ISSN: 2278-5213

RESEARCH ARTICLE

Fortification of Mango Peel and Kernel Powder in Cookies Formulation

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Abstract

Mango processing industries leave behind considerable of mango seed kernels and peels which are generally discarded as waste. They are rich sources of natural bioactive compounds which play an important role in prevention of diseases. The study was carried out on mango kernel powder (MKP) and mango peel powder (MPP) at different replacing levels in cookies formulation. The results revealed that MPP has higher ash, crude fibre, water holding and oil holding capacity than that of MKP. The phenolics content increased from 3.4 mg GAE/g to 15.3 mg GAE/g and 22.4 mg GAE/g of biscuits incorporated with 30% of MPP and MKP respectively. The results indicate that mango peels and kernels could be utilized up to 30% level with flour for cookies formulation to enhance its nutritional quality without affecting the textural and sensory properties.

Keywords: Mango seed kernels, peels, cookies formulation, phenolics content, sensory properties.

Introduction

Synthetic antioxidants such as butylated hydroxy toluene (BHT) and butylated hydroxy anisole (BHA) are commonly used in processed foods. However, it has been reported that these compounds have some side effects and are carcinogenic (Branen, 1975). Natural antioxidants present in foods have therefore attracted considerable interest because of their safety and potential nutritional and therapeutic value. The increased interest in natural antioxidant has led to the antioxidant evaluation in many species of fruits, vegetables, herbs, spices and cereals (Veloglu *et al.,* 1998). Antioxidants like phenolics in food and pharmaceutical supplements can scavenge reactive oxygen species and protect against degenerative diseases like cardiovascular diseases and cancer (Rimm *et al.,* 1996).

Mangoes belong to the genus *Mangifera* of the family *Anacardiaceae*, is one of the most cultivated fruit in the world. Several million tons of mango seeds and peels are discarded annually from food processing industries because thousand tons of mango fruits are processed in products such as puree, nectar, pickles and canned slices etc. which have worldwide popularity (Loelillet, 1994). During processing of mango, peel is a major byproduct which is not currently utilized for any commercial purpose. It is known from literature that the peel contains different phytochemicals like polyphenols, carotenoids, vitamin E, dietary fibres and vitamin C and it also exhibited good antioxidant properties (Kim *et al.,* 2010; Ashoush and Gadallah, 2011). Researchers have shown that the peel can be utilized as a source of pectin also.

Ajila *et al.* (2010) utilized mango peel powder as potential source of antioxidant in macaroni preparation. The study showed that kernel; inside the seed represents 45-75% of the whole seed (Maisuthisakul and Gordon, 2009). Soong *et al.* (2004) indicated that mango seed kernel has potent antioxidant activity with relatively high phenolic contents. Mango seed kernel was also shown to contain stigmasterol and tocopherols. The antioxidant effect of the mango seed kernel is due to high content of polyphenols, sesquiterpenoids and tocopherols. It is also rich in phytosterols and microelements like selenium, copper and zinc (Schiber *et al.,* 2003; Nunez-Selles, 2005). Being an excellent source of unique fatty acids composition, mango kernel butter exhibits beneficial moisturizing properties for skin lotions and lubricants. Mango kernel fat smells sweet and nutty in its pure form can be proposed as a substitute for cocoa butter in chocolate (Moharram and Moustafa, 1982). Mango kernels are dried and ground to flour which is mixed with wheat or rice flour to make bread and it is also used in puddings. Biscuits are the most popularly consumed bakery items in the world. Some of the reasons for such wide popularity are their ready to eat nature, affordable cost, good nutritional quality, availability in different tastes and longer shelf-life. Studies by Ajila *et al.* (2008) showed mango peel powder incorporated into soft dough biscuits increased soluble dietary fibre (SDF) content, polyphenols and carotenoids. Against these backdrops, the main objective of this study is to characterize and analyze MKP and MPP and to make use them in cookies preparation when substituted with wheat flour in different proportions.

Materials and methods

Materials: Ripe mango seeds and peels were collected after mango pulp processing from Chausa variety during summer season of 2013 from the local market. Commercial wheat flour, bakery fat, powdered sugar and skimmed milk powder were purchased from the local market. Food grade dextrose, sodium chloride, sodium bicarbonate and ammonium bicarbonate were used in biscuit processing. Sodium carbonate and methanol of AR grade were used. Folin-Ciocalteus phenol reagent and gallic acid were purchased from Sigma-Aldrich Inc. (St. Louis, MO, USA).

Preparation of MKP and MPP: Mango peels were washed with tap water to remove any foreign particles. The peels were spread thin in trays and dried at 55°C using a cross flow drier for 12 h to a moisture content around 10%. The dried peels were powdered and passed through 80-mesh (1770 μm openings) sieve. The mango seeds were washed, air-dried and the kernels were removed from seeds manually. The kernels were chopped and dried at 55°C. The dried material was converted into powder form.

Physico-chemical properties of MKP and MPP: Proximate composition of MPP and MKP were determined for measuring moisture, ash, crude fibre, protein and fat content according to the methods described in AOAC (1995). Nitrogen content was estimated by micro-Kjeldahl method and converted to protein by using the factor 6.25. For the determinations of water-holding capacity (WHC) and oil-holding capacity (OHC), 25 mL of distilled water or commercial corn oil were added to 0.5 g of MPP or MKP, vigorously shaken for 1 min and then centrifuged for 15 min at 10,000 g. The residue was weighed and the WHC and OHC were calculated as g water or oil per g of dry sample, respectively (Larrauri *et al.,* 1996). Total carbohydrate was measured by hydrolyzing the polysaccharides into simple sugars with acid hydrolysis and estimating the resultant monosaccharides (DuBois *et al.,* 1956). About 100 mg of the sample was taken in a boiling tube and hydrolyzed by keeping it in boiling water bath for 3 h with 5 mL of 2.5 N HCl. The sample was cooled to room temperature and neutralized with solid Na_2CO_3 until effervescence ceased. The volume of the mixture was adjusted to 100 mL and finally the mixture was centrifuged. About 0.1 and 0.2 mL of the supernatant solution was taken in two separate test tubes and the volume was adjusted to 1 mL with distilled water. About 1 mL of 5% phenol solution and 5 mL of 96% H_2SO_4 was added to each test tube. The solution was stand for 10 min, shaken well and placed in water bath at 25°C for 20 min. The colour of the solution was measured at 490 nm with the aid of UV-VIS-Spectrophotometer (Jasco, Japan, V630). Standard curve was prepared using standard glucose solution.

Determination of total phenolics content: The extracts of MPP and MKP were obtained as described by Bloor (2001). Half gram from each of MPP, MKP and cookies samples was extracted with 20 mL of methanol: water (60:40 v/v). The mixture was centrifuged and the supernatant was adjusted to 25 mL. An aliquot of these extracts were used for the quantification of total phenolics content. Total phenolics content of the extracts were used for the quantification of total phenolics. The total phenolics content was determined colorimetrically, using the Folin-Ciocalteu method as described by Singleton *et al*. (1999). Aliquots of 1 mL of the extract were added to 1 mL of Folin-Ciocalteu reagent followed by addition of 1 mL of an aqueous 7.5% solution of sodium carbonate. The mixture was stirred and allowed to stand for 30 min. The absorbance at 765 nm was measured using a model UV/VIS-Spectrophotometer (Jasco, Japan, V630). A blank sample consisting of water and reagents was used as a reference. The results were expressed as milligrams of gallic acid equivalents per gram powder (mg GAE/g powder).

Cookies processing: Cookies samples were processed from doughs containing 20, 30, 50% of MPP and 20, 30 and 50% MKP as substituting levels for wheat flour according to the method described by Leelavathi and Haridas Rao (1993). The formula used was as follows: 200 g wheat flour, 60 g sugar, 50 g shortening, 2 g sodium chloride, 0.8 g sodium bicarbonate, 3 g ammonium bicarbonate, 4 g dextrose, 4 g skimmed milk powder and 40-42 mL water.

Procedure: Flour and MPP/MKP is blended with fat. The ground powder sugar is added. Sodium bicarbonate and sodium chloride were dissolved in water and added. Skimmed milk powder was made into suspension with water and transferred to the mixture and dextrose is added. The contents were blended with water to form dough. The dough was rolled and sheeted to a thickness of 3.5 mm cut using a circular mould (51 mm dia) and placed on greased trays, baked at lower temperature of 150°C and upper temperature of 190°C for 10-12 min. After baking, cookies were left to cool at room temperature and were wrapped tightly with polypropylene pouches and kept until further analysis.

*Evaluation of cookies***:** Moisture and ash content in cookies were determined according to the method described in AOAC (1995). The total phenolics content was determined colorimetrically, using the Folin-Ciocalteu method, as described by Singleton *et al*. (1999).

Sensory evaluation: Cookies incorporated with MPP and MKP were coded with different numbers and followed by sensory evaluation by ten trained panel members of food technology department. The panel lists were asked to rate each sensory attribute using the control cookies as the basic for evaluation.

Cookies were evaluated for taste, colour, flavour, body and texture, consistency and overall acceptability on a 9-point hedonic scale (Hooda and Jood, 2005).

Statistical analysis: All data were expressed as mean values ± Standard deviation (S.D). Statistical analysis was performed by calculating coefficient of variance (CV) and standard error (SE).

Results and discussion

Physicochemical properties of MPP and MKP: The results of proximate analysis, WHC, OHC and total phenolics of MPP and MKP are shown in Table 1. The results revealed that MPP has higher ash, crude fibre, water holding and oil holding capacity than that of MKP whereas, MKP has higher moisture, fat and protein compared to MPP. WHC and OHC of MPP were higher than MKP, representing higher fibre content in MPP compared to MKP. The table shows that the total phenolics content present in both MKP and MPP (27.9 and 24.3 mg GAE/g respectively) were significantly high.

Characteristics of cookies fortified with different levels of MPP and MKP: The moisture content in control biscuits is 4.5%, increased to 5.2% when MPP is incorporated at 20% level (Table 2). The lower moisture content is observed when MKP is incorporated up to 30% level. The increases in moisture content of cookies containing MPP may be due to increased water absorption of crude fibre present in MPP with higher percentage compared to MKP. The result shows that increasing levels of MPP and MKP in cookies gradually increase the total phenolics content.

Total phenolics present in control cookies is 3.4 mg GAE/g, increased up to 18.6 and 6.3 mg GAE/g when incorporated with 50% of MPP and MKP respectively. Although during baking, there may be some loss of total phenolics content and there is an increase in phenolic content in cookies by the replacement of MPP and MKP at different levels with flours (Ajila *et al.,* 2008; 2010).

Sensory evaluation of cookies: Sensory evaluation of different types of cookies is shown in Table 3. It has been found that the taste, colour, flavour, body and texture and consistency of cookies incorporated with 20% of both MPP and MKP are comparable with control one.

Conclusion

Considering the colour, appearance, texture and flavour attributes, it could be concluded that 20% level of incorporation of MPP or MKP were optimum. At higher percentage level, the cookies had a slight bitter taste which may be due to high polyphenol content. MPP and MKP impart health benefits through its fibre and antioxidant content in cookies.

Table 1. Proximate analysis of MKP and MPP.

Characteristics	MPP	MKP
Moisture (%)	5.9±0.56	7.1±0.35
Ash (%)	4.2±0.32	2.1±0.14
Fat (%)	1.4±0.13	9.8±0.28
Total Carbohydrate (%)	75.7±0.51	73.1±0.75
Protein (%)	2.8±0.21	7.2±0.30
WHC (g H_2O/g)	4.3±0.11	1.9±0.15
OHC (g oil/g)	2.2±0.04	1.8±0.12
Crude fibre (%)	9.9±0.59	0.5±0.1
Total phenolics (mg GAE/g)	24.3±0.42	27.9±0.38

Datas are the mean±S.D, n=5.

Table 2. Characteristics of cookies fortified with different levels of MPP and MKP.

Treatments	Moisture (%)	Ash (%)	Total phenolics (mg GAE/g)
Control	4.98±0.41	1.4±0.22	3.4±0.32
MPP (%)			
20	5.2±0.54	1.8±0.28	12.4±0.18
30	5.8±0.39	1.9±0.63	15.3±0.51
50	6.9±0.06	2.0±0.31	18.6±0.35
MKP (%)			
20	3.2±0.82	1.8±0.44	18.8±0.45
30	3.9±0.11	2.0±0.27	22.4±0.26
50	5.2±0.56	2.2±0.12	26.3±0.73

Acknowledgements

Authors acknowledge Honourable Managing Director of JIS Group, Kolkata, for financial support and inspiration.

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Table 3. Sensory evaluation of cookies fortified with different levels of MPP and MKP.

Sample	Taste	Colour	Flavour	Body and texture	Consistency	Overall acceptance
Control						
Avg±S.D	7.33±0.47	7.5±0.5	7.17±0.37	7.17±0.89	7.17±0.89	7.17±0.37
C.V	6.41	6.67	5.16	12.41	12.41	5.16
S.Error	0.19	0.2	0.15	0.36	0.36	0.15
MPP 20%						
Avg±S.D	7.67±0.47	7.33±0.47	7.66±0.47	6.5±0.5	6.17±0.69	6.83±0.37
C.V	6.13	6.41	6.14	7.69	11.18	5.42
S.Error	0.19	0.19	0.19	0.2	0.28	0.15
MPP 30%						
Avg±S.D	7	7.17±0.37	6.83±1.07	6.0±0.58	5.83±0.69	6.66±0.47
C.V	0	5.16	15.66	9.67	11.83	7.06
S.Error	0	0.15	0.44	0.24	0.28	0.19
MPP 50%						
Avg±S.D	6.5±0.5	6.83±0.76	6.66±0.47	6.66±0.47	6.33±0.47	6.66±0.47
C.V	7.69	11.13	7.06	7.06	7.42	7.06
S.Error	0.2	0.3	0.19	0.19	0.19	0.19
MKP 20%						
Avg±S.D	8	7.2±0.4	7.8±0.4	7.6±0.49	8	7.8±0.4
C.V	0	5.55	5.13	6.45	0	5.13
S.Error	0	0.16	0.16	0.2	0	0.16
MKP 30%						
Avg±S.D	7.5±0.55	6.78±0.49	7.3±0.52	7	7.66±0.52	7.2±0.84
C.V.	7.33	7.23	7.12	0	6.79	11.61
S.Error	0.22	0.20	0.21	0	0.21	0.34
MKP 50%						
Avg±S.D	7±0.63	6.4±0.49	7	6.6±0.49	7	6.8±0.4
C.V	9	7.65	0	7.42	0	5.88
S.Error	0.26	0.2	0	0.2	0	0.16

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