J. Glob. Innov. Agric. Soc. Sci., 2014, 2(2): 76-81.
ISSN (Online): 2311-3839; ISSN (Print): 2312-5225
DOI: 10.17957/JGIASS/2.2.533
http://www.jgiass.com

UTILIZATION OF MANGO WASTE MATERIAL (PEEL, KERNEL) TO ENHANCE DIETARY FIBER CONTENT AND ANTIOXIDANT PROPERTIES OF BISCUIT

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Mango peels (MP) and kernels (MK) are the major bio-waste of mango processing industry, these are natural rich sources of bioactive substances that play a significant role in prevention of diseases. In present study, the effect of Mango Peels Powder (MPP) and Mango Kernels Powder (MKP) at different replacing levels (5, 10 and 15%) separately on rheological, proximate, physical, sensory and antioxidant properties of biscuits were evaluated. The results demonstrated that mango peel powder had high contents of crude fiber and antioxidant activity whereas mango kernel powder characterized by higher protein, total phenolic and ash contents as compared to mango peel powder. Farinograph study of composite flour of MPP and MKP revealed an increase in water absorption (WA) from 60 to 69.8%. The crude fiber contents of biscuits were improved from 0.22-16.79% by addition of mango peel and kernel powder. Their phenolic contents increased from 0.43 to 10.28 mg/g. The biscuits incorporated with MK and MP powder showed an increment in their antioxidant activity. Sensory performance exhibited that the biscuit acceptable with mango taste and flavor were obtained by substitution up to 10% mango peel powder and up to 5% with mango kernel powder. From the results, it is concluded that by incorporating of MPP and MKP played important role in enhancing the nutritional properties of biscuits through improving especially their fiber content, antioxidant activity during storage up to 30 days at room temperature.
Keywords: Mango peels, Dietary Content, Antioxidant, Biscuits

INTRODUCTION

Fruits are necessary for diet plan and gaining much fame all over the world due to their importance (Azam *et al.*, 2013). Mango is most popular tropical fruit belong to genus Mangifera member of family Anacardiaceae. Almost 20 % of total world mango production is processed to produce a variety of products like fruit leathers, juice, pickle, nectar as well as canned products along with using as a common ingredient for the development of functional foods as a flavor, colorant etc. Moreover, the utilization of mango bio-waste as a functional ingredients in processed products like beverages, bakery, cereal, pasta products (Ajila *et al*., 2007). Limited research works on application of waste leads towards the lack of popularity of the compositional importance of fruits wastes material. Recently, it has been investigated that waste of fruit and vegetables are rich source of biologically active compound. Numerous studies exist about the use of fruit and vegetable waste in bakery products like the use of orange pomace for supplementation contributes in the dietary fiber content of cookies (Larrea *et al*., 2005) Furthermore, Bilgicli *et al*. (2007) studied the effect of lemon and apple as a fiber on quality of biscuit. As functional ingredient has been reported like apple pomace acted as a rich source of polyphenols and shown good anti-proliferative and antioxidant activity (Wolfe *et al*., 2003). Similarly, Grape pomace, exhibited as a good source of catechins, phenolic acids, anthocyanins and flavanoids as well as dietary fiber (Larrauri *et al.*, 1999).

In recent decades people become conscious about their diet and health. Nutritionist suggested that to take food that has low fat content and provide less calories as well as rich in antioxidant and dietary fiber contents (Ajila*et al*., 2008). Antioxidants and dietary fiber gaining popularity because they contribute significantly in lowering the cholesterol and preventing the cardiovascular diseases and constipation (Schieber *et al*., 2001). Dietary fiber sourced from fruits and vegetables has higher content of soluble dietary fiber that impart positively in using the dietary fiber as a functional ingredient. Dietary fiber incorporation prolong the shelf life, modify the structural and physical characteristics of product such as texture, water and oil holding capacity as well as viscosity and sensory properties (Figuerola *et al*., 2005).

Mango peel powder contains total polyphenol and carotenoid contents 55 to 110 mg /g and 387 to 3337mg/g respectively as well as 44-78% total dietary fiber (Ajila *et al*., 2007). It has been investigated that butylatedhy droxyanisole and butylatedhy droxytoluene are synthetic antioxidants which are mostly used in processed products. It has been reported that synthetic antioxidants should be used in limited quantity because they exhibit toxicity and carcino genecity properties. So, the interest towards the natural antioxidants has been growing for this substitution a lot of work has been carry out to screen the natural and inexpensive source of antioxidants (Butsat, 2009).

The objective of present study was to evaluate the effect of mango by-products which is found to be rich in phytochemicals on the physical, chemical, rheological and

sensory characteristics of biscuits. Total phenolic content and antioxidant activity in biscuits supplemented with mango peel and mango kernel were also determined.

MATERIALS AND METHODS

Ripe mangoes, commercial wheat flour, vegetable ghee, powdered sugar and eggs and baking powder were purchased from the local market of Faisalabad.

Waste material collection: Peel and seed as a mango wastes were obtained from pulping section after extracting and storage of pulp. Collected peel and seeds were then washed, dried, packed and stored at room temperature for further processing.

Preparation of mango peel and kernel powders: Powder dried peel and seeds were then developed by means of grinder, packed in air tight plastic pouches and stored at room temperature.

Preparation of biscuits: Biscuits were prepared through mixing mango peel and seed powder separately in three different concentrations (5, 10 and 15%) with other basic ingredients of biscuits like shortening, sugar, baking powder and eggs. That homogeneous mixture was then spread, cut, backed, cooled and packed (AACC, 2000).

Storage and analysis of biscuits: Prepared biscuits were then stored at room temperature and analyzed after each 10 days of interval from 0 day to 30 days through different physic-chemical, phyto-chemical and sensory parameters like.

Stored Physical analysis

Width, thickness, spread factor measurement: The physical parameters like thickness (T), width (W), and spread factor for biscuits were estimated as presented AACC (2000).

Texture analysis of biscuit: Texture of cookies was determined at different storage intervals according to Piga *et al*. (2005) by using a texture analyzer.

Color measurement: Color value will be determined with color meter (Neuhaus color test-II, Neotec, Germany) according the method described by Rocha and Morais (2003).

Proximate analysis: Different treatments of biscuit were analyzed through moisture, ash, crude protein, crude fiber, and crude fat contents through following the methodology of AACC (2000).

Phyto-chemical test

a. Total phenolic contents

Total phenolic contents in all biscuit treatments were carried out through using Folin-Ciocalteu method as described by Chan *et al.* (2008).

b. Free radical scavenging ability

DPPH radical scavenging activity in all treatments of biscuits was analyzed through extracts as described by Gupta and Prakash (2009).

Sensory evaluation: Sensory evaluation of treated biscuit treatments were investigate through different parameters like colour, taste, crispiness, texture, flavour and overall acceptability by using 9-Point Hedonic Scale sensory evaluation parameter as descrebed by Meilgaard *et al*. (2007).

Statistical analysis: The data obtained for each parameter of biscuit treatments were analyzed through statistical method as described by Steel *et al*. (1997).

RESULTS AND DISCUSSION

Effect of MPP and MKP on Rheological Parameters: Farinograph parameters were determined for wheat flour and wheat flour substituted with 5, 10, 15 % of mango peel powder and mango kernel powder separately and showed significant difference in dough properties. Addition of mango peel and kernel powder at different levels increased the water absorption from 64.1(5%) to 69.8% (15%). While the water absorption range 61.4 (5%) to 65.7% (15%) was observed in mango kernel powder. However the water absorption in control was 60% (Figure-1). Sudhakar and Maini (2000) reported that the increase in water absorption was due to the interaction between water and hydroxyl groups of polysaccharides through hydrogen bonding. Similar trend in increase in the water absorption was observed by Ajila *et al*. (2008).

The dough development time (DDT) in control 4.4min, however increased from 5.0 to 5.9 min with 15% incorporation of mango peel powder. While in case of mango kernel powder the the dough development time increased from 4.8 to 5.6min (Figure-2). Dough stability (DS), which indicates the dough strength, decreased from 6.0 to 4.6min and 5.8 to 4.4min with incorporation of 15% MPP and MKP respectively as presented in Figure-3. Ajila *et al*. (2008) reported that increase in dough development time and decrease in dough stability indicated the decrease in dough strength may be due to the dilution of gluten proteins in wheat flour upon addition of mango peel and kernel powder. Recently, Sudha *et al.* (2007) reported an increase in dough development time and decrease in dough stability in wheat flour upon addition of cereal brans. There was an increase in mixing tolerance index (MTI) as shown in Figure-4, in control sample the MTI was 30 BU. These results are close agreement with Ashoush and Gadallah (2011).

Physical tests of biscuits: The mechanical characteristics of biscuits are important to evaluate the acceptance point of view of consumer. Among the attributes the physical properties of biscuit depends upon the composition of matrix. The result obtained for effect of treatment on the mechanical properties of biscuit presented in Table-1.

Table 1: Influence of MPP and MKP with different levels on the color, hardness, fracturability, width, thickness, spread factor of biscuits

Treatment	Color (CTn)	Hardness (g)	Fracturability (mm)	Width (mm)	Thickness (mm)	Spread factor
T_o	149	1122.80	76.49	44.86	18.96	23.69
T_1	127	1230.60	75.67	44.06	19.45	22.68
T_2	118	1335.00	75.53	43.46	19.95	21.81
T_3	104	1440.80	74.94	42.64	20.22	21.06
T_4	135	1355.90	74.82	42.57	19.76	21.56
T_5	123	1402.90	74.40	41.81	20.65	20.27
T_6	113	1525.60	73.85	41.32	21.27	19.45

Table 2: Effect of storage on the means of physical characteristics of cookies

Storage	Color (CTn)	Hardness (g)	Fracturability (mm)	Width (mm)	Thickness (mm)	Spread factor
0	128	1375.10	74.58	43.59	20.52	21.22
10	125	1356.20	74.96	43.25	20.16	21.44
20	122	1334.70	75.31	42.92	19.89	21.59
30	121	1313.30	75.56	42.66	19.57	21.79

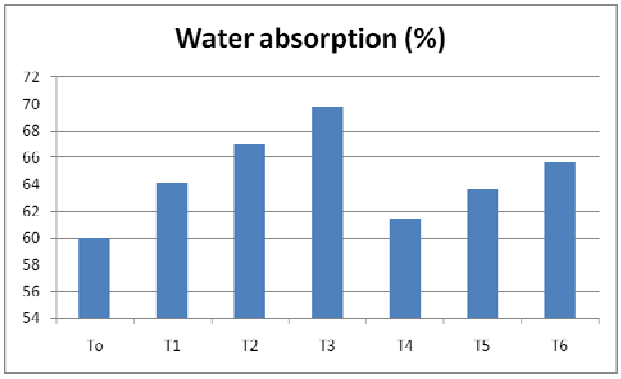

Figure 1: Effect of mango peel and kernel powder on water absorption of biscuit dough

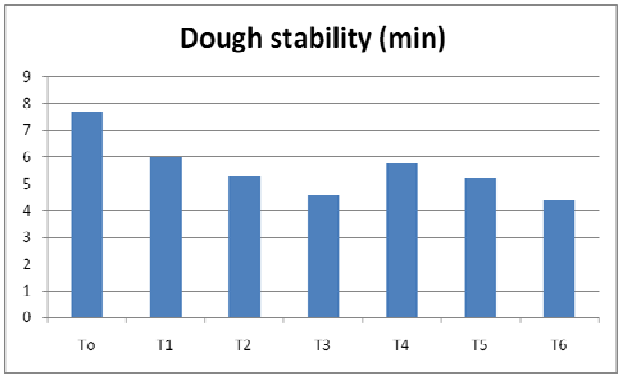

Figure 2: Effect of mango peel and kernel powder on dough stability of biscuit dough

The biscuits with 15% mango kernel powder and 95% flour (T_6) and with 15% mango peel powder and 95% flour (T_3) were significantly harder than biscuits that made with 100% flour (T_o). The hardness of biscuit as a result of development of gluten network. Gluten promotes the network development by attracting the water molecules (Mushtaq *et al.*, 2010). The impact of storage on the physical attributes of biscuit is given in (Table-2) the hardness of the biscuit decrease progressively with the increase in storage period. Maximum hardness was observed at day (1375.10g). This change in the hardness due to hygroscopic nature of ingredients as a result of it the moisture contents of biscuit increased with the passage of time.

Fracturability of biscuit indicates the crispiness of product (Table-1). The lower fracturabilty reflects the highest crispiness of products vice versa. Fracturabilty decrease from to having highest score (76.49 mm) to T6 (73.85 mm) having lowest score. Fracturabilty of biscuits is non Significantly affected by storage (Table-2). Maximum score observed was at 0 day of storage which decreases gradually with storage period. This change can be associated with the increase of moisture content of biscuits.

The color values of the biscuits are shown in Table-1. The color values are indication of the lightness or darkness of samples. Higher color values indicate a lighter surface color. The mean values for biscuit made with 100% wheat flour was 149CTn and lowest color score 113CTn was observed in T_6 (15% mango kernel powder and 85% wheat flour). Which were significantly lower than the mean value for biscuits made with 100% wheat flour. Ajila *et al.* (2008) reported that the mango peel (MP) and kernel powder contain peroxidase and polyphenol oxidase activities and they are rich in polyphenols that are substrates for these enzymes. Due to this enzymatic browning the brightness of biscuit decrease. Somewhat due to darker color of mango peel and kernel the darkness of the biscuit in color increased.

The width, thickness and spread factor are highly affected by the increase the level of incorporation of mango peel and mango kernel powder. The width of the control was 44.86mm highest among treatments while the lower width was observed in T_6 (41.32mm) in mango kernel and T_3 in mango peel powder case. The thickness of the control sample 18.96mm while the in case of mango kernel and mango peel the highest thickness was observed in T_6 (21.27mm) and T_3 (20.27mm) respectively. This decrease in the width and increase in the thickness was due to the dilution of gluten. Moreover the Turksoy*et al.* (2011) studied the addition of black carrot as a fiber source that reduced the width and increased in thickness of various treatments significantly due to high water absorption of

Table 3: Influence of MPP and MKP with different levels on the moisture, ash, crude fiber, crude protein, crude fat of biscuits

Treatment	Moisture (%)	Ash (%)	Crude fiber (%)	Crude protein (%)	Crude fat (%)
T_o	1.75	0.70	0.22	7.52	22.12
T_1	2.25	0.93	9.41	7.53	22.58
T_2	2.50	0.97	13.63	7.57	22.64
T_3	2.68	1.00	16.79	7.60	22.70
T_4	2.21	1.02	7.27	7.54	22.62
T_5	2.34	1.07	10.51	7.58	22.66
T_6	2.61	1.10	13.73	7.61	22.71

Table 4: Effect of storage on the means of chemical analysis of biscuit

Storage	Moisture (%)	Ash (%)	Crude fiber (%)	Crude protein (%)	Crude fat (%)
0	2.30^d	0.981	10.27	7.60	22.62
10	2.32^c	0.971	10.24	7.56	22.59
20	2.35^b	0.953	10.21	7.52	22.56
30	2.36^a	0.943	10.18	7.48	22.53

Table 5: Influence of MPP and MKP with different levels on the color, flavor, taste, texture, overall acceptability of biscuits

Treatment	Color	Flavor	Taste	Texture	Overall acceptability
T_o	8.13	8.48	8.60	8.43	8.41
T_1	7.71	7.65	7.65	8.10	7.93
T_2	8.15	8.05	7.85	8.23	8.03
T_3	7.40	7.45	6.98	7.23	7.25
T_4	7.77	7.10	7.13	7.55	7.39
T_5	7.15	6.63	6.33	7.10	6.76
T_6	5.55	6.13	6.13	5.75	5.93

Table 6: Effect of storage on the means of sensory evaluation of biscuit

Storage	Color	Flavor	Taste	Texture	Overall acceptability
0	7.79	7.76	7.66	7.91	7.79
10	7.53	7.47	7.40	7.64	7.52
20	7.28	7.23	7.09	7.37	7.25
30	7.04	6.96	6.80	7.00	6.97

fiber. In fiber the oligosaccharide that attract the water more, the dough viscosity increased that leads that lead the thickness increased and spread factor decrease.

The decreasing trend for spread factor was observed among treatment in Table-1. Abu-Salem and Abou-Arab (2011) who recorded that as the substitution level of bambara flour going on increased the spread factor was lowering down. While the storage period shown non-significant impact on width, thickness, spread factor Table-2. The width and thickness decreased while the spread factor was increased The result was nearly matched with the findings of Zaker *et al*. (2012) who studied the effect of supplementation of defeated soy flour on the nutritional and physical characteristics of biscuits. The reason behind our study was that the decrease of thickness cause increase in spread factor.

Chemical analysis of biscuit: Effect of various treatments on the means of chemical analysis is presented in Table-1. There is a highly significant change in moisture, ash, fiber contents and non-significant impact on fat and protein.

Among the treatment (Table-3), lowest moisture contents was observed in T_o (1.75%) having highest score to T_3 (2.68%) in mango peel and 2.61% in T_6 (mango kernel). Similar trend of moisture for various treatments is conformed to the findings of Ashoush and Gadallah (2011). They reported that moisture contents in mango peel supplemented biscuits showed higher moisture content then control and mango kernel supplemented biscuit. The highest crude fiber content among treatment was observed in T_3 (16.79%) in mango peel and 13.735 in T_6 in case of mango kernel powder. While the lowest Fiber was observed in T_o(0.22%) Furthermore, Ajila*et al*. (2008) also recorded the similar pattern in fiber content of biscuits with increasing level of supplementation of mango peel powder. The lowest ash content (0.70%) was observed in T_o (control). The highest ash content was recorded in T_6 (15% MKP +85% wheat flour) 1.10% in mango kernel supplementation and T_3 (1%) in mango peel powder substitution. Same trend increase in ash level among treated biscuits that were supplemented with moringa leaves powder was observed (Dachana*et al.*, 2010).

During the storage (Table-4), biscuits showed significant changes in moisture contents and non-significant changes in fat, ash, protein and fiber contents These results are in close agreement with Pasha *et al.* (2002).. The minimum moisture content was observed at 0 day with 2.30% and highest moisture contents 2.36% was observed at 30th day of storage. The current findings are in harmony with Mushtaq*et al*. (2010), who explained that during the storage the moisture contents increased due to the hygroscopic nature of some ingredients.

Sensory Evaluation of Biscuits: The biscuit prepared from different level of mango peel and kernel powder were subjected to sensory evaluation for colour, taste, flavour, texture and overall acceptability at 0, 10, 20 and 30 days interval of storage.

Sensory evaluation studies showed that the surface color and appearance of biscuits containing up to 10% of mango peel and up to 5% of mango kernel were as acceptable as those of control biscuits (Table-5).

As the percentage of the incorporation of mango kernel and mango peel powder increased the surface color of the biscuit going on the darker due to the enzymatic browning. Increase in darkness also reflected by color (CTn) values as shown in Table-1. These obtained results are harmony with those of Ashoush and Gadallah(2011) andAjila *et al.*(2008)

However the results also showed that biscuits had acceptable texture upto 10% mango peel powder and upto 5% mango kernel powder as compared to 100% wheat flour biscuit (Table-5). The hardness of the higher supplemented biscuit increased relatively as compared to the control biscuit sample due to higher water holding capacity. These data are in agreement with Smith (1972).

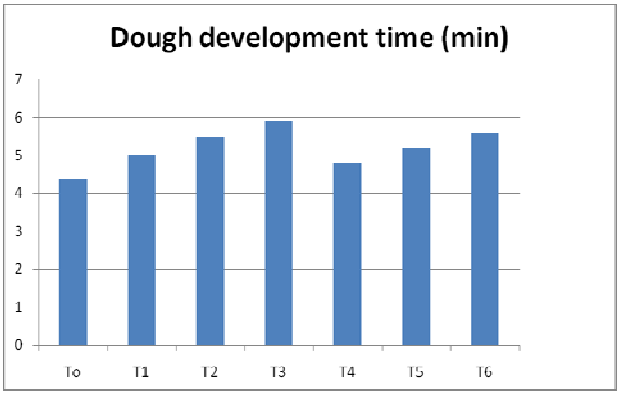

Figure 3: Effect of mango peel and kernel powder on dough development time of biscuit dough

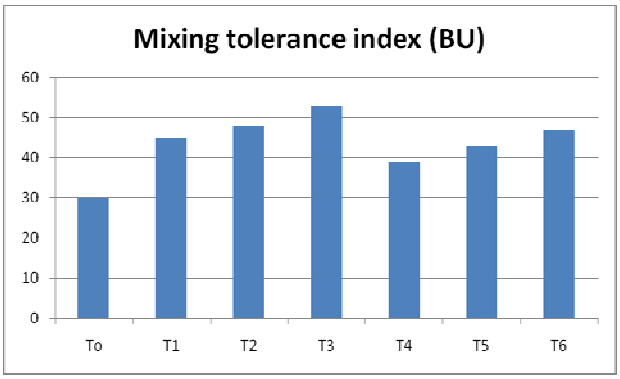

Figure 4: Effect of mango peel and kernel powder on mixing tolerance index of biscuit dough

The taste and flavor of biscuits were improved with incorporation of mango kernel and peel powder as these biscuits had typical pleasant mango flavor. However, at levels of 15% of mango peel powder (MPP) and 10% of mango kernel powder (MKP) the biscuits had a slight bitter taste which may be due to high polyphenols content. Also, the presence of tannins in mango kernel powder enhanced the biscuit coloration and could explain the relatively lower flavor scores compared with T_o (Table-5). These data are in line with finding of with Arogba (1999).

Regarding to overall quality, it could be observed that biscuits incorporated with mango peel powder MPP up to 10% (T_2) and with up to 5% MKP (T_4) showed higher scores compared to control (Table-5). The lower score values of mango kernel crackers could be due to the unattractive color and the unpleasant taste. It could be concluded that biscuits with acceptable overall quality can be prepared by substituted 10% and 5% of wheat flour with mango peel powder and mango kernel powder respectively

Analysis of variance disclosed a highly significant difference among treatments and storage means, but the interaction was non-significant. There was a gradual decrease in the overall acceptability of the biscuit during storage days but biscuit remain acceptable even after 30 days storage (Table-6).

CONCLUSION

From above discussion it can be concluded that every year fruit processing industry is wasting a considerable amount of bio-active material that can play a vital role to cure and prevent many diseases. In present study when bio waste of many fruits (mango peel and mango kernel) both in powder form were analyzed separately by replacing for different levels(5,10 and 15%) on rheological, proximate, physical, sensory and anti oxidant properties of biscuits by incorporating MPP(mango peel powder) and MPK(mango peel kernel) fruit fibers contents of biscuits were improved from 6.20-16.79%. Moreover *Psychograph* study of composite flour MPT and MKT is reveals and the records water absorption form 60 to 69.18% during storage of up to 30 days at room temperature.

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