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RESEARCH PAPER

Effect of different juice extraction methods on the quality of pomegranate juice

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SUMMARY : Effects of different pomegranate juice extraction methods on quality and stability of pomegranate juice were evaluated. Hand press method, mechanical extraction using screw type hand juicer and electrically operated fruit juicer and machine extraction using electrically operated hydraulic basket press methods were used for extraction from manually separated arils of pomegranate fruit cv. BHAGWA. Extracted juice was analyzed for physicochemical and sensorial parameters *viz.*, juice recovery, specific gravity, pH, TSS, acidity, sugars, phenols anthocyanins, antioxidant activity, colour, flavour, taste and overall acceptability. Microbial limit tests were also carried out. Screw type hand fruit juicer with fiber molded crusher gave highest per cent juice recovery on fruit and aril weight basis. It also recorded maximum anthocyanin content (85.815mg per 100 g fruit wt.) and sugars (16.818 %) in juice. Highest overall acceptability score (8.607) with low microbial population (7.95 x 10^3cfu/ml juice) was observed with this method. Hand press method recorded maximum acidity (0.42%), TSS (15.75^{0}Brix) and specific gravity (1.136) in juice. Juice extraction by electrically operated basket press gave the maximum percentage (0.290%) of total polyphenols. The lowest pH of juice was recorded in hand press extraction.

Key Words : Pomegranate juice, Extraction methods, Anthocyanin, Polyphenol, Antioxidant activity

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Pomegranate (*Punica granatum* L.) is a highly seasonal, favourite table fruit with a high level of production and is referred as 'superfruit' because of its high nutritive value, antioxidant capacity, bioactive compounds and high consumer appeal. Pomegranate fruit has been regarded as a food medicine of great importance for therapeutic purposes (Sadeghi *et al.,* 2009). Globally, there has been remarkable increase in the commercial farming of pomegranate due to the potential health benefits of the fruit. Excellent flavour, nutritive value and medicinal properties of pomegranate fruit indicates its good potentiality for processing into value added products having extended shelf life. Minimally processed pomegranate and the pomegranate juice presents a more appealing produce to consumers than whole fruit. The juice from the pomegranate is one of the nature's most powerful antioxidants. It can be used in beverages, for jellies, as flavouring and colouring agents and for dietetic and prophylactic treatment purposes (Magerramov, 2007). Though there is a great potential of pomegranate derived products like juice, the industrial processing of the pomegranate is scarce due to lack of technological development. Hence, the present investigation was undertaken to develop the pomegranate juice processing technology by using different juice extraction methods and studying their effect on the quality and stability of the pomegranate juice.

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EXPERIMENTAL METHODS

Pomegranate fruits cv. Bhagwa were washed under tap

water and surface sterilized with 100 ppm chlorine for 5 minutes as per the method suggested by Church and Parsons (1995). Fruits were peeled and arils were extracted manually. The juice from arils was extracted by employing hand press method (E_1), mechanical extraction method using screw type hand juicer with fiber molded crusher (E_2), mechanical extraction method using electrically operated fruit juicer (E_3) and machine extraction method using electrically operated hydraulic basket press (E_4). In hand press method of juice extraction, the manually separated pomegranate arils of known weight were squeezed gently through two layered clean muslin cloth to get juice. In mechanical extraction method the arils were crushed in the hand operated juicer with fiber molded crusher. In electrically operated fruit juicer, juice was extracted by using the plastic fiber molded specific designed blades for kneading to minimize the crushing of the pomegranate seeds in order to reduce bitterness and haze in the juice. In electrically operated hydraulic basket press method, the pomegranate arils were filled in the nylon net basket and were pressed for 5 minutes for each of the 5 step pressing by applying the hydraulic pressure less than 100 psi to avoid undue yield of tannins from crushing of the pomegranate seeds. The juice was strained out, filled in green bottles and then stored at 5^0C for further analysis of various physicochemical constituents and organoleptic evaluation. The experiment was conducted in completely randomized block design with four treatments and four replications.

Physico-chemical analysis:

The juice recovery percentage was worked out on fruit weight basis as well as on aril weight basis. Specific gravity of pomegranate juice was determined by dividing mass by volume. A unit was measured and weighed exactly. The pH of pomegranate juice was measured by using Perkin-Elmer pH meter. The total titratable acidity was determined by the method given by AOAC (2005) and expressed in terms of the citric acid. The total soluble solids were determined with the help of a hand refractometer and expressed in terms of ^{0}Brix. The reducing and total sugars were determined by the method of Lane and Eynon (1923) with slight modification suggested by Ranganna (1986). Total anthocyanin content was estimated by the procedure described by Ranganna (1986) and calculated by use of molecular extinction coefficient values. The polyphenol content in the juice was determined by the colorimetric method using Folin Denis reagent (AOAC, 2005). Per cent total antioxidant activity was determined on the basis of scavenging activity of the stable 2,2-diphenyl-1-picrylhydrazyl (DPPH) free radical as described by Sandhu *et al.* (2003) and Bhalodia *et al.* (2011).

Sensory evaluation:

Juice extracted from pomegranate fruits by different methods was analyzed organoleptically by panel of seven judges in terms of colour, appearance, taste, flavour and overall acceptability by using a 9-point hedonic scale of Amerine *et al.* (1965).

Microbial analysis :

Microbial limit tests for extracted fresh unpasteurized pomegranate juice were carried out for the total viable bacterial and fungal count and for detection of specific indicator microbial species such as *E. coli, Staphylococcus aureus, Psuedomonas* sp., *Salmonella* sp. by following the standard operating procedure described in USFDA (BAM) I 5401: 2002, 5402: 2002 (Anonymous, 2011) and prescribed by Bureau of Indian Standards.

EXPERIMENTAL FINDINGS AND ANALYSIS

The physical characteristics of the pomegranate fruits cv. Bhagwa employed for the extraction is reported in Table 1. Round shaped fruits with attractive saffron red coloured skin and bold, dark blood red coloured arils with average whole fruit weight of 274.24 g were selected for extraction of juice. The average percentage of arils to the whole fruit weight basis was 61.74 per cent and that of peels was 38.26 per cent. The average proportion of seeds to whole fruit weight basis was recorded to 21.46 per cent.

Table 1 : Physical characteristics of pomegranate fruits cv. Bhagwa

Sr. No.	Characteristics	Criteria
1.	Shape of the fruit	Round
2.	Skin colour of the fruit	Saffron red
3.	Colour of arils	Dark blood red
4.	Average weight (g)	274.24
5.	Proportion of arils to whole fruit (%)	61.74
6.	Proportion of peels to whole fruit (%)	38.26
7.	Aril : Rind ratio	1.614
8.	Proportion of seeds to whole fruit (%)	21.46

Physical parameters:

It was clear from the data (Table 2) that with mechanical extraction method consisting of screw type pomegranate hand juicer with fiber molded crusher gave highest recovery of juice on whole fruit weight basis (48.70 %) and on aril weight basis (79.86 %) with maximum volume of juice (470.28 ml). The highest percentage of pomace/seeds was obtained in machine extraction method which employed electrically operated hydraulic basket press (25.78 %) followed by hand press method (19.00 %) resulting in improper crushing of arils and yielded minimum recovery of pomegranate juice. The highest specific gravity value (1.136) and the lowest pH (3.465) of juice were recorded in the hand press method.

Table 2 : Effect of extraction methods on physical properties of pomegranate juice

Treatments	Recovery of juice		Volume of juice obtained on whole fruit basis (ml)	Percentage of pomace/seeds obtained on fruit weight basis	pH	Specific gravity
	Whole fruit wt. basis (%)	Aril weight basis (%)				
E_1	38.47	63.18	338.24	19.00	3.465	1.136
E_2	48.70	79.86	470.28	13.74	3.668	1.036
E_3	46.66	75.82	448.38	13.33	3.698	1.041
E_4	35.09	56.38	333.78	25.78	3.685	1.052
GM	42.23	68.81	397.67	17.96	3.629	1.066
SE±	1.404	2.198	12.212	1.921	0.046	0.018
C.D. (P=0.05)	3.061	4.791	26.621	4.187	0.100	0.039
C.D. (P=0.01)	4.283	6.703	37.245	5.857	0.140	0.054
CV (%)	6.651	6.388	6.142	21.387	2.535	3.316

Chemical parameters:

The data in respect of effect of extraction methods on the changes in physico-chemical constituents of pomegranate juice are presented in Table 3.

The data (Table 3) revealed that the juice obtained by using hand press method recorded the maximum per cent acidity (0.42%), TSS (15.75^{0}Brix) as compared to the other pomegranate juice extraction methods while the juice obtained by machine extraction method by using electrically operated basket press gave the maximum percentage of total polyphenols (0.290 %). This may be due the crushing of pomegranate seeds due to hydraulic pressure applied during each pressing. This resulted haze formation in juice during extraction. Similar results were reported by Vardin and Fenercioglu (2009). The use of screw type hand fruit juicer with fiber molded crusher recorded the maximum anthocyanins (85.815mg per 100 g fruit wt.) and sugars (16.818%) in pomegranate juice. Highest antioxidant activity was recorded in the pomegranate juice extracted by mechanical extraction method (Table 2) using screw type hand juicer with fiber molded crusher (45.998%) followed by machine extraction method using hydraulic basket press (45.385%). There was a positive relationship between antioxidant activity (%) and total anthocyanin content and total phenolic content indicating the effect of anthocyanins and polyphenol content on antioxidant activity.

Sensorial analysis:

The data regarding the organoleptic score for the pomegranate juice extracted by four different methods are given in Table 4.From the data, it was clear that the mechanical extraction method using screw type hand juice with the fiber molded crusher and machine extraction using hydraulic basket press gave the highest organoleptic score (8.60 and 8.429, respectively) for colour, appearance, taste and flavour as compared to the remaining treatments.

Microbial limit tests analysis:

The pomegranate juice extracted by using the four different extraction methods was analyzed for microbial limit tests without heat treatment to find out the microbial population in freshly extracted juice (Table 4). Yeast and mold growths were under the limit of detection for all treatments. The aerobic bacteria were in the range of 4.75 x 10^3 to 2.91 x 10^4 cfu per ml of juice. The lowest aerobic count was recorded in the pomegranate juice extracted by using the mechanical extraction method with screw type hand juicer (E_2) having fiber molded crusher (7.95 x

Table 3 : Effect of extraction methods on chemical constituents of pomegranate juice

Treatments	TSS (^{0}Brix)	Acidity (%)	Reducing sugars (%)	Non-reducing sugars (%)	Total sugars (%)	Total polyphenols (%)	Total anthocyanins (mg/100g of fruit)	Antioxidant activity (%)
E_1	15.75	0.423	13.835	1.275	15.110	0.253	76.655	41.563
E_2	15.30	0.388	15.425	1.393	16.818	0.276	85.815	45.998
E_3	15.05	0.400	14.908	1.343	16.250	0.271	83.165	44.645
E_4	14.50	0.385	14.855	1.385	16.240	0.290	84.335	45.385
GM	15.15	0.399	14.756	1.349	16.104	0.273	82.493	44.398
S.E.±	0.177	0.006	0.356	0.028	0.360	0.004	1.516	1.001
C.D. (P=0.05)	0.385	0.013	0.776	0.061	0.784	0.010	3.304	2.183
C.D. (P=0.01)	0.539	0.018	1.085	0.0855	1.097	0.013658	4.623	3.054
CV (%)	2.333	2.941	4.823	4.158	4.466	3.286573	3.675	4.511

Table 4 : Effect of extraction methods on sensory evaluation and microbial population of the pomegranate juice

Treatments	Colour	Appearance	Taste	Flavour	Overall acceptability	Total bacterial population (cfu/ml of juice)	Total yeast and mould population (cfu/ml of juice)	Total aerobic count (cfu/ml of juice)
E_1	7.00	7.143	7.000	7.143	7.071	2.91×10^4	6.00×10^3	3.51×10^4
E_2	8.714	8.714	8.429	8.577	8.607	4.75×10^3	3.20×10^3	7.95×10^3
E_3	7.857	7.714	8.000	7.857	7.857	6.05×10^3	3.80×10^3	9.85×10^3
E_4	8.571	8.571	8.143	8.429	8.429	7.65×10^3	4.28×10^3	1.19×10^4
GM	8.25	7.775	7.750	8.500	8.063	1.19×10^4	4.32×10^3	1.62×10^4
S.E.±	0.289	0.322	0.314	0.300	0.157	0.521	0.249	0.631
C.D. (P=0.05)	0.595	0.664	0.647	0.618	0.323	1.136	0.544	1.375
C.D. (P=0.01)	0.808	0.902	0.879	0.841	0.439697	1.589	0.761	1.923
CV (%)	9.258	10.996	10.722	9.345	5.153172	8.766	11.553	7.782

Table 5 : Microbial limit test of the pomegranate juice obtained by using different extraction methods

Treatments	Indicator organism			
	Staphylococcus aureus	*Pseudomonas*	*E. coli*	*Salmonella* spp.
E_1	Absent	Absent	Absent	Absent
E_2	Absent	Absent	Absent	Absent
E_3	Absent	Absent	Absent	Absent
E_4	Absent	Absent	Absent	Absent

10^3 cfu/ml juice) followed by the mechanical extraction method (E_3) using electrically operated fruit juicer (9.85×10^3). The indicator organisms were absent in all the juice samples extracted by using different extraction methods (Table 5). Thus the pomegranate juice was safe for the consumption.

Conclusion:

This study presents information on the extraction of pomegranate juice by using different methods that influences the physicochemical constituents, sensorial attributes and microbial population. The results obtained from the different juice extraction methods suggested that the highest juice recovery in terms of whole fruit weight basis and aril weight basis with maximum anthocyanin content and highest antioxidant activity (%) was recorded in mechanical extraction method using screw type hand juicer with fiber molded crusher followed by machine extraction using hydraulic basket press. Organoleptic evaluation of the mechanically extracted pomegranate juice with hand juicer having fiber molded crusher was excellent in terms of the overall acceptance and evaluation. As colour, appearance, taste, anthocyanins, polyphenols and nutraceutical values like antioxidant capacity also affect the consumer preference. Further studies on the research, design and development of pomegranate juicer with fiber molded crusher is needed for commercial production.

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