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Pectic principles of mango peel from mango processing waste as influenced by microwave energy

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ABSTRACT

Mango var. Totapuri is extensively processed into mango puree by the fruit processing industries. It results in generation of huge quantities of processing waste comprising of mango peel, stone and fibre. Microwave energy levels of 250, 440, 660 and 1000 W with time period ranging from 10 min to 25 min were studied for pectin extraction from mango peel. Microwave extraction affected the yield, methoxyl content, galacturonic acid and viscosity of pectin. Maximum pectin yield could be obtained with a short heating period as compared to the conventional method of extractions reported earlier. Higher methoxyl content and viscosity were observed in the mango peel pectin extracted at 660 and 1000 W for 20 min indicating the better gelling properties of the pectin. Yield of pectin was found to be maximum from the mango peel exposed at microwave energy of 1000 W for 20 min. Methoxyl content, viscosity, galacturonic acid decreased at 25 min of extraction at all microwave energy levels studied. Pectin extracted at the optimum conditions contained galacturonic acid, methoxyl content and viscosity of 57.2 g/100 g, 8.2 g/100 g and 98.2 mPa s respectively. Microwave extraction of mango peel under selected conditions resulted in higher yield of pectin.

1. Introduction

Mango is an important tropical fruit crop widely cultivated in different regions of India. It is also the major producer of mangoes reported to be about 16.2 million metric tonnes of mangoes during the year 2012–2013(NHB, 2013). Mango pulp produced from ripe mangoes is a value added product with wide applications in food industry mainly fruit juice beverage industry. The waste generated by the mango pulp producing industries include mango peel, kernel and pulper waste. Ripe mango fruit comprises of 15–20 g/100 g peel as a waste (Dabhade & Khedkar, 1980). Mango peel is reported to have good amount of pectin and other carbohydrates (Ajila & Prasada Rao, 2013; Beerh, Raghuramaiah, Krishnamurthy, & Giridhar, 1976). Pectin is a plant polysaccharide found in between plant cell wall and middle lamella and contributes to the rigidity of plant cell (Bagherian, Zokaee Ashtiani, Fouladitajar, & Mohtashamy, 2011). Extraction of pectin is carried out by different methods such as acid extraction and salt extraction followed by solvent precipitation (Li, Jia, Wei, & Liu, 2012). Commercial pectin extraction by using inorganic acids is more widely used. Inorganic acids such as HCl, H_2SO_4, HNO_3 were used for the extraction of pectin from passion fruit peel (Kulkarni & Vijayanand, 2010). Extraction conditions such as heating, acid concentration, peel to extractant ratio, extraction time and temperature affect the quality characteristics of pectin (Fishman, Chau, Hoagland, & Hotchkiss, 2006; Kulkarni & Vijayanand, 2010). Microwave energy has been used for heating purposes which generates heat energy within short time periods (Metaxas & Meredith, 1993). Microwave energy can be exploited where rapid increase in temperature is desired. Microwave assisted extraction consists of heating the solvent in contact with the sample by means of microwave energy (Eskilsson & Björklund, 2000; Kratchanova, Pavlova, & Panchev, 2004). Microwave

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heating of citrus peel and apple pomace were shown to increase in pectin yield (Fishman, Chau, Coffin, & Hotchkiss, 2003). Commercial pectin extracted from apple pomace or citrus peels has been widely used in food applications (Díaz, Giannuzzi, & Giner, 2009). Microwave assisted extraction of pectin in a short time heating period was reported in albedo portion of lime (Fishman et al., 2003). Conventional method of pectin extraction involved long heating periods such as 60–90 min in passion fruit peel, 60 min in sunflower and 90 min in orange peel which may affect the pectin quality characteristics (Iglesias & Lozano, 2004; Kulkarni & Vijayanand, 2010; Kar & Arslan, 1999). Extraction of the peels with minimum heating period is desirable for obtaining better quality pectin. Therefore, the main objective of the present investigation is to study the microwave extraction of pectin from mango peel at different conditions and its effect on the quality characteristics.

2. Materials and methods

2.1. Materials

Mature, ripe mangoes var. Totapuri was procured from the local fruit market, Mysore, India. The fruits were washed, cut and passed through a pulper extractor fitted with a stainless steel sieve having a pore diameter of 0.8 mm. Peels collected after the pulp extraction were washed in tap water and crushed in a fruit mill to obtain pieces of 4–5 mm. Crushed peel was blanched in steam jacketed kettles containing hot water maintained at 95 °C for 10 min. Blanched peels were drained and cooled by spraying tap water. Cooled peels were allowed to drain for 15 min and loaded on perforated stainless steel trays of 8meshwitha tray load of 8.82 kg m^{-2}. The trays were kept in across flow hot air drier maintained at 60 ± 1 °C and dried to final moisture content of 4–6 g/100 g. Dehydrated peels were packed in low density polyethylene bags having thickness of 75 μm, kept in a tin container and stored at room temperature29 ± 2 °C. These dried mango peels were used for the experiments.

2.2. Microwave extraction

Dehydrated mango peel of 20 g was weighed in a 1000 mL borosil glass beaker and pH of extractant was adjusted to 1.45 using hydrochloric acid and water mixed in the ratio of 1:25 (1 part of peel and 25 parts of extractant) allowed to soak for 20 min at 30 ± 2 °C. The beaker with soaked peel was placed in the microwave oven Panasonic, Model No. NN-C784MF Instruments, India. Extraction was carried out with microwave energy of 250, 440, 600 and 1000 W for 10, 15, 20 and 25 min for two times. Loss of evaporation during the extraction was replaced by adding extractant to make up the evaporation loss. The extract after the specified time was filtered through a nylon cloth (0.1 mm pore diameter). The residue was again transferred back to the beaker for second extraction at the same conditions and filtered. The extracts obtained from 1st and 2nd extraction were weighed separately and filtered through Buchner funnel using Whatman No.3 filter paper. The filtered extract was added with ethanol (95 mL/100 mL) in the ratio of (1:2) with continuous stirring and kept for 3 h at room temperature for the precipitation of pectin. The precipitated pectin was washed successively with 70, 80 and 90 mL/100mLethanol. Washed pectin was dried in a vacuum oven at 50 °C for 2–3 h to a constant weight. Dried pectin was weighed, pulverized and passed through 250 μm mesh. The pectin powder was packed in metallized polyester polyethylene pouches, sealed and kept in a desiccator at room temperature for further studies (Fishman & Chau, 2000).

Yield of pectin was calculated as follows:

$$Pectin(g/100g) = \frac{weight\ of\ dried\ pectin \times 100}{weight(g)\ of\ dried\ peel\ taken\ for\ extraction}$$

2.3. Methoxyl content

One g of pectin sample was weighed, dissolved in glass distilled water and made up to 100 mL in a volumetric flask. 25 mL of the pectin solution was transferred to a 250 mL conical flask. One g of sodium chloride was added along with six drops of Hinton's indicator. The pectin solution was titrated with 0.1 mol equi/L NaOH until the colour of the indicator changes to magenta colour and pH 7.5. To this neutralized solution, 25 mL of 0.25 mol equi/L NaOH was added, mixed thoroughly, and allowed to stand for 30 min at room temperature. 25 mL of 0.25 mol equi/L HCl was added mixed thoroughly and titrated with 0.1 mol equi/L NaOH (Ranganna, 1986; Norziah, Fang& Karim, 2000).

2.4. Galacturonic acid content

Total Galacturonic acid of the pectin sample was determined using a modified m-hydroxyl diphenyl sulphuric acid method. The colour forming product was measured by spectrophotometer using D-galacturonic acid (Fluka, Slovakia) as a standard (Blumenkrantz & Asboe-Hansen, 1973).

2.5. Viscosity

One g of pectin was weighed, in glass distilled water and made up to 100 mL in a volumetric flask. The solution was kept at room temperature for 1 h. Viscosity of the solution was measured using Brookfield Viscometer, (Model No; R.IM.3 M/s Rheology international Ltd, Shannon, Ireland). Viscosity was measured using spindle number 3 at 100 rpm for 30 s. Auto zeroing at the start, standardized the instrument, the spindle no. 3 was inserted up to mark and reading was noted and expressed as mPa s (Miyamoto & Chang, 1992; Schmelter, Wientjes, Vreeker, & Klaffke, 2002).

2.6. Statistical analysis

The entire experiments were performed with three replications, and data are presented as means ± standard deviation (SD). The data was subjected to analysis of variance using Microsoft Excel 2007 to find out the significance of treatments.

3. Results and discussion

3.1. Yield of pectin

The yield of pectin from 1st and 2nd extractions is shown in Fig. 1. Mango peel subjected to microwave extraction for a period of 10–25 min showed increase in yield of pectin during 1st extraction. The yield of pectin ranged from 1.7 to 9.9 g/100 g at different microwave energy levels during 1st extraction. It increased with increase of microwave energy and highest yield of pectin was observed at 600 W. Further increase in yield of pectin was not observed at 1000 W. Yield of pectin during 2nd extraction ranged from 1.5 g/100 g to 6.5 g/100 g at different microwave energy levels. Yield of pectin was three times more at 600 W microwave energy and 1000 W. Among the time periods studied the yield of pectin increased with increase in time of extraction up to 20 min and showed very little increase thereafter.