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Apple pomace as a source of dietary fiber and polyphenols and its effect on the rheological characteristics and cake making

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Abstract

Apple pomace, a by-product of apple juice industry, is a rich source of fibre and polyphenols. Also in view of the antioxidant property of pomace, it would play an important role in prevention of diseases. Apple pomace procured from fruit juice industry, contained 10.8% moisture, 0.5% ash and 51.1% of dietary fibre. Finely ground apple pomace was incorporated in wheat flour at 5%, 10% and 15% levels and studied for rheological characteristics. Water absorption increased significantly from 60.1% to 70.6% with increase in pomace from 0% to 15%. Dough stability decreased and mixing tolerance index increased, indicating weakening of the dough. Resistance to extension values significantly increased from 336 to 742 BU whereas extensibility values decreased from 127 to 51 mm. Amylograph studies showed decrease in peak viscosity and cold paste viscosity from 950 to 730 BU and 1760 to 970 BU respectively. Cakes were prepared from blends of wheat flour containing 0–30% apple pomace. The volume of cakes decreased from 850 to 620 cc with increase in pomace content from 0% to 30%. Cakes prepared from 25% of apple pomace had a dietary fibre content of 14.2% The total phenol content in wheat flour and apple pomace was 1.19 and 7.16 mg/g respectively where as cakes prepared from 0% and 25% apple pomace blends had 2.07 and 3.15 mg/g indicating that apple pomace can serve as a good source of both polyphenols and dietary fibre.

Keywords: Apple pomace; Farinograph; Extensograph; Pasting characteristics; Cake; Dietary fibre; Total phenol content

1. Introduction

Dietary fibre functions as a bulking agent and increases the intestinal mobility and moisture content of the feces (Forsythe, Chenoweth, & Bennink, 1976). Several authors have reviewed the importance of dietary fibre since 1970s (Eastwood, 1974; Leveille, 1975; Southgate, 1975). Dietary fibre consists of cellulose, hemicelluloses, lignins, pectins, gums etc. (Gallaher & Schneeman, 2001 & Lamghari et al., 2000). Dietary fibres from different sources have been used to replace wheat flour in the preparation of bakery products. Pomeranz, Shogren, Finney, and Bechtel (1977) used cellulose, wheat bran and oat bran in bread making. Potato peel, a by-product from potato industry, rich in dietary fibre, was used as a source of dietary fibre in bread making (Toma, Orr, D'Appolonia, Dintzis, & Tabekhia, 1979). Apple pomace is the residue that remains after the extraction of juice from apple. Dried apple pomace, a fruit industry by-product, is considered as a potential food ingredient having dietary fibre content of about 36.8% and has been used in apple pie filling and in oatmeal cookies (Carson, Collins, & Penfield, 1994). Apple fibre wheat flour blends were shown to have poor bread baking quality (Chen, Rubenthaler, & Schanus, 1988a). Further, Chen, Rubenthaler, Leung, and Baranowski (1988b) having characterized by chemical and physical methods, found apple fibre to be superior to wheat and oat bran. They used apple pomace in cookie and muffin formulations at 4% level so that the quality of the end product was acceptable. In addition, citrus and apple fibres are known to consist of bioac-

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tive compounds such as flavonoids, polyphenols and carotenoids and also have been considered as a source of better quality dietary fibre (Fernández-Ginéz, Fernández-López, Sayas-Barberá, & Pérez-Alvarez, 2003). Fernando, Maria, Ana Maria, Chiffelle, and Fernando (2005) evaluated for some functional properties and reported that fibre concentrates from apple pomace and citrus peel can be considered as a potential source for fibre enrichment. Masoodi, Bhavana, and Chauhan (2002) studied cake making from apple pomace wheat flour blends at 5%, 10% and 15%, so as to enrich the cake with fibre content. Fresh apples seem to have antioxidant activity equivalent to 1500 mg of vitamin C and are suppose to inhibit the growth of colon and liver cancer cells (Eberhardt, Lee, & Liu, 2000). Lu and Foo (2000) indicated that the polyphenols, which are mainly responsible for the antioxidant activity, are present in apple pomace and hence could be a cheap and readily available source of dietary antioxidants. Several workers have also carried studies on the recovery of pectin and phenolic compounds from apple pomace by several workers (Schieber et al., 2003; Escarpa & González, 1988; Jham, 1996; Lu & Foo, 1997; Schieber, Keller, & Carle, 2001). The objective of the present study was to characterize the apple fibre chemically, and to study its influence on dough properties and on cake making. Polyphenols present in the pomace as well as in cake prepared using apple pomace were also investigated.

2. Materials and methods

2.1. Materials

Dried apple pomace was procured from a fruit juice industry (Southern Citrus Products Pvt. Ltd., Gudur, India). The dried apple pomace consisting of peel, stem and seed along with residue of juice extract was ground to powder to pass through 150 μm sieve. Commercial wheat flour procured from local market, having 11.4% moisture, 10.1% protein and 0.45% ash was used in the study.

2.2. Chemical analysis

Dried apple pomace was analysed for moisture, ash, protein and fat contents as per the standard AACC methods (2000). Nitrogen content was estimated by semi-micro Kjeldhal method and was converted to protein using factor 6.25. Total dietary fibre (TDF), soluble (SDF) and insoluble (IDF) dietary fibre contents were estimated according to Asp, Johansson, Hallmer, and Siljestroem (1983). Bulk density of the apple pomace was determined using a calibrated graduated cylinder. Cylinder was filled with apple pomace with slight shaking and the contents of the cylinder was weighed and expressed as g/ml. The packed density was determined by pressing the sample in a graduated cylinder using a rubber stopper attached to a glass rod (Chen et al., 1988b). For water holding capacity determination, 1 g of apple pomace powder was mixed with 50 ml of distilled water vigorously for 1 min and then centrifuged for 15 min at 10,000*g* at 20 °C. The supernatant was discarded and the tube was kept inverted for 10 min. Moisture content of the precipitate was determined (Chen et al., 1988b). All analysis for the samples were carried out in triplicate and average value was expressed.

2.3. Rheological characteristics

Apple pomace blends at 0%, 5%, 10% and 15% levels were prepared by replacing wheat flour. The effect of apple pomace on the mixing profile of the dough was studied using farinograph (Brabender, Duisburg, Germany) according to the standard AACC methods (2000). The elastic properties of the dough was studied using extensograph (Brabender, Duisburg, Germany) according to the standard AACC methods (2000). Pasting characteristics of the blends were determined using visco-amylograph (Brabender, Duisburg, Germany) according to the standard AACC methods (2000).

2.4. Baking tests

Cakes were prepared from blends containing 0%, 10%, 20% and 30% of apple pomace. The formula included 100 g flour blend, 100 g sugar, 120 g egg, 25 g shortening, 40 g refined vegetable oil, 0.5 g baking powder and 1.5 g salt. Cake batter was prepared in a Hobart mixer (N-50) using flour batter method, wherein, the flour, shortening, salt and baking powder were creamed together to get a fluffy cream; eggs and sugar were whipped together until semi-firm foam resulted. The sugar–egg foam was mixed with the creamed flour and shortening, after which the vegetable oil was added in small portions. Cake batter (450 g) was poured into a wooden pan and baked at 160 °C for 1 h. Cakes were cooled to room temperature and packed in polypropylene pouches.

2.5. Physical characteristics of cakes

Volume (V, cc) of cakes was measured using rapeseed displacement method. Weight of the cakes was measured (W, g) and density (W/V, g/cc) was calculated. The texture of the cakes was measured objectively using food texturometer (TAHDi, Stable Micro System, UK) as per the standard AACC methods (2000). A pre-test speed of 2.0 mm s^{-1} and a test speed of 1.67 mm s^{-1} were used. A 35 mm diameter cylinder aluminum probe (P-35), was used to measure the required compression force. Force required to compress 25% of the cake slice (2.54 cm) was recorded.

2.6. Sensory analysis

Sensory evaluation of cakes were carried out by six panelists on a five point hedonic scale for different parameters such as crust colour, crumb colour, grain, texture, eating quality and overall quality.