Simultaneous extraction of pectin, fibre, anthocyanin and oil from mulberry pomace

Neelima Garg*, Preeti Yadav & Sanjay Kumar
Division of Post Harvest Management, ICAR-Central Institute for Subtropical Horticulture, Lucknow-226 101, Uttar Pradesh, India

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Mulberry (Morus alba L.), (Fam. Moraceae) has characteristic tiny juicy fruits with sweet-tart taste. Its ripe fruits range in colour from white, pale, green, red, purple to black. The juice from red-purple mulberry variety has significant antioxidant value and food colouring properties. Though, a lot of research work has been carried out on mulberry juice, utilization of its pomace (processing waste comprising peel and seeds), has been largely ignored. Pomace constitutes about 40% of total fruit weight. Here, we have standardized protocols for potential extraction of pigment anthocyanin, fibre, pectin, and oil from mulberry pomace using a combination of organic and inorganic solvents and obtained an yield of 5.3% fibre, 1.58% pectin, 2.0% crude anthocyanins and 4.9% oil. The protocol allows complete utilization of waste left behind after juice extraction.

Keywords: Fruit peel, Morus alba

With the increasing health awareness among masses and growing popularity of processed products due to their high nutraceutical values, fruit processing industry is expanding fast, world over. As a result, huge quantum of fruit and vegetable waste is generated every year by the industry, leading to problem of its disposal coupled with environmental pollution issues. Over the last few years, considerable emphasis has been put on the recovery, recycling and upgrading of organic waste that can be transformed into several different useful products like biomolecules, phytochemicals, enzymes, food flavours, probiotics for food and feed and bio-fuels, etc.1. China is the leading country in the world in mulberry production2. In India, mulberry is cultivated in around 282 thousand hectares of land with Karnataka as the leading state followed by Andhra Pradesh, Manipur, West Bengal. Mulberry is grown primarily for silk production as its leaves have been used as feed for silk worms for hundreds of years.

The fruits mature with red and purple colors due to plentiful anthocyanins, while some cultivars retain white, green fruits. Mulberry processing is extremely limited. Only few units in India is engaged in juice production. No other product is available in the market. Mulberry pomace, a byproduct of mulberry juice industry consisting of mainly peels, stems and seeds, accounts for approximately 40% of the fresh weight. Typically, mulberry pomace is used as a soil enhancer, feed and fertilizer or is otherwise dumped in landfills, which contributes to environmental problems3. Djilas et al.4 have recommended utilization of pomace as substrate for getting food supplements with high nutraceutical value. Present paper describes approach for simultaneous extraction of pectin, fibre, anthocyanin and oil from mulberry pomace for further use in food industry.

Materials and Methods

Collection of fruits

Mulberry accession, MI-497 was collected from the experimental farm of ICAR-Central Institute for Subtropical Horticulture, Lucknow and washed under running tap water. The juice was extracted with the help of hydraulic press.

Preparation of material

Pomace left after mulberry fruit juice extraction comprising of peel, stem and seeds, was dried in dehydrator at 60°C till constant weight. For extraction of oil, seeds were separated from pomace manually.

Methodology

For extraction of anthocyanin, fibre, pectin and oil, methods described in AOAC5 were followed. Protocol has been described in Fig. 1. Boiling the pomace with 3% sodium hexametaphosphate for 2 h resulted in separation of pectin and anthocyanin from fibre. Fibre was obtained using the residue part, while supernatant was used for extraction of anthocyanin and pectin. For this, acetone was added to supernatant in 3:1 ratio and kept overnight at 4°C. The contents were filtered and the precipitate was used as pectin while the filtrate was freeze dried for getting anthocyanin. Oil was extracted from seeds with hexane as solvent. The fatty acid in the oil was estimated as per the method described by Christie6. The samples containing fatty acid were first esterified using methanol. The fatty
acid composition was determined by GC (Perkin Elmer, Clarus 500) using flame ionization detector under the following operating conditions: capillary column- Elite FFAP (30 m × 0.25 mm × 0.25 um); Nitrogen, Hydrogen and air flow @ 40, 40 and 400 mL/min, respectively; column temperature 100°C held for 5 min then increased at the rate of 3 mL/min up to 240°C, held for 15 min; injector temperature 210°C and FID temperature 280°C. The fatty acids were identified using authentic standards and reported as a relative percentage.

Results and Discussion

There are reports of individual extraction of total dietary fibre (9.29 %), anthocyanin (285.5 mg/100 g) oil (29%) and pectin individually from mulberry pomace7-10. However, product yield one after another may not be economically viable. Therefore, an integrated protocol was worked out for extraction of fibre, pectin, pigment and oil from mulberry pomace, using a combination of organic and inorganic solvents. The products obtained have been shown in Fig. 2.

A yield of 5.3% fibre, 1.58% pectin and 2% crude anthocyanin was obtained from mulberry pomace. Zhang et al.8 have reported recovery of 285.5 mg/100 g anthocyanin from mulberry pomace. The major anthocyanins reported in mulberry are cyanidin-3-glucoside and cyanidin-3-rutinoside. These pigments hold potential for use as dietary modulators, mechanisms for various diseases, and as natural food colorant. There are no reports on pectin extraction from mulberry pomace, however, apple pomace and citrus peel are rich source of pectin11.

Oil yield of 4.7% was obtained from mulberry pomace of accessions MI-497 while separated seeds contained 28-30%. Jin et al.9 have reported that mulberry seeds yielded 29.3% oil whereas Xiaolan et al.12 have reported a 30.7% oil yield for white mulberry seeds. While our results are in accordance with the previous reports on mulberry seeds, variations in oil yield and content may be due to the differences in variety of plant, cultivation climate, ripening stage, the harvesting time of mulberry and its location and the extraction method used. Oomah et al.13 reported that black mulberry seed was higher (30%), in oil content than grape seed (11.6-19.6%), cotton seed (15.2-22.0%), olive (12.0-28.0%) and raspberry seed (10.7%).

GC analysis indicated presence of saturated fatty acid viz. stearic acid (21.47%), palmitic acid (45.90%), arachidic acid (1.69%), lignoceric acid (2.18%) and docosanoate (0.91%). Choe and Min14 reported that saturated fatty acids provide oxidative stability for lipids. Unsaturated fatty acid identified in mulberry pomace oil were oleic acid (21.80%), myristic acid (0.35%), linoleic acid (3.22%) and erucic acid (2.42%). It is widely accepted that unsaturated fatty acids are desirable for healthy living15. Yılmaz & Durmaz16 have also reported the presence of palmitic, stearic, oleic, linoleic and...
linolenic acid in mulberry pomace oil obtained from local mulberry cultivars of Malatya, Turkey.

Above results encourage utilization of mulberry pomace for high value products viz. pectin, fibre, anthocyanin and oil for market potential. Though, oil yield from pure seeds was five times higher than pomace, seed separation from pomace is not economically feasible as yet. Hence, suitable intervention is required for seed separation from pomace. Market potential for these products needs to be explored at industrial scale. It will help in optimum utilization of biomass, enhanced income to farmers/industry employment generation and capital formation.

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