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Use of Mango Seed Kernels for the Development of Antioxidant Rich Biscuits

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Abstract: ***Mango seeds are nutritionally dense by-product of mangoes but commonly discarded as waste. The purpose of the study was proper utilization of mango seed kernels. Mango seed kernels were processed and flour was prepared for the development of antioxidant rich biscuits. One control and four experimental samples were prepared by incorporating 10-40 percent level of mango seed kernel flour and evaluated for their sensory attributes. Control and acceptable experimental sample were analysed for their nutritional composition. Incorporation of mango seed kernel flour in biscuits at 30 percent level was organoleptically acceptable. The energy, crude fat, crude fiber and total ash content of developed biscuits were significantly higher (p<0.01) as compare to control samples. A significant increase (p<0.01) in minerals such as calcium, iron and magnesium content of developed biscuits was found. Antioxidant activity was found to be significantly higher (p<0.01) in mango seed kernel flour supplemented biscuits and percent increase in antioxidant activity was 23 per cent. Hence, the use of mango seed kernel flour can play an important role in improving nutritional value of diets.***

Keywords: mango seed kernel flour, sensory attributes, nutritional composition, antioxidant activity

1. Introduction

Mango is one of the most economically important fruit which is known as "king of fruits". Mango seed is an important part of fruit. After consumption and industrial processing of mango, considerable amount of the seeds are discareded as waste. but nutritionally, fruit seed is the most enriched part of fruit because it acts as a storage site of nutrients. By breaking the hard seed coat of mango seed, kernel is obtained. Mango seed kernel is approximately 20 percent of total fruit weight. Starch, fat and protein are major component of mango seed kernels [1]. Mango seed kernels contain average protein 6, fat 11, carbohydrate 77, crude fiber 2 and ash 2 per cent on dry weight basis [2]. Mango seed kernels contain high amount of iron, potassium, calcium and magnesium. Due to the presence of phenolic compounds, mango seed kernel is a potential source of natural antioxidants. Tannins and flavonoids are major phenolic components in mango seed kernels [3]. It contains tannin 20.7 mg, gallic acid 6.0 mg, cinnamic acid 11.2 mg, ferulic acid 10.4 mg, mangiferin 4.2 mg, vanillin 20.2 mg and caffeic acid 7.7 mg/100 g of dry mango seed kernels weight [4]. Antioxidant activity of mango seed kernel is higher among variety of fruit seeds such as jackfruit, tamarind and avocado due to its high polyphenolic content [5]. Mango seed kernels showed antioxidant effect due to polyphenols, phytosterols and microelements such as zinc, copper and selenium [6], [7]. For supplementation of staple foods, mango seed kernels are processed into flour. Several value added products can be developed from different combination of mango seed kernels flour with other flours. It is utilized as a food preservative because it helps to increase oxidative stability of food.

In recent years, increased interest in health foods has made consumers demand foods with health benefits and acceptable sensory qualities. Many convenient foods enriched with antioxidants and phytonutrients are made accountable. The current study designed for development of food products with incorporation of mango seed kernels flour for nutritional enhancement.

2. Materials and Methods

2.1 Procurement of mango seeds and preparation of flour

During the summer season, ripe mango seeds as by-product were collected from local fruit processing units of ludhiana.

2.1.1 Preparation of mango seed kernels flour

For this purpose, mango seeds were washed, mango seed kernels separated, blanched for 2 minutes, dried at 60° c for 6 hours in hot air oven and ground into flour.

2.2 Product Development

Biscuit were prepared from refined wheat flour and mango seed kernel flour in the ratios of 100:0, 90:10, 80:20, 70:30 and 60:40, respectively. Refined wheat flour biscuits were considered as control. The standardized recipe for the biscuits had the ingredients as 100 g flour, 20 g sugar, 50 g ghee, 2 g salt and 1.2 g baking powder. Fat was rubbed on a clean surface till it became light. Refined flour, mango seed kernels flour and baking powder were sieved togather and gradually added into rubbed fat. Salt and sugar were dissolved in water and made smooth dough with it. The dough was rolled out with rolling pin and cut into desired shape with cutter. The cut pieces were placed over a perforated tray and baked at 150° C for 20 minutes.

2.3 Sensory analysis of biscuits

Biscuits were evaluated for sensory characteristics by a panel of 10 semi-trained members using a 9 point hedonic scale. The judges were served each preparation with one control and four experimental samples. Biscuits were

evaluated for their color, appearance, flavour, texture, taste and overall acceptability [8]

2.4 Proximate analysis

Protein, fat, moisture, ash and crude fiber were determined by the AOAC methods [9]. The carbohydrate content was calculated by difference method.

2.5 Estimation of mineral content

Samples were prepared by wet digestion method [9] in which 0.5 gm of sample which was moisture free was taken in the conical flask and 25 ml of diacid (nitric acid and perchloric acid were mixed in the ratio 5:1) was added to each sample. Samples were digested on hot plate till 1ml volume is left and colourless. Then volume was made to 100 ml and after it was filtered through whatman no. 41 filter paper. representative sample in a suitable liquid form is sprayed into the flame of an atomic absorption spectrophotometer and the absorption or emission of the mineral to be analysed was measured at a specific wavelength.

2.6 Antioxidant activity

Two gram of dried sample was extracted with 20 ml methanol (99.5%). the extraction process was done twice (20 ml + 20 ml) each for 2 hours in a shaking machine. supernatant was filtered using whatman no. 1 filter paper after centrifuging the suspension at 10,000 rpm for 15 minutes. an aliquot of 0.1 ml of the samples was taken in a test tube and then 2.9 ml of 0.01mm dpph reagent was added, vortexed and let to stand at room temperature in the dark for 30 minutes. the decrease in absorbance at 517 nm was measured. antioxidant activity (aa) was expressed as percentage inhibition of the dpph radical and was determined by the following equation:

$$\text{Antioxidant activity \%} = (1\text{-}a/b \times 100)$$

where, a = absorbance of the sample, b = absorbance of the blank.

2.7 Statistical analysis

The data were analysed with the help of statistical tools such as mean, standard error and to test the significant difference between the control and experimental samples, kruskal wallis and two tail t-test were applied using SPSS 16 software.

3. Results

3.1 Proximate composition of mango seed kernel flour and refined wheat flour

Proximate composition of mango seed kernel flour and refined wheat flour is presented in Table 1. Results revealed that mango seed kernel contained higher amount of crude fat (10.50%), crude fiber (2.0%), total ash (2.68%), carbohydrates (76.81%) and energy content (430 Kcal) than refined wheat flour. From the results in Table 1, one can see that replacing mango seed kernel flour with refined wheat flour increase in fat, ash, fiber and energy content of products. A similar research study shown that amngo seed kernel flour was containing protein 10.06, carbohydrate 70.12, oil 14.80, crude fibre 2.40, ash 2.62 percent and energy content 453 KJ/100 g [10].

Table 1: Proximate composition of mango seed kernel flour and refined wheat flour

Nutrients	Mango seed kernel flour	Refined wheat flour
Moisture (%)	9.24±0.05	13.30±0.03
Crude protein (%)	6.80±0.05	10.2±0.10
Crude fat (%)	10.50±0.05	0.90±0.29
Crude fiber(%)	2.00±0.57	0.40±0.10
Total ash (%)	2.68±0.05	1.30±0.04
Carbohydrates(g/100g) (by difference)	76.81±0.25	73.90±0.25
Energy (Kcal)	430±0.05	344±0.05

Values are expressed as Mean±SE

3.2 Mineral analysis of mango seed kernel flour and refined wheat flour

Mineral analysis of mango seed kernel flour and refined wheat flour was done and results are represented in Table 2. Mango seed kernel flour and refined wheat flour contained calcium 59.75 and 15.0 mg/100 g, iron 11.85 and 2.41 mg/100 g, zinc 0.68 and 0.85 mg/100 g and magnesium 94.0 and 29.6 mg/100 g, respectively. Mango seed kernel flour contained higher amount of calcium, iron and magnesiun as compare to refined wheat flour.

3.3 Antioxidant activity of mango seed kernel flour and refined wheat flour

As represents in Table 3, antioxidant activity of MSK flour was higher with 73.0 percent as compared to refined wheat flour which was 22.4 percent. Mango seed kernel has a strong antioxidant activity possibly due to its high phenolic compounds content. On the basis of the wet and dry weight, mango seed kernel had 95 per cent antioxidant activity [5].

Table 2: Mineral analysis of mango seed kernel flour and refined wheat flour

Minerals	Mango seed kernel flour	Refined wheat flour
Calcium (mg/100 g)	59.75±0.05	15.0±0.15
Iron (mg/100 g)	11.85±0.05	2.41±0.15
Zinc (mg/100 g)	0.68±0.05	0.85±0.15
Magnesium(mg/100 g)	94.0±0.05	29.6±0.15

Values are expressed as Mean±SE

Table 3: Antioxidant activity of mango seed kernel flour and refined wheat flour

	Mango seed kernel flour	Refined wheat flour
Antioxidant Activity (%)	73.0±0.05	22.4±0.01

Values are expressed as Mean±SE

3.4 Sensory evaluation of biscuits

Five samples of biscuits were prepared using refined wheat flour for control and for experimental samples, mango seed kernel flour was incorporated with refined wheat flour at different levels (10, 20, 30 and 40%). The mean scores of

organoleptic evaluation of biscuits are presented in Table 4. The data revealed that the E3 experiment (30% mango seed kernels flour) with an overall acceptability score of 7.82 was liked very much by panelists. Although, overall acceptability score of E3 (7.82) was lower than control (7.90) but it was higher among experimental samples. Hence, E3 (30 % mango seed kernels flour) was selected as the final product for analysis.

Table 4: Mean organoleptic scores for biscuits supplemented with mango seed kernels flour (mean±SE)

Proportions	Parameters					
	Appearance	Colour	Texture	Flavour	Taste	Overall acceptability
C (Control)	8.0±0.21	8.0±0.26	7.9±0.23	7.7±0.21	7.7±0.21	7.9±0.23
E1(10 % mango seed kernels flour)	7.6±0.25	7.7±0.23	7.6±0.25	7.5±0.24	7.5±0.22	7.6±0.26
E2(20 % mango seed kernels flour)	7.9±0.22	7.9±0.29	7.6±0.29	7.7±0.23	7.7±0.20	7.7±0.24
E3(30 % mango seed kernels flour)	7.9±0.24	7.9±0.20	7.9±0.20	7.7±0.25	7.7±0.28	7.8±0.20
E4(40 % mango seed kernels flour)	7.7±0.25	7.7±0.20	7.7±0.20	7.5±0.29	7.5±0.27	7.6±0.23
χ^2	2.112^{NS}	1.546^{NS}	1.467^{NS}	1.345^{NS}	1.345^{NS}	2.686^{NS}

NS -non significant

Biscuits supplemented with mango seed kernels powder up to 40 percent obtained higher overall acceptability scores [11]. Whole wheat flour containing up to 30 percent mango seed kernel flour were acceptable for biscuit production without adverse effect on sensory qualities [12].

3.5 Proximate analysis of biscuits

Proximate composition of control and experimental biscuits with 30 percent mango seed kernel flour incorporation is given in Table 5. It was found that moisture content of control sample was 3.87 percent which was lower than experimental sample (30% mango seed kernels flour) with 4.10 percent. Crude protein content of control sample (4.85%) was significantly higher ($p<0.01$) than the experimental sample (4.35%). Crude fat content was higher in experimental sample with 26.03 percent than the control sample with 24.55 percent because mango seed kernels flour contained higher amount of crude fat than refined wheat flour. Our results are in accordance with ifesan (2017) where fat content of whole wheat flour biscuits increased from 3.73 to 4.63 percent with supplementation of mango seed kernel flour. Crude fiber content of experimental sample (0.81%) was significantly increased ($p<0.01$) from control sample (0.30%). Ash content was also lower in control sample that was 1.84 percent as compared to experimental sample that was 1.91 percent. Fat, ash and fiber contents of biscuits were increased with incorporation of mango seed kernel flour [12]. Carbohydrates were higher in control sample with 68.42 g than experimental sample with 66.83 g. energy content was higher in experimental sample (519 kcal) than control sample (514 kcal). from the results, it was concluded that the supplementation of mango seed kernels flour at 30 percent level in biscuits leads to significant increase in moisture, energy, fat, fiber and ash and energy content as compare to control biscuits.

Table 5: Proximate composition of developed biscuits (on dry weight basis)

Biscuits	Moisture (%)	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Total ash (%)	Carbohydrates (g/100g) (by difference)	Energy (kcal)
Control	3.87±0.05	4.85±0.05	24.55±0.05	0.30±0.05	1.84±0.05	68.42±0.05	514±0.05
Experimental (30% mango seed kernels flour)	4.10±0.05	4.35±0.05	26.03±0.05	0.81±0.05	1.91±0.05	66.83±0.05	519±0.05
t-value	21.50^{**}	61.23^{**}	181.26^{**}	77.50^{**}	8.57^{**}	194.73^{**}	617.27^{**}

values are expressed as mean±SE
**significant at 1% level ($p<0.01$)

3.6 Mineral analysis of biscuits

Table 3 depicts the effect of mango seed kernel flour incorporation on mineral composition of biscuits. with the incorporation of mango seed kernel flour at 30 percent level in the biscuits formulation, significant increase ($p<0.01$) in calcium, iron and magnesium content was observed. There was no significant difference in zinc content of control sample (0.55 mg/100g) and experimental sample (0.70 mg/100 g). Increment in calcium content was found from 28.72 to 32.27 mg/100 g ,iron from 2.93 to 5.59 mg/100 g and magnesium from 30.49 to 49.23 mg/100 g. Mango seed kernel flour is a good source of calcium 10.21mg/100 g, magnesium 22.34 mg/100 g [13] and iron 11.1 mg/100g [10].

Table 6: Mineral content of developed Biscuits (on dry weight basis)

Biscuits	Calcium (mg/100g)	Iron (mg/100g)	Zinc (mg/100g)	Magnesium (mg/100g)
Control	28.72±0.05	2.93±0.05	0.55±0.05	30.49±0.05
Experimental (30% mango seed kernels flour)	32.27±0.05	5.59±0.05	0.70±0.05	49.23 ±0.05
t-value	765.5^{**}	693.8^{**}	1.22^{NS}	37.00^{**}

values are expressed as mean±SE
**significant at 1% level ($p<0.01$) NS-non significant

3.7 Antioxidant activity of developed biscuits

The antioxidant activity in control and experimental biscuits showed that addition of mango seed kernel flour increased the antioxidant activity of biscuits from 21.3 to 26.1 percent

(Table 7). DPPH radical scavenging activity is a widely used method to evaluate antioxidant activity. With incorporation of mango seed kernel flour at 30 percent level, antioxidant activity showed significant increment ($p<0.01$).

Table 7: Antioxidant activity of developed biscuits

Biscuits	Antioxidant activity (%)
Control	21.3±0.03
Experimental (30% mango seed kernels flour)	26.1±0.05
t-value	491.0**

values are expressed as mean±SE
**significant at 1% level ($p<0.01$)

The increase in antioxidant activity may be attributed to increase in the content of polyphenols through incorporation of mango seed kernel flour. Inline to our study, aslam *et al* (2014) reported that composite flour of mango peel and mango seed kernel powder increased the phenolic content of biscuits from 0.43 to 10.28 mg/g. The antioxidant activity of biscuits incorporated with mango seed kernel and peel powder was higher than control.

4. Conclusion

Incorporation of mango seed kernel, a by-product of fruit industry, in biscuit formulation showed considerable effects on physico-chemical and sensory properties of biscuits. The results of the study concludes that biscuits with acceptable sensory properties, high antioxidant activity, enhanced fat, ash, dietary fiber, calcium, iron and magnesium content can be developed by incorporating mango seed kernel flour up to a level of 30 percent level in refined wheat flour. Since, the use of composite flours is the latest trend in the bakery industry, mango seed kernel flour could also be used as a potential source for various bakery products and functional food ingredients.

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