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Original Article

Utilization of mango peel in development of instant drink

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Abstract

Worldwide, fruit and vegetable processing industries are generating massive agro-industrial by-products. The industrial processing of mango generates a lot of by-products. Usually the major is with mango peel having a 7-24% portion of total fruit and not normally utilized. In the present research, mango peel was utilized in the formulation of instant drink as an experiment to harvest its nutrients. The mango peel was dried in the dehydrator and ground to obtain the fine quality powder. The mango peel powder (MPP) obtained was evaluated for its nutritional profile. The powder was added in the instant drink 5 g (T_1), 10 g (T_2) and 15 g (T_3) concentration per 250 mL along with water, sugar, citric acid and permitted color and flavor. The instant drink was evaluated at the 0, 30 and 60th-day storage intervals for various physicochemical characteristics. Results showed that mango peel is an abundant source of moisture, ash, fat, protein, carbohydrate, and crude fiber. The antioxidant activity, vitamin C and total phenolic content were 73%, 14.8 mg/100g, and 81.3 mg/g GAE, respectively. The mean values for total sugars, Total Soluble Solids (Brix), Titratable Acidity etc. differed considerably among all the treatments. During the storage interval from 0 to 60 days a significant decrease in pH, total soluble solids and total sugars, free radical scavenging activity and total phenolic content were observed, while the acidity of the drinks was gradually increased. The drink with 5 g mango peel powder showed the best sensory attributes in terms of flavor, taste and mouthfeel compared to 10 g and 15 g. This research can be helpful to utilize mango peel waste into food products to harvest the functional, nutraceutical and bioactive compounds.

Keywords: Food waste, Functional food, Storage, Physicochemical properties

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Introduction

The fruit and vegetable processing industries are generating a huge quantity of agro-industrial by-products annually. If not properly treated, these waste products create the problem of disposal and also pose a threat to ecological contamination. Therefore, their competent, inexpensive and exact removal is one of the essential requirements for a friendly environment. These by-products are the intense source of phytochemicals, particularly the fruit peels, and attract the primary consideration of scientists and researchers regarding their extraction and processing. (Manzoor et al., 2012).

Due to enjoyable taste, rich flavor and high nourishing value of Mango (*Mangifera indica L., Anacardiaceae*) it is named as "king" of fruits. It is a rich source of different micronutrients such as vitamins and minerals, antioxidants and phytochemicals (Palafox-Carlos et al. 2011). Pakistan is ranged at the 5th largest mango producer among the countries of the world and its contribution is about 5.1% of world production. Pakistan is considered as 4th highest and best quality mango producer in the world (Jegede, 2019).

The mango generally consists of pulp 33-70%, seed 7-24% and peel 15-20% of the total fruit weight. During processing, the main by-products of mango are peels and kernels. Although these products have great importance for use in the manufacture of different products, they are generally disposed-off as waste. Disposal of these by-products imparts significant risk for environmental pollution because they are generally composed of the high content of nitrogen, phosphorus, sugars and high-water activity (Sogi et al., 2013). In addition, the mango processing industries, generally bear significant transport costs to evacuate these wastes from production facilities in order to avoid cross-contamination of the site and the hazardous effects of the waste. This imparts a negative impact on the market future of the mango processing industries. Recent studies have examined that mango peel is a rich source of several vitamins and other photochemical. Captivatingly, the mango peel has greater polyphenol content than present in the pulp (Ajila, 2007).

Powdered mango peel is advantageous because its shelf life is quite long at room temperature, convenient to use and has low transportation costs. It plays important role in the baked products and it can be used in different products such as bread and biscuits, ice cream, extruded foods such as snacks and meat products (Castillo et al., 2013). Instant powdered beverages made from fruit-based products have a good nutritional value because of the high quantity of dietary fiber present in the fruit. The mango peel powder, rich in its nutritional value, is the ideal way for the formulation of instant drinks. (Ajila and Rao, 2013; Benjamin and Spener, 2009).

Observing the significance of mango peel, a study was designed to prepare and characterize the MPP in the development of instant drink. The nutritional characteristics of the mango peel powder and the instant drink were tested with proximate and physiochemical analysis. Instant drink prepared from mango peel powder could be the cheapest source of functional ingredients and bioactive compounds especially antioxidants, polyphenols, flavonoids, anthocyanin and vitamin C.

Material and Methods

Fresh and healthy local variety (Chaunsa) of Mango fruit was procured from the local market of Rawalpindi. The fruit was immediately transferred for further research to the Institute of Food and Nutritional Sciences, PMAS-Arid Agriculture University Rawalpindi, Pakistan

Development of mango peel powder (MPP)

The collected mango samples were washed properly with clean water to eliminate the filth and foreign matter. Sterilized knives were used to remove the peel in uniform pieces and blanching of this peel at 98°C for 1min to inactivate the enzymes. Mango peel powder was obtained by hot air drying in a dehydrator. Mango peel of uniform size pieces was put into the hot air cabinet drier for drying at 50°C for approximately 4 hours (until constant weight).

Storage of mango peel powder

The dried mango peel obtained was subsequently ground to a fine powder and stored at room temperature in a dark place. Mango peel powder was stored in a sealed plastic bag of 75µm thickness at ambient temperature and analyzed for different physicochemical parameters.

Proximate analysis

The AOAC (2006) method was used to examine the moisture content of MPP by drying at 105 ° C in a forced draft oven (Model: DO-1-30/02, PCSIR, Pakistan) until a constant weight was obtained. The protein content of MPP, as given in AOAC (2006),

was evaluated. Kjeldahl method (model: D40599, Behr Labor Technik, Gmbh-Germany) was reliable and appropriate in mango peel samples to evaluate crude protein content. The crude fat was analyzed by using the standard method of AOAC (2006) by the Soxtec system. The crude fiber was determined by digesting in 1.25% sulphuric acid and then in the sodium hydroxide 1.25% by using equipment Labconco Fibertech (Labconco Corporation Kansas, USA) as mentioned in the AOAC (2006). The muffle furnace (MF1/02, PCSIR, Pakistan) was used for ash by implementing the method of AOAC (2006). The total amount of carbohydrate in peel was also determined by the method given in AOAC (2006).

Ascorbic acid (mg/100g)

The ascorbic acid in peel powder was evaluated by using spectrophotometer (CE-2021, CECIL Instruments, and England) and the absorbance was recorded at 243 nm wavelength.

Preparation of antioxidant extracts

Ethanol was used as a solvent for developing the antioxidant extracts of MPP. For 8hr, extracts were put into the orbital shaker for mixing. Then kept in a centrifuge machine for 15 min at 7000rpm. For the filtration purposes, vacuum filtration assembly was used for the resulting extracts. Rotary Evaporator was used to recover the remaining solvents at 40°C (Rusak et al., 2008). The extracts were used further for the estimation of DPPH (1,1-diphenyl-2-picrylhydrazyl) free radical scavenging and total phenolic content.

Total phenolic contents (mg/g GAE)

The phenolic compounds of the MPP were estimated by using the Folin-Ciocalteu method (Rekha et al., 2012). A UV-vis spectrophotometer (CECIL CE7200) was used to determine the absorbance at 765 nm. The standard gallic acid calibration/curve was drawn at known concentrations from 0.05 to 0.30 mg/mL.

$C=c\times V/m$

C = phenolic compounds in the plant extract in the form of mg/g, GAE

c = calculation from the calibration curve mg/ml, the concentration of gallic acid

V = extract volume in mL

m = Plant extract weight in g

DPPH free radical scavenging activity (%)

The scavenging activity of the sample was determined by using the Brand-Williams et al. (1995) test. A new methanol solution of DPPH (1,1-diphenyl-2-picrylhdrazyl) for the experiment was developed prior to the test. Many concentrations (40, 80, 120, 160, 200 and 240 µg / mL) of every sample were mixed to 1 mL DPPH solution. The resultant solutions were gently shaken and allowed to stand for 30 min at the ambient temperature. The spectrophotometer was used to record the absorbance at 520 nm, and calculate by using the following formula:

Reduction of absorbance (%) = [(AB - AA) / AB] × 100

Development of instant drink

Mango peel powder based instant drink was prepared by adding ingredients (water, sugar, citric acid, CMC, and food-grade flavor) in the MPP. The supplementation of mango peel in the Instant drink was done at 3 different levels of MPP (T_1 @ 5g/250mL, T_2 @ 10g/250mL, and T_3 @ 15g/250mL). This mango peel-based drink was analyzed for its physiochemical analysis at the storage interval of 0, 30, 60 days.

Physicochemical evaluation of drink

Instant drink prepared was evaluated for different parameters that include, total solids, pH value, titratable acidity, total sugars, ascorbic acid, total phenolic content and antioxidant activity during two months of storage at ambient temperature.

Total soluble solids (Brix°)

The TSS of the instant drink was analyzed by hand refractometer ((TAMCO, Model No. 90021) using the method as depicted in the AOAC (2006). Homogenous samples were collected on a calibrated refractometer's prism and direct reading (Brix) was taken on scales.

Titratable acidity (%)

The titratable acidity of the instant drink was determined by adopting the reference method of the AOAC (2006). The acidity of the instant drink was determined by taking 10 mL from each sample and diluted with distilled water in a beaker. Phenolphthalein was added (2-3 drops) as an indicator and the samples were titrated against 0.1N NaOH solution up to the light pink color endpoint.

pH value

The pH value of instant drink was calculated through a digital pH meter (InoLab 720, Germany) as

described in AOAC (2006) by taking 50mL instant drinks in the flask.

Total sugars (%)
Total sugars of the instant drink were estimated by using the Lane and Eynon method as explained in AOAC (2006).

Sensory evaluation
A nine-point Hedonic scale, 9 (excellent) to 1 (very poor) as defined by Meilgaard et al. (2007) was used for the sensory evaluation of prepared drinks in terms of color, flavor, taste, mouthfeel and general acceptability. Instant drinks (T_1, T_2, T_3) were evaluated for these characteristics. Written instructions were given to each panelist for the marks of practical drinks. Developed drinks were filled in the polystyrene cups marked with casual codes at room temperature to improve the accuracy.

Statistical analysis
The data obtained were analyzed by means of statistical tools using a completely randomized design (CRD) using the Minitab 18 statistical program and interpreted by Steel (1997). All measurements were performed threefold and findings are stated as mean ± standard deviations. For the measurement of the level of consequence, statistical analysis was conducted using variance analysis (ANOVA) et al.

Results and Discussion

The proximate composition has been presented in Table 1. The moisture content, protein, ash, crude fiber, fat and carbohydrate were, 10.3%, 3.8%, 3.3%, 8.9%, 2.6% and 86.4% respectively. The moisture content, fat, protein, fiber, ash and carbohydrate content are important determinants of food. These components determine the nutritive value as well as the shelf value of the product. Characterization of these constituents was essential for the evaluation of components of concern. The results of proximate composition were found in close conformity with the Ajila et al. (2010) who described the values of 10.5%, 3.6%, 3.0%, 9.4%, 2.0%, and 80.7% for moisture content, protein, ash, crude fiber, fat and carbohydrates respectively.

Bioactive compounds
The mean values for the antioxidant activity and total phenolic contents were noticed to be 73.1% and 81.3 mg/g GAE respectively (Table 1). The presence of these bioactive compounds represents the nutritional qualities and antioxidant potential of the MPP. These antioxidants very essential for the reduction of free radicals from the body and prevent cardiovascular disease. (Bakar et al., 2009). Mango peel contains more anti-oxidant than present in the other fruit peel as the Dragon fruit peel (Hiylocereus polyrhizus) represents 50.1%, banana tissue 52.1 %, and quince peel 28% however it contains less total phenol content than present in the orange peel (154±10.2 mg GAE/100g) as reported by Mokbel and Hashinaga (2005). The findings are similar to the results of Imran et al. (2013) who reported the values of 79.4 mg/g GAE and 71% for the total phenolic contents and antioxidant activity in their experiment. Similarly, Ajila and Rao (2013) also studied total phenolic contents and antioxidants activity of mango peel powder in the range of 82.7mg/g GAE and 79% respectively.

Table-1: Proximate composition of mango peel

Components	Mean ± SD
Moisture (%)	10.3±0.05
Protein (%)	03.8±0.15
Crude Fiber (%)	08.9±0.59
Ash (%)	03.3±0.17
Carbohydrate (%)	86.4±0.43
Fat (%)	02.6±0.11
Total Phenolic (mg/g GAE)	81.3± 0.45
Antioxidant Activity (%)	73.0±0.41
Ascorbic Acid (mg/100g)	14.8±0.26

Ascorbic acid (mg/100g)
The ascorbic acid had a mean value of 14.8mg/100g. Ascorbic acid mainly acts as antioxidants to fight free radicals and play an imperative character in the development and progression of the human body. The presence of this acid along with other bioactive compounds favors the use of this nutrient-rich powder in daily diet. The results are in harmony with Chau and Huang (2003) who reported the mean value of ascorbic acid to be 16.7mg/100g in the mango peel.

Physicochemical evaluation of drink

Titratable acidity (%)
Titratable acidity is an important characteristic as acidity gives unique sourness to the product and

tartness is the key factor in the acceptability of any drink. The effect of treatments and storage on the instant drink is depicted in Table 2. The data represents that the acidity varied significantly among treatments and storage. The mean value for the treatments T_1, T_2, and T_3 was found to be 0.16, 0.17, and 0.20 % respectively. The predominant acid in the MPP was ellagic acid and by increasing the concentration of the MPP in the treatment, the acidity of the drinks increased. During the storage from 0 to 60 days means values for the treatments increased from 0.16 to 0.19 respectively (Table 3). This increase in acidity was endorsed to the breakdown of sugars into carboxyl acids. Ayub et al. (2010) observed a parallel inclination of a decrease in the acidity for the storage of strawberry juice under controlled conditions.

Table-2. Effect of treatments on the chemical characteristics of mango peel drink

	T_1	T_2	T_3
TA	0.16±0.02b	0.17±0.01b	0.20±0.02a
pH	3.72± 0.12a	3.62±0.16ab	3.47±0.14b
TSS	3.54±0.05c	4.62±0.25b	6.9±0.35a
TS	10.41±0.89c	12.86±1.04b	15.59a
DPPH	47.6±6.5c	50.3±6.5b	52±7.54a
TPC	72.18±10.6b	73.10±9.68ab	74.50±13.9a

Means (±SD) carrying similar alphabets in a column do not differ significantly ($p<0.05$)

Table-3. Effect of storage on the chemical characteristics of mango peel drink

Storage Interval (days)	TA	pH	TSS	TS	DPPH	TPC
0	0.16± 0.02c	3.74± 0.09a	4.63±1 .30b	14.37± 3.52a	56.60± 2.51a	84.21± 4.54a
30	0.17± 0.02b	3.60± 0.13b	5.00±1 .17ab	13.36± 2.9b	50.30± 2.34b	73.74± 2.35b
60	0.19± 0.03a	3.42± 0.14c	5.46±1 .01a	11.13± 1.50c	43.00± 1.73c	61.84± 2.11c

Means (±SD) carrying similar alphabets in a row do not differ significantly ($p<0.05$)

pH

The pH of any food substance is a very main element in terms of consumer acceptance. The statistical analysis disclosed that there is a momentous fall in ph among treatments. The highest values exist for T_1 and the lowest value found in T_3. The main purpose of the decrease in pH was due to an increase in the acidity among treatments from T_1 to T_3. Storage interval also significantly effects the pH. From 0 to 60 days, pH decreased from 3.74 to 3.42 respectively. This decrease in pH might be due to the breakdown of sugars and peptic bodies into acidic compounds. The results of the pH were similar to the findings of with the Kausar et al. (2012) who reported a similar pattern for the pH decrease during storage in their studies.

Total soluble solids (°Brix)

The results exhibited that there were considerable differences in TSS for treatments and storage interval. Highest mean values recorded in T_3 while lowest in the T_1. TSS showed an increasing trend from T_1 to T_3. This increase in the total soluble solid was mainly due to a large amount of total sugar present in the mango peel. However, the mean values during storage interval for TSS also increase from 4.63 to 5.46 from zero to 60th days respectively. This may be due to breakdown of complex sugars e.g. polysaccharides and oligosaccharides into simpler sugars e.g. monosaccharides. Klimczak et al. (2007) record a similar pattern of TSS increase in drinks during storage at the controlled condition in their studies.

Total sugars (%)

Total sugars contain all mono and disaccharides present in food substances. The total sugars on instant drinks represent that significant differences exist among treatments. The mean values of T_1, T_2, T_3, were 11.07, 13.98, and 18.08% respectively. Total sugars contents increase with the addition of mango peel powder in the drinks. This attributes to the presence of diverse monosaccharides and oligosaccharides in the mango peel powder (Ajila, 2007). Storage of drinks decreased their total sugars contents. Momentous differences exist during the storage period with the highest value recorded (14.37%) when drinks were freshly prepared compared to the 60thday storage (11.13%). The fall in total sugars links to the degradation and conversion of sugars to invert sugars (Zapata et al., 2017). These results are in conformity to the reported by Akhtar et al. (2010). Mokbel and Hashinaga (2005) reported that the total sugar range present in the mango peel was much greater than present in the banana peel.

DPPH (free radical scavenging activity)

DPPH is the stable free radical model designed to assess antioxidant activity. Antioxidants are important to the human body since they play a crucial role in protecting the body during the metabolism of stress. The statistical data analysis demonstrated significant

differences (47.6-52) for treatments and storage (56.6-43). An increasing pattern is seen in T_1 to T_3 treatments. The main reason for increasing free radical scavenging activity could be due to an upturn in the content of polyphenols and carotenoids through enhanced MPP fusion. During storage free radical scavenging activity decreases from 0 to days that might be due to oxidation and breakdown of polyphenols due to light and temperature exposure. Ventura et al. (2013) represented a similar trend for pomegranate juice storage in their studies.

Total phenolic content (mg/g GAE)

Tables 2 & 3 elucidated that the momentous differences exist in the TPC among treatments (72.18-74.5mg/g GAE) and during storage interval (84.2 to 61.8mg/g GAE). TPC contents increase among treatments with an increase in the incorporation of mango peel powder. Therefore, it was noted that bioactive compounds and the nutraceutical potential of the drinks improve with the rise in the fortification of MPP in the drinks. It was observed that storage adversely affects the TPC and mean values decreases from 84.21 to 61.84 mg/g GAE. This decrease in TPC links to the deterioration of polyphenol to polyphenol oxidase due to oxidation (Zapata et al., 2017). Similar findings for TPC reduction during storage was given by Varela-Santos et al. (2012) for pomegranate juice in their studies.

Sensory evaluation

Color

The data manifests that color scores were improved with the intensification in the combination of MPP among treatments with the highest value that exists for T_3 (8.3) while lowest in T_1 (6.96). This variation in color may be due to color pigment's presence in MPP. Two months of storage interval decreases the color scores from 7.1(0days) to 6.4 (60). This variation in color links to the browning reactions between sugars and amino acids (Mishra et al. 2012).

Taste

The maximum taste score observes in T_1 (8.0) while minimum in T_3 (6.8). An increase in mango peel powder concentration decreases the taste of drinks due to the increase in the acidity among treatments. Storage intervals showed non-momentous alteration in taste with a maximum score recorded when it was freshly prepared (7.5) and after two months (7.1). The results of color and taste were in close conformity with Mishra et al. (2012).

Flavor

Figure 1 & 2 represents the flavour scores among treatments. Significant differences exist for flavours with T_1 shows the best score among treatments. An increase in organic acid with the addition of MPP concentration in the drinks reduces its flavor. Storage days also show significant variations and the best flavor score was observed when the drinks were freshly prepared. The value changes from 8.1 (0 days) to 6.9 (60 days). This change might be due to variations in volatile components with an increase in storage (Ajila, 2007).

Mouthfeel

The best results for the mouthfeel were recorded in T_1 (7.9). Significant differences in mouthfeel represent that the increase in MPP declines its mouthfeel. The storage days reduce the mouthfeel of the drinks with the best results recorded at zero day storage (7.6). The reason for the decline was due to the inversion of sugar content and the formation of carboxylic compounds with storage periods (Kausar et al., 2012). Ahmad et al. (2013) observed a similar result for the storage of drinks in his studies.

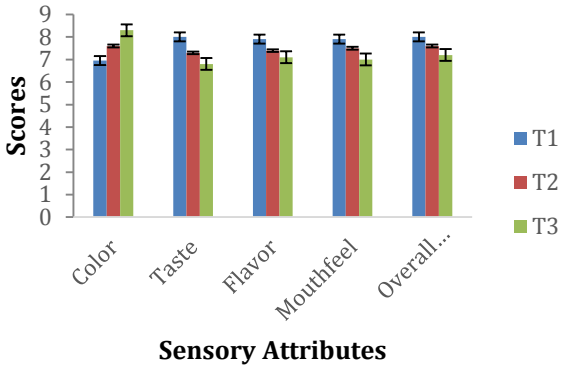

Figure-1: Effect of treatments on sensory scores of mango peel drink

Overall acceptability

The overall acceptability score of drinks among treatments is demonstrated in Figures 1 & 2. The highest score was found in the T_1 (8). The acceptability of drinks decreases with an increase in MPP substitution among treatments. Freshly prepared drink shows best results during the storage interval. The overall acceptability score was 8.1 (zero days) when prepared fresh while it changes to 6.4 (60day) during 2month storage (Figure 2). This change was due to the

degradation of sugar content and the deterioration of peptic bodies during the storage period (Ajila and Rao, 2013). The findings are similar to the results of Zapata et al. (2017).

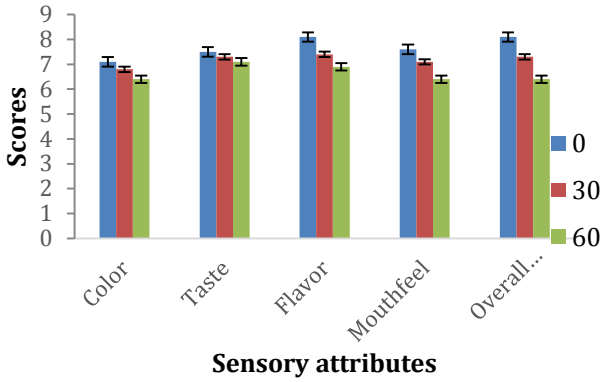

Figure-2: Effect of storage on sensory scores of mango peel drink

Conclusion

Mango peel which is usually discarded as waste possesses good nutraceutical potential and its characterization exhibited a rich source of micronutrients, which can be harvested as a supplement in different food products. The utilization of mango peel at 5g/250mL concentration in instant drinks shows the best result for physio-chemical parameters and shows stability during storage among other treatments. The 5g/250mL concentration of mango peel in the instant drinks also shows the best sensory attributes in terms of flavor, taste and mouthfeel and it can be used in the future on daily basis for the value addition of drinks.

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Khalid N: Conceived idea and designed research methodology
Shibli S: Supervised lab work and data collection
Amir RM: Literature review and data interpretation
Malik AM: Data analysis and interpretation
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