10% PMM was found to be good in terms of sensory acceptability as well as nutritional indices. PMM incorporation increased the protein and ash content of the panjiri. From this study it may be concluded that utilization of B. juncea meal, an oil milling by-product, can be diversified to food uses after reduction of anti-nutritional components and enhancement of palatability through microwave-assisted processing. The processed B. juncea meal can thus be effectively utilized as an ingredient of supplementary foods propagating the
important aspects like by-product utilization and low cost health foods using locally available crops.

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