Research Article

Studies on Quality Evaluation of Underutilized Mulberry Fruit Juice Extracted by Five Different Methods

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Abstract

Mulberry (*Morus alba* L.) is one of the unique minor fruit crop which has got great commercial importance because of its high antioxidant, functional and medicinal properties. Commercial mulberry juice is available in China but not readily available in India. The present studies were carried out for the screening of best juice extraction method. Fresh mulberry fruit juice was extracted by five different methods viz., manual, by food processor, screw type juice extractor, pulper (brush type) and by hydraulic press. The quality of juice extracted by different methods interms of TSS, acidity, vitamin C, anthocyanins, total phenols and sensory characteristics were compared to screen best method for juice extraction. Out of 5 methods tried juice extracted by hydraulic press contains higher TSS (14.25 ^{o}B), titratable acidity (0.44 %), ascorbic acid content (14.11 mg/100 g), anthocyanins (22.14 mg/100 g) and total phenols (153.70 mg/100 g) besides higher juice yield (58.45 %) and sensory characteristics scores. Further, no microbial contamination or visual spoilage could be seen upto 3 months of storage of juice in deep freezer (-18 ^{o}C) packed in PET jars during storage.

Keywords: Mulberry, juice, extraction method, anthocyanins, total phenols, sensory evaluation

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Introduction

Mulberry (*Morus alba* L.) a underutilized wild fruit is known as *shahtut*, *chinni* and tut in Himachal Pradesh (HP). It belongs to genera *Morus* in family moraceae. This genus is widely distributed in Asia, Africa, Europe, South and North America. It is also widely found in hilly areas of Himalayas up to 3300 m elevation [1]. Among various *Morus* species *Morus alba* L. has been cultivated widely in Asia especially in China, Japan and India for rearing silkworms besides fruit purpose [2]. In India, *Morus alba* is widely distributed in Jammu and Kashmir, UP, Karnataka, Tamilnadu, West Bengal, Kerala, HP and found at an elevation between 400 to 2000 m above mean sea level [3].

Fruits of this species are long, ovoid or cylindrical, which are variable in colour like white, pink or purple to black and this colour arise from the presence of anthocyanins [4]. The fruiting season of this fruit starts from the first week of April and continues till the last week of June, depending upon the climatic conditions and area. Harvesting period of this fruit is too long and fruits from a single tree are being harvested in many pickings. The fruit yield increases with tree size and a fully grown tree can yield between 10-15 kg mulberry fruits [5]. Mulberry fruits contain essential fatty acids, vitamins, polyphenols including flavonols, carbohydrates, fibre, minerals, riboflavin, ascorbic acid, carotene and nicotinic acid [2, 6]. Its fruits contains higher moisture content (81.68 ± 0.64 %), TSS (14.15 ± 1.05 ^{o}B), titratable acidity (0.44 ± 0.12 % as citric acid), pH (4.22 ± 0.01), ascorbic acid (14.07 ± 0.79 mg/100 g), crude fibre (0.93 ± 0.12 %), anthocyanins (22.17 ± 1.12 mg/100 g) and total phenolic content (153.30 ± 1.64 mg/100 g) [7].

With abundant medicinal properties mulberry finds a unique position in herbal remedies and is extensively used in Ayurvedic for curing many serious diseases. Antioxidant activity is a dominant feature of mulberry fruit. Anthocyanins are antioxidants and antimicrobial substances. As antioxidants, anthocyanins can function as hydrogen donors to free radicals and capture metallic ions to prevent oxidation reactions [8]. Therefore, these pigments can reduce the risk of various chronic diseases, such as cancer, diabetes, and coronary thrombosis [9]. Mulberry fruit also contains phenols, which posses a wide spectrum of biochemical activities such as antioxidant, antimutagenic, anticarcinogenic and can prevent inflammation and aneurysms [10, 11]. Its fruits also contain quercetin (flavonoid) with antioxidant activity which helps in reduction of heart diseases and high blood pressure [12]. Mulberry juice is

full of antiaging properties and enriches the blood, protecting liver from damage, calms the nerves, balances internal secretions and enhances immunity [13].

Very short shelf life of fresh fruits 1-2 days after harvest is one of the major factors that give the necessity of developing a cheap and efficient preservation process or value-addition for growers of this fruit. Due to short shelf life very less work on processing of this fruit has been reported so far in India. Mulberry fruit will discolor and mildew after 1–2 days at room temperature due to the high water content of more than 80 per cent. So, mulberry fruit is not easy to store and preserve. Therefore, fresh mulberry is not directly consumed, even if it has significant functions.

Generally, it needs to be further processed as an attempt to develop functional foods or health products. Shelf life of fresh mulberries is very short as these rot very fast after harvest, thus it becomes rather difficult to commercialize this plant for fresh fruit and need to be processed for preserving as juice, drink, squash, syrup, jam, jelly, frozen fruit, dried fruit etc. immediately after harvesting. As nutritive value of fruit beverages is much more than the synthetic products, so looking to the demand of natural beverages, there is great scope for the preparation of juices and other fruit based beverages [14]. Mulberry fruit juice is very popular in Kashmir under brand name Snowkist which is sugar free and is marketed by J&K State Agro Industries Development Co-operation Ltd. [15]. But in HP more emphasis has been given for its use in silkworm rearing, not on the fruits, as a result the fruits goes waste. So, being a rich source of antioxidants especially phenols and anthocyanins, this fruit can be exploited for the development of various value-added products. But before that standardization of juice extraction method to retain maximum quality and juice preservation method is the need of the future hour to get preserved juice throughout the year for the development of various value-added products. Thus, the present studies were under taken with the objective to optimize juice extraction method from this underutilized fruit on the basis of juice yield and various quality parameters including sensory characteristics.

Materials and Methods

The mature fruits of *Morus alba* procured from Bela area of Hamirpur district of Himachal Pradesh in the month of April 2015 and brought to the department of Food Science and Technology, Nauni, Solan, HP and used for various physico-chemical analysis and optimization of juice extraction method.

Juice extraction

Fruits after thorough washing in water were used for juice extraction. The juice from the mulberry fruits was extracted by following methods:

- Manual juice extraction: 1 kg fruits were tied in double folded muslin cloth and juice was extracted by pressing manually.
- Food processor: A power driven food processor of Maharaja Pvt. Ltd., New Delhi make was used for extraction of juice from 1 kg of fruits.
- Screw type juice extractor: A power driven screw type juice extractor of Gardeners Corp., New Delhi make was used for extraction of juice from 1 kg fruits.
- Pulper: A power driven commercial pulper having brushes of B.Sen Berry., New Delhi make was used for extraction of juice from 5 kg of fruits.
- Hydraulic press: A hydraulic pump driven commercial hydraulic press of Gardeners Corp., New Delhi make was used for extraction of juice from 5 kg of fruits.

Juice extracted by all these methods/means was compared on the basis of juice yield and various quality characteristics including sensory characteristics. Best selected method was used for juice extraction from fruits on large scale.

Storage of juice

Extracted juice was stored as fresh in PET (Polyethylene terephthalate) jars in deep freezer (-18 ^{o}C) immediately after extraction.

Physico-chemical analysis

The colour of juice in terms of different tintometer colour units (TCU) was observed with Tintometer (Lovibond

Tintometer Model-E). The apparent viscosity of the juice was determined by using Ostwald viscometer and was expressed in time (flow rate in seconds) taken for samples to pass through the tube. TSS (^{o}B), reducing and total sugars (%), titratable acidity (%), ascorbic acid content (mg/100 g), and anthocyanins (mg/100 g) of juice were determined according to method described by Ranganna [16] and AOAC [17]. The pH of the samples was determined by using a digital pH meter (CRISON Instrument, Ltd, Spain). Total phenols content (mg/100 g as gallic acid) of juice was determined by Folin-Ciocalteu procedure given by Singleton and Rossi [18]. Juice yield percentage was calculated as follows:

$$\text{Juice \%} = \frac{\text{Weight of juice extracted}}{\text{Weight of fruits taken}} \times 100$$

Sensory evaluation

Nine points hedonic rating test was followed for conducting the sensory evaluation of juice [19]. The panel of ten judges was selected to evaluate the juice for sensory parameters such as colour, body, taste, aroma and overall acceptability. Efforts were made to keep the same panel for sensory evaluation throughout the entire period of study.

Statistical analysis

Data on physico-chemical characteristics of mulberry juice was analysed by Completely Randomized Design (CRD), whereas, data pertaining to the sensory evaluation were analyzed by using Randomized Block Design (RBD) as described by Mahony [20]. The experiments conducted during study period were replicated four times.

Results and Discussion

Physical characteristics

The yield of mulberry fruit juice extracted by using different methods/modes ranged between 46.33 to 66.50 per cent. The maximum (66.50 %) yield was observed in manual juice extraction, whereas, the lowest juice yield (46.33 %) was recorded in food processor. Our values of juice yield were found near to the values of juice yield recorded by Masilamani *et al*. [21] and Zengin *et al*. [22] in mulberry fruits. Corresponding to the juice yield the pomace left after extraction of juice by different methods ranged between 33.50 to 53.67 per cent. The visual red and yellow TCU of extracted juice from different methods/modes ranged between 14.83 to 16.06 and 3.04 to 3.46, respectively. The maximum apparent viscosity was found in juice extracted with pulper (brush type) while the lowest was found in juice extracted by means of hydraulic press (**Figure 1**). The highest juice recovery by manual and hydraulic press might be due to complete extraction of juice from mulberry fruit as compared to other methods. Masilamani *et al*. [21] have reported juice content as 50 to 60 per cent during spring season, whereas, lower juice content as 30 to 40 per cent have been reported during summer season from mulberry cultivar MR-2 in Tamilnadu (India). Zengin *et al*. [22] have observed a wider range (40.67-64.67 %) of juice yield in 28 different genotypes of *M. alba* fruits from Turkey.

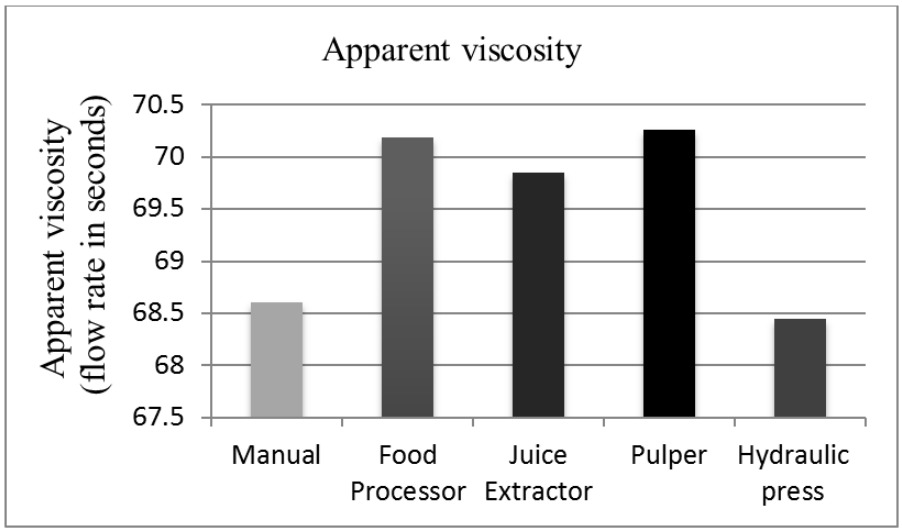

Figure 1 Effect of different extraction methods on apparent viscosity (Flow rate in seconds) of mulberry juice

Chemical characteristics

The data on chemical characteristics of juice presented in the **Table 1** show that, among the various methods of juice extraction with respect to all chemical characteristics of extracted juice there was no significant differences observed (except anthocyanins).

The anthocyanins content of fruit juice extracted by using different methods/modes ranged between 22.10 to 23.63 mg/100 ml. The maximum anthocyanins content was found in the juice extracted with brush type pulper (23.63 mg/100 g), whereas, minimum anthocyanins content was found (22.10 mg/100 g) in juice extracted with screw type juice extractor which was statistically at par with juice extracted with hydraulic press (22.14 mg/100 g). The highest anthocyanins in the juice extracted with brush type pulper might be due to maximum extraction of pulp, which led to more anthocyanins content in the juice.

Sensory characteristics

It is clear from the data (**Table 2**) that maximum colour (8.00), body (7.87), taste (7.97), aroma (7.65) and overall acceptability (7.90) scores of juice extracted by different methods/modes were obtained in the juice extracted with the help of hydraulic press. Whereas, minimum scores for colour (4.57), body (5.70), taste (4.50), aroma (5.60) and overall acceptability (5.09) scores were obtained in juice extracted with help of juice extractor (screw type). The maximum scores for sensory parameters like colour, body, taste, aroma and overall acceptability were recorded in the juice extracted by hydraulic press (**Figure 2**) because there was maximum extraction of juice from fruits, good colour of juice and higher juice yield than other methods.

Table 1 Physico-chemical characteristics of mulberry juice extracted by different methods

Equipment / Parameter	Manual	Food Processor	Juice Extractor (Screw type)	Pulper	Hydraulic press	$CD_{0.05}$
Physical characteristics						
Juice yield (%)	66.50	46.33	*51.50	*47.66	58.45	1.57
Pomace (%)	33.50	53.67	48.50	52.34	41.55	1.57
Tintometer Colour Units Red (TCU)	14.83	16.06	14.39	15.28	15.00	0.93
Yellow (TCU)	3.30	3.46	3.04	3.39	3.20	0.03
Chemical characteristics						
TSS (^{o}B)	14.20	14.23	14.30	14.40	14.25	NS
Titratable acidity (%)	0.42	0.43	0.40	0.43	0.44	NS
pH	4.23	4.22	4.20	4.26	4.23	NS
Ascorbic acid (mg/100 g)	14.08	14.25	14.18	14.24	14.11	NS
Reducing sugars (%)	9.18	9.10	9.07	9.10	9.17	NS
Total sugars (%)	11.91	11.96	11.87	11.95	11.93	NS
Anthocyanins (mg/100 g)	22.16	23.08	22.10	23.63	22.14	0.04
Total phenols (mg/100 g)	153.59	154.30	152.90	152.45	153.70	NS

* After pulp extraction juice was filtered through muslin cloth.

Table 2 Sensory characteristics of mulberry juice extracted by different methods

Equipment / Parameter	Manual	Food Processor	Juice Extractor (Screw type)	Pulper	Hydraulic press	$CD_{0.05}$
Colour	7.15	6.62	4.57	5.80	8.00	0.22
Body	7.12	6.90	5.70	6.50	7.87	0.43
Taste	7.27	6.96	4.50	7.05	7.97	0.51
Aroma	7.35	7.15	5.60	7.10	7.65	0.33
Overall acceptability	7.22	6.90	5.09	6.60	7.90	0.28

#: Based on 9 point Hedonic scale

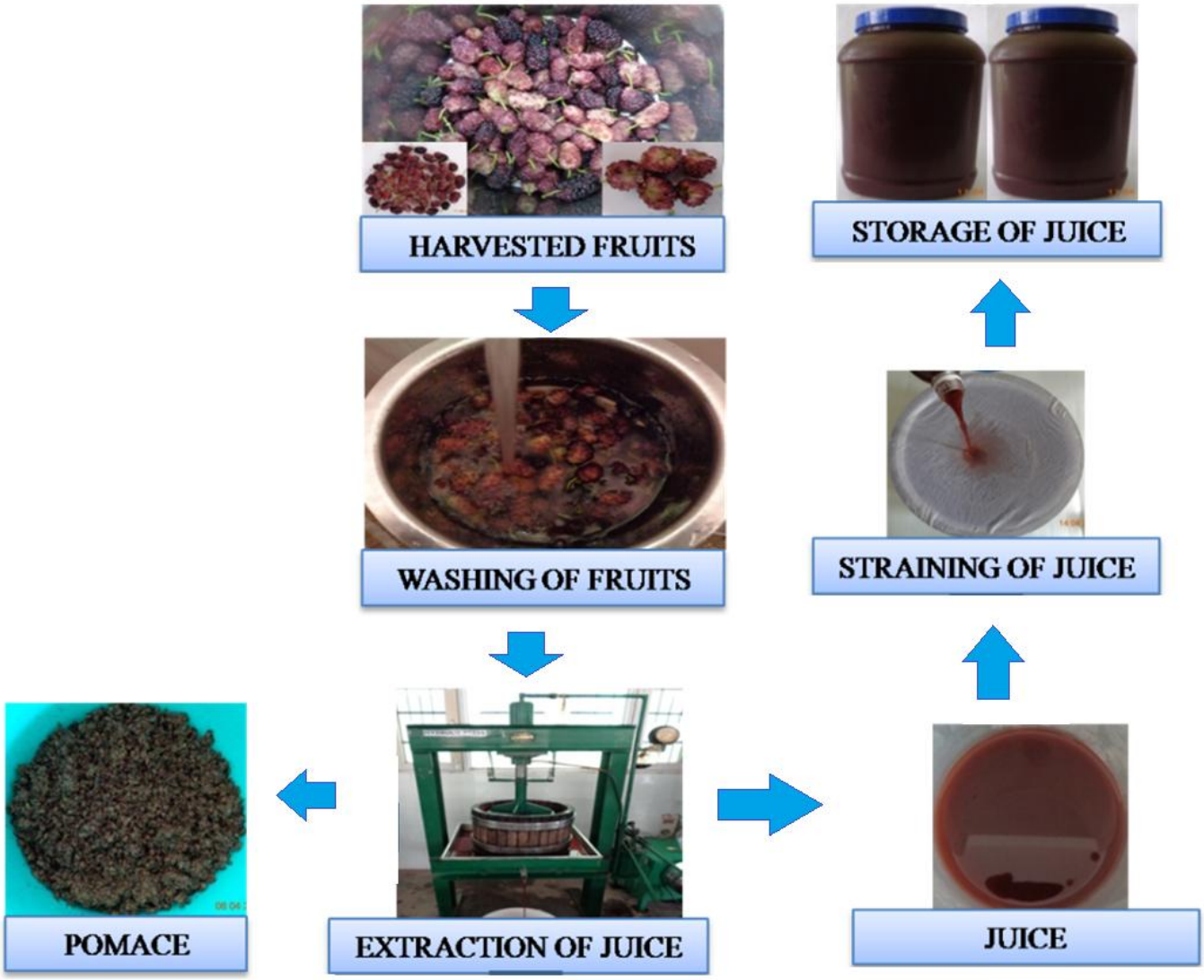

Figure 2 Unit operations for the extraction of juice from mulberry fruit by standardized method

Conclusion

On the basis of sensory attributes and some physical characteristics of juice it was concluded that hydraulic press was found to be the best method/mode for extraction of juice from mulberry fruits as compared to others. Out of 5 methods tried juice extracted by hydraulic press retains highest sensory characteristics scores including colour (8.00), body (7.87), taste (7.97), aroma (7.65) and overall acceptability (7.90) besides various physico-chemical parameters including anthocyanins and total phenols. The extracted juice can be stored for upto 3 months in deep freezer (-18 ^{o}C) with least physico-chemical changes interms of TSS, acidity, vitamin C, anthocyanins and total phenols. So fruits of this genus have tremendous potential for providing various valuable functional food products of very high economic value for human beings. The present study will help the farmers to go for value addition of mulberry fruit besides using the mulberry leaves for silkworm rearing for cocoon production.

References

[1] Zafar, M. S. Muhammad, F. Javed, I. Akhtar, M. Khaliq, T. Aslam, B. Waheed, A. Yasmin, R. and Zafar, H. 2013. International Journal of Agriculture and Biology, 15(3):612-62.
[2] Ercisli, S. and Orhan, E. 2007. Food Chemistry, 103:1380-1384.
[3] Kaur, H. and Sharma, M. Flora of Sirmour (HP). Bishen Singh Mahendra Pal Singh Publication, Dehradun, 2004, p770.
[4] Akkarachaneeyakorn, S. and Tinrat, S. 2015. Food Science and Nutrition, 3(3):213–220.

[5] Sharma, S. K. and Zote, K. K. 2010. Range Management and Agroforestry, 31(2):97-101.
[6] Bae, S. H. and Suh, H. J. 2007. LWT-Food Science and Technology, 40(5):955-962.
[7] Hamid and Thakur N. S. 2017. Journal of Applied and Natural Science, 9(4):2235 – 2241.
[8] Kong, J. M., Chia, L. S. Goh, N. K., Chia, T. F. and Brouillard, R. 2003. Phytochemistry, 64:923–933.
[9] Lazze, M. C. Savio, M. Pizzala, R. Cazzalini O. Perucca, P. Scovass A. I., et al. 2004. J. Carcinog. 25:1427–1433.
[10] Duthie, G. G. Duthie, S. J. and Kyle, J. A. M. 2000. J. Nutr. 13:79–106.
[11] Gungor, N. and Sengul, M. 2008. International Journal of Food Properties, 11(1):44-52.
[12] Manach, C. Mazur, A. and Scalbert, A. 2005. Curr. Opin. Lipidol. 16:77–84.
[13] Yadav, P. Neelima, G. and Kumar, S. 2014. Indian Journal of Natural Products and Resources, 5(1):62-66.
[14] Gupta, R. Malav, M. Kushwaha, N. K. and Pandey, A. 2015. The Bioscan, 10(3):1041-1043.
[15] Gulzar P. 2015. Studies on Quality Evaluation and Value Addition of Temperate Mulberry Fruit Varieties. Ph.D. Thesis. Temperate Sericulture Research Institute, Faculty of Agriculture Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir.
[16] Ranganna, S. Handbook of analysis and quality control for fruit and vegetable products (2nd Edn.). Tata McGraw Hill, New Delhi, 2009. p1112.
[17] AOAC. 1990. Official methods of analysis of the associa-tion of official analytical chemist, Hortwits W (ed). Association of Official Analytical Chemists, Washing-ton DC, U.S.A.
[18] Singelton, V. L. and Rossi, J. A. 1965. American Journal of Enology and Viticulture, 16:144-158.
[19] Amerine, M. A., Pangborn R. M. and Roessler, E. B. Principles of sensory evaluation of food. Academic Press: London. 1965, p.236-268.
[20] Mahony, M. O. Sensory evaluation of food: statistical methods and procedures. Marcel Dekker: New York. 1985, p.168-169.
[21] Masilamani, S. Quadri, S. M. H. and Dandin, S. B. 2008. Indian Silk, 46:12.
[22] Zengin, Y. Yilmaz, K. U. Ercisli, S. Demirtas, M. N. Kan, T. and Nazli, A. 2012. The Journal of Animal and Plant Sciences, 22(1):211-214.

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