ORIGINAL ARTICLE

Nutritional and Physicochemical Properties and Shelf Life Analysis of Mulberry Powder Incorporated Bread

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ABSTRACT The mulberry fruit are edible, good texture, delicious taste and nutritional qualities. The mulberry fruit called super fruit also. Because of their nutritional qualities the black mulberry powder was used in the production of bread. Firstly, the proximate nutrients, some vitamin and minerals, non nutrient compounds and antioxidant compounds were assessed in dry black mulberry powder. Then the products were prepared by incorporation of black mulberry powder. The bread were prepared in four variants- variant A (5% black mulberry powder), variant B (10% black mulberry powder), variant C (20% black mulberry powder), variant D (30% black mulberry powder). All the variants were examined for sensory acceptability. The most acceptable variant of bread found was variant C. The proximate composition, mineral and vitamin content, physical evaluations and shelf life analysis were performed on all the variants. And the some differential nutrients components like soluble carbohydrate, amylase, amylpectin, resistance starch, saturated fatty acid, linoleic acid, selenium, zinc and vitamin E were performed only the most acceptable variant of bread (variant C). In proximate analysis, mulberry powder was found to be rich in carbohydrate, ash, vitamin C and calcium. The mulberry powder was low in crude fiber, fat, moisture and iron. In non nutrients compounds mulberry powder was found to contain saponins, alkaloids and the powder was low in total polyphenol, tannins and total flavonoids. In antioxidant activity DPPH was rich in mulberry powder and metal chelating activity was found low in mulberry powder.

Keywords: Mulberry, Compounds, Vitamin E, Selenium, Shelf life

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INTRODUCTION

Scientific Classification

Botanical name - *Morus nigra L.*

Common name - *Black mulberry, shahtoot*

Kingdom - *Plantae*

Family - *Moraceae*

Order - *Rosales*

Genus - *Morus*

Tribe - *Moreae*

Species - *M. nigra*[1]

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Mulberry belongs to the genus Morus of the family Moraceae. The most mulberry cultivated are- the white mulberry (*Morus alba*), black mulberry (*Morus nigra*) and the American mulberry or red mulberry (*Morus rubra*). Mulberries are eaten by fresh form and prosessed form like pickle, jam, chutney, natural dyes which used in the cosmetics industry[1]. The mulberry fruit contains of water, carbohydrate (sugars, mainly glucose and fructose), protein, fat (mainly fatty acids, such as linoleic, stearic, and oleic acids in the seeds), free acids (mainly malic acid), fiber, minerals and vitamin C, ash, energy, thiamine,

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riboflavin, niacin, âcarotene, calcium, zinc[2], amino acids, pectin, fibrin, citric acid, mucilage[3], polyphenol components like anthocyanins (flavonoids, cyanidin-3-O-glucoside and cyanidin-3-O-rutinoside) (Kamiloglu *et al.*, 2013). Because of all these compounds mulberry fruit was help to control the some major diseases like- antidiabetic, antioxidative, antiinflammatory, antihyperlipidemic activities[4], neuroprotecting effect, cardioprotective effect, antiallergic, antithrombotic, hepatoprotective, antiviral, carcinogenic activities[5] and some chronic diseases like Alzheimer's disease, many forms of cancer, Parkinson's disease, degenerative diseases such as chronic arthritis and atherosclerosis[2]. These all compounds was protects our body from the harmful oxidation of free radicals, cyaniding 3-glucoside of mulberry helps to protects our body against cardiovascular disease, diabetes and improving the blood circulation level in human body[1].

Production

In India the mulberry fruit was cultivated at Panchagani, Maharashtra, wide spread in northern India. Mulberry fruit has been commercially produced in China, Japan and Korea[1], Turkey, Asia, Europe (Ukraine), North America, South America, and Africa, Pakistan, Iran, Afghanistan, Iraq, Pakistan, Syria, Lebanon, Jordan, Palestine and Israel[6].

Morphological Characters

- The mulberry is deciduous tree which grow around 12 meter tall and 15 meter broad. The leaves of mulberries are 12-20 cm long and 5-10 cm broad.
- The fruit is dark purple in color. Sometimes it looks like in black color. The mulberry fruit was long around 2-3 centimeters.

But the consumption of fruit is low in India. If they are used in different food products their health benefits can be obtained. So the present study was done to prepare bread by incorporation of black mulberry powder. Nutritive value of black mulberry powder and incorporated products-bread was also assessed along with their sensory acceptability.

MATERIAL AND METHODS

Making of Mulberry Powder: Mulberry fruit was purchased from the local market of Ghaziabad, washed and blanched for 2 minutes then sliced mashed. The mulberry pieces were dried by using hot air oven at 60 °C. After drying of mulberry fruit converted into a powder form in the milder grinder. Then nutritional composition of powder was estimated and then incorporated in bread in different propositions.

Nutritional Composition of Powder

Proximate Compounds: Moisture content was determined by hot air oven method[7], Mineral ash was determined by charring method[7], Crude fat content were determined by soxhlet method[7]. Crude fiber content was determined by acid and alkali digestion method[8], Crude protein was determined by Micro kjeldahl method[8], carbohydrate was determined by difference method.

Mineral Compounds: Iron content was determined by Wong's method[7]. Calcium content was determined by titrametric method[8].

Vitamin Compounds: Vitamin C were determined by dye (2,6 dichlorophenol indophenol) titration method[8].

Non Nutrients Compounds: Total polyphenol, alkaloids, tannins, total flavonoids, saponins were determined by standard methods[9].

Antioxidant Capacity: DPPH (1-diphanyl-2-picryl hydrazyl)[10] [The DPPH assay compound- standard ascorbic acid solution were used as control group in different concentration- 10 µg/ml, 25 µg/ml, 50 µg/ml, 75 µg/ml and 100 µg/ml], metal chelating activity[11].

Preparation of Bread

For the standard bread in a medium bowl all the ingredients- Flour, salt, sugar, margarine, dried yeast were mixed with wooden spoon in mixing bowl. Then water was added and makes dough and leaves it for five minutes. Then shape of bread was given to the dough and placed it on the greased baking tray. Now set the oven at the temperature at 450 °F and placed the baking tray into the oven. And bake the loaf for 25-30 minutes. Then cool it slightly and stored in airtight container. The mulberry powder was incorporated in four proportions. The powder proportions are- the variant A bread was incorporated 5% of powder, variant B bread was incorporated 10% of powder, the variant C was incorporated 20% of powder, the variant D was incorporated 30% of mulberry powder.

Nutritional Composition of Bread

Proximate Compounds: In proximate compounds moisture content, mineral ash content, crude fat content, crude fiber content, protein content and carbohydrate content was also assessed in all the variants.

Mineral Compound: In mineral content iron content and calcium content was assessed in all the variants.

Vitamin Compound: The vitamin C was also analyzed in all the variants.

Physical Analysis: Physical parameters were determined all the samples (standard sample, A variant, B variant, C variant, D variant). Total soluble solids (TSS) (brix hand refractometer, RHB-32), Titrable acidity[8], Water activity (thermocouple detector), Texture profile analysis (TA XT2 texture analyzer), Viscosity (viscometer) and pH (pH meter).

Table 1: Ingredients of Standard Bread

Ingridents	Amount
All purpose flour	265.0 gm
Salt	3.50 gm
Margarine	15.0 gm
Easy bland dried yeast	7.00 gm
Sugar	40.0 gm
Warm water	170 ml

Shelf Life Analysis or Storage Ability of Bread: In the storage ability of bread Microbial load like- TPC, coliform and yeast & moulds (Standard plate count) was analyzed in all the variants.

Differential Nutrients Components: In the differential nutrients compounds were include these compounds which are- Soluble Carbohydrate[12], Amylose[13], Amylopectin[14], Resistant Starch[15], Saturated Fatty Acids[16], Conjugated Linoleic Acid[17], Vitamin E[18], Selenium[19], Zinc[20] was assessed only the acceptable bread variant C.

Sensory Evaluation of Bread: Acceptability rating of the products was tested with the help of semi trained panel selected on the basis of threshold and discrimination tests. Twenty panel members were selected by triangle test and directed to judge each samples on the basis of appearance, colour, flavour, odour, texture, mouth feel, over all acceptability and indicate their degree of liking on a nine point of hedonic scale (Aziah *et al.*, 2012). The age range of the panel members was between 25-28 year olds and all the panel members are females only.

Statistical Analysis: Data was analyzed with means and standard deviation. Three replications were used for all the analysis.

RESULTS AND DISCUSSION

Nutritional and chemical composition of black mulberry powder per 100 g is depicted in Table 2. The nutritional and chemical composition is as follows, carbohydrate content 88.30±0.45 gm/100 gm, crude fat content 1.60±0.10 gm/100 gm, protein content 1.73±0.27 gm/100 gm, moisture content 0.46±0.05 gm/100 gm, mineral ash content 6.31±0.28 gm/100 gm, crude fiber content 1.55±0.09 gm/100 gm, vitamin C content 35.80±0.92 mg/100 g, calcium content 20.40±0.40 mg/100 g, iron content 9.02±0.02 mg/100 gm.

In non nutrient composition is as follows, saponins 16.30±0.41 mg/100 g, alkaloids 2.73±0.11 mg/100 g, total polyphenol 0.16±0.12 mg/100 g, tannins 0.02±0.01 mg/100 g, total flavonoids 0.05±0.01 mg/100 g is depicted in Table 2. The results obtained were same as the finding with other auther[4].

In antioxidant activity, DPPH activity was 5.75±0.24 mg/100 g and metal chelating activity was Ethylenediamine 0.03±0.00 mg/100 g, Porphine 0.04±0.01 mg/100 g, Heme 0.30±0.00 mg/100 g, Dimercap 0.01±0.00 mg/100 g. The antioxidant

Table 2: Nutritional and Chemical Composition of Powder

Parameters	Result (Mean ± SD)
Proximate Analysis	
Moisture (gm/100 gm)	0.46±0.05
Mineral ash (gm/100 gm)	6.31±0.28
Crude fat (gm/100 gm)	1.60±0.10
Crude fiber (gm/100 gm)	1.55±0.09
Protein (gm/100 gm)	1.73±0.27
Carbohydrate (gm/100 gm)	88.30±0.45
Iron (mg/100 g)	9.02±0.02
Calcium (mg/100 g)	20.40±0.40
Vitamin C (mg/100 g)	35.80±0.92
Non Nutrients	
Total polyphenol (mg/100 g)	0.16±0.12
Alkaloids (mg/100 g)	2.73±0.11
Tannins (mg/100 g)	0.02±0.01
Total flavonoids (mg/100 g)	0.05±0.01
Saponins (mg/100 g)	16.30±0.41

Table 3: Antioxidant Activity of Red Cherry Powder

Antioxidant Activity	Results (Mean ± SD)
DPPH (mg/100 g)	5.75±0.24
Metal Chelating Activity	
Ethylenediamine (mg/100 g)	0.03±0.00
Porphine (mg/100 g)	0.04±0.01
Heme (mg/100 g)	0.03±0.00
Dimercap (mg/100 g)	0.01±0.00

compounds are shown in Table 3. Results obtained were in agreement with the finding of other authers[4].

Nutritional and Physical Characteristics of Bread Incorporated with Black Mulberry Powder: The nutritional and physical composition of bread is shown in Table 4. The standard bread were found low in protein 12.70±0.40 gm/100 gm as compared to bread incorporated with black mulberry powder and variant D bread was found to contain highest protein content 21.40±0.40 gm/100 gm. So the mulberry powder helps to increase the amount of bread protein. In all the variants of bread (A, B, C, D) the carbohydrate was low as compared to standard bread because the mulberry powder was low in the carbohydrate content. The standard bread was high in carbohydrate 62.90±0.40 gm/100 gm and variant D was low in carbohydrate 29.60±0.30 gm/100 gm.

The mulberry powder incorporated bread was high in crude fiber the mulberry powder increase the crude fiber in all the variant bread and the standard bread were low in crude fiber 4.20±0.20 gm/100 gm. The standard bread were found low in fat 4.10±0.04 gm/100 gm and the variant D bread 16.40±0.40 gm/100 gm were found high in fat as compared to other bread. The variant A bread were found low in mineral ash 2.20±0.30 gm/100 gm and the standard bread were found rich in mineral ash 8.30±0.10 gm/100 gm. The mulberry powder was increase the moisture content of all the variant bread. The variant D was high in moisture content 17.40±0.40 gm/100 gm and standard bread low in moisture content 7.80±0.30 gm/100 gm. In mineral content the standard sample of bread were found low in iron content 18.50±0.50 mg/100 g and variant D were found high in iron content 29.20±0.20 mg/100 g. In calcium content the standard sample were found low 12.50±0.50 mg/100 g and the variant D bread were found high in calcium content 26.50±0.20 mg/100 g. The results are similar with the reported literature by[6].

In physical activity the variant A (Table 5) were found low in total soluble solids content 40.00±0.40% and variant D bread were found high in total soluble solids content 46.30±0.30%. The standard sample was found low in water activity1.30±0.01% and the variant D bread was found high in water activity 2.70±0.30%. The standard sample was found low in pH 6.10±0.10 and variant D bread was found high in pH 7.20±0.30. The results are similar with the reported literature by[6].

The textural properties of bread were shown in Table 6. The variant A 45.10±0.30 Pas/Sec and standard sample 45.70±0.40 Pas/Sec bread were found low in viscosity and variant D bread were high in viscosity 68.20±0.30 Pas/Sec. The standard sample were found low in breaking strength 0.20±0.10 N/nm^2 and variant C sample were found high in breaking strength 0.06±0.03 N/nm^2. The incorporated bread was good in breaking strength as raise the powder percentage. The viscosity was also improved the variants A, B, C and D as compare to standard sample.

Shelf Life Analysis

The shelf life analysis of bread was shown in Table 7. The standard bread were found high in TPC 3386 cfu/gm as compare to variant B, variant C, variant D but variant A were found high in TPC 4908 cfu/gm as compare to standard sample. The coliform were absent in all the samples. The

Table 4: Nutritional Composition of Bread

Parameters		Results (Mean ± SD)			
Proximate Analysis	**Standard**	**Variant A**	**Variant B**	**Variant C**	**Variant D**
Moisture (gm/100 gm)	7.80±0.30	15.30±0.40	15.40±0.40	16.50±0.40	17.40±0.40
Mineral ash (gm/100 gm)	8.30±0.10	2.20±0.30	2.20±0.30	2.30±0.30	2.80±0.10
Fat (gm/100 gm)	4.10±0.04	12.60±0.40	13.50±0.40	15.60±0.20	16.40±0.40
Crude fiber (gm/100 gm)	4.20±0.20	8.70±0.20	9.40±0.50	11.60±0.40	12.40±0.30
Protein (gm/100 gm)	12.70±0.40	16.90±0.30	17.00±0.40	19.70±0.30	21.40±0.40
Carbohydrate(gm/100 gm)	62.90±0.40	44.30±0.30	42.50±0.40	34.30±0.30	29.60±0.30
Iron (mg/100 g)	18.50±0.50	24.20±0.20	25.50±0.40	27.50±0.40	29.20±0.20
Calcium (mg/100 g)	12.50±0.50	20.50±0.20	22.60±0.30	24.40±0.20	26.50±0.20
Vitamin C (mg/100 g)	0	0	0	0	0

Table 5: Physico-Chemical Properties of Bread

Parameters		Results (Mean ± SD)			
Physical Analysis	**Standard**	**Variant A**	**Variant B**	**Variant C**	**Variant D**
Total soluble solids (%)	40.00±0.06	40.00±0.40	45.50±0.30	44.30±0.40	46.30±0.30
Water activity (%)	1.30±0.01	1.30±0.40	2.40±0.20	2.40±0.30	2.70±0.30
pH	6.10±0.10	6.10±0.30	6.70±0.30	6.80±0.10	7.20±0.30

Table 6: Textural Properties of Bread

Parameters		Results (Mean ± SD)			
Texture Profile Analysis	**Standard**	**Variant A**	**Variant B**	**Variant C**	**Variant D**
Structure	Rectangular	Rectangular	Rectangular	Rectangular	Rectangular
Breaking strength (N/nm^2)	0.20±0.10	0.20±0.02	0.05±0.02	0.06±0.03	0.06±0.02
Viscosity (Pas/Sec)	45.70±0.40	45.10±0.30	66.40±0.20	65.60±0.30	68.20±0.30

Table 7: Shelf Life Analysis

Parameters	Standard	Variant A	Variant B	Variant C	Variant D
TPC (cfu/gm)	3386	4908	3312	3336	3348
Coliform (gm)	0	0	0	0	0
Yeast&Mould (cfu/gm)	1520	1560	1560	1560	1560

yeast and mould of bread standard sample was low 1520 cfu/gm as compare all the four variants (variant A 1560 cfu/gm, variant B 1560 cfu/gm, variant C 1560 cfu/gm, variant D 1560 cfu/gm).

Differential Nutrients Components for Accepted Bread Products

The differential nutrients compounds were performed only accepted bread variant and standard sample only. The differential nutrients compounds are soluble carbohydrate, amylase, amylopectin, resistant starch, saturated fatty acids, conjugated linoleic acid, vitamin E, selenium and zinc. The soluble carbohydrate was rich in variant C 42.20±0.20 gm/100 gm as compare to standard sample 41.20±0.20 gm/100 gm. The amylase content was rich in standard sample 4.20±0.20 mg/100 gm and the variant C were found low

Table 8: Differential Nutrients Components

Parameters	Standard Sample (Mean ± SD)	Variant C (Mean ± SD)
Soluble carbohydrate (gm/100 gm)	41.20±0.20	42.20±0.20
Amylase (mg/100 gm)	4.20±0.20	3.20±0.20
Amylopectin (mg/100 gm)	6.40±0.40	5.20±0.30
Resistant starch (gm/100 gm)	12.20±0.20	11.30±0.30
Saturated fatty acids (%)	0	0
Conjugated linoleic acid (%)	12.20±0.20	10.20±0.20
Vitamin E (mg/100 gm)	0	0
Selenium (ppm/100 gm)	0.20±0.10	0.20±0.07
Zinc (ppm/100 gm)	1.70±0.10	1.50±0.20

3.20±0.20 mg/100 gm. The standard sample amylopectin was high 6.40±0.40 mg/100 gm as compare to variant C 5.20±0.30 mg/100 gm. Resistant starch was high in variant C 11.30±0.30 gm/100 gm as compare to standard sample 12.20±0.20 gm/100 gm. The saturated fatty acid content was absent in both the samples. In conjugated linoleic acids variant C 10.20±0.20% was found low as the standard sample 12.20±0.20%. The vitamin E content was found absent in both the samples. The selenium content of both the samples was found almost the same standard sample 0.20±0.10 ppm/100 gm and variant C 0.20±0.07 ppm/100 gm. The zinc content was high in standard sample 1.70±0.10 ppm/100 gm as the variant C sample 1.50±0.20 ppm/100 gm.

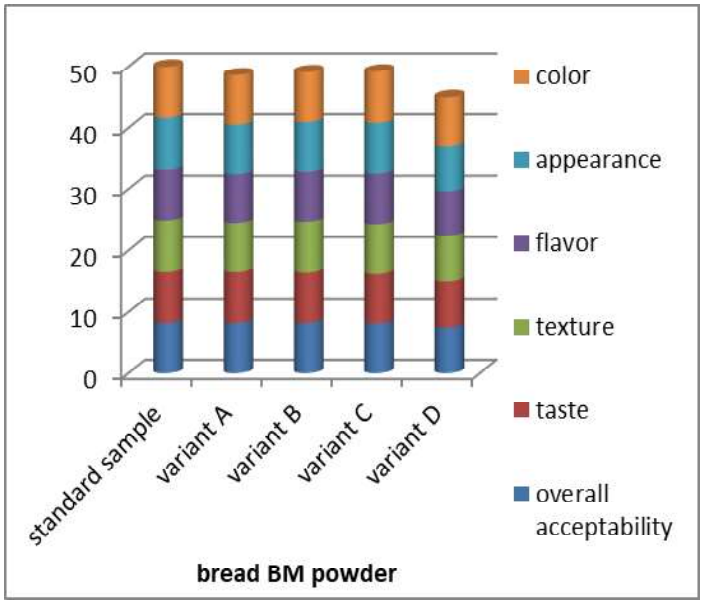
Sensory Acceptability of Bread Incorporated with Black Mulberry Powder

The sensory evaluation of bread is presented in table 9. Bread prepared from black mulberry powder was rated high in good color of all the bread. All four variant are good appearance with not lot of significant difference as compared to standard sample. The flavor was also good for all the variants. The texture and taste of bread was good like standard bread. The overall acceptability of all the bread was good. The standard bread and variant C bread have significant little difference in overall acceptability. Because as compare to standard sample the other all four variant were also good in color, appearance, texture, taste and overall acceptability. The flavor was also good for all the variants. The texture and taste of cookies was good like standard cookies. The overall acceptability of all the bread was good. But as compare about all the variants (A, B, C and D) variant C was the most acceptable bread in all the other variants. Variant C was accepted because of the parameters which include in this study (color, appearance, flavor, texture, taste and overall acceptability). The sensory parameters were help to decide the accepted bread (variant C).Variant C was the best incorporate bread out of all the four variants. Variant C is best because it is good in attractive color, good appearance, flavor, texture, good taste and it is easily overall acceptable as compare to other three variants A, B and D. The sensory acceptability was based on the parameters and the nutritional and physical characteristics were different. The nutritional and physical characteristics are based on the results which obtained in the study.

Table 9: Sensory Evaluation of All Bread

Parameters	Standard Sample	Variant A	Variant B	Variant C	Variant D
Color	8.40±0.60	8.10±0.60	8.20±0.60	8.40±0.60	8.04±0.90
Appearance	8.40±0.70	8.10±0.40	8.10±0.60	8.30±0.80	7.40±1.20
Flavor	8.40±0.70	8.00±0.50	8.20±0.60	8.30±0.70	7.30±1.30
Texture	8.40±0.70	8.00±0.50	8.30±0.60	8.10±0.60	7.40±1.30
Taste	8.20±0.90	8.20±0.50	8.10±0.60	8.00±0.60	7.40±1.30
Overall acceptability	8.20±1.00	8.20±0.50	8.20±0.60	8.10±0.60	7.50±1.30

Figure 2: Mean Values of Hedonic Acceptability Score of Bread Incorporated by BM Powder



CONCLUSION

A successful and innovative bread formulas production with black mulberry powder was developed. The consumption of black mulberry fruit is able to improve the human health. The fruit is capable to overcome so many diseases like heart diseases, cancer prevention, help to prevent arthritis and gout, diabetes. Additionally, the black mulberry powder is able to improve the bread properties either it is physicochemical or physical. But it could be recommended that using of black mulberry should be encouraged in food industries to utilize local raw materials economically to produce high functional food products.

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