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Original Article

To Study the Physico Chemical Characteristics and Mineral Contant of Pomegranate Arils Juice

Janat Ul Mawa[1], Humaira Wasila[2], Imran Ahmed[3], Murad Ali[4], Lubna Pervez[2], Hina Saleem[2], Maria Noor Us Saba[1], Kalsoom Bibi[2], Muhammad Zubair[5]*

[1]Department Of Food Science & Nutrition- Women University Swabi- Swabi- Pakistan.
[2]Department Of Human Nutrition- Agriculture University Peshawar- Peshawar- Pakistan.
[3]Department Of Horticulture- Agriculture University Peshawar- Peshawar- Pakistan.
[4]Department Of Food Science And Technology- Agriculture University Peshawar- Peshawar- Pakistan.
[5]Department Of Medical Imaging Technology- Women University Swabi- Swabi- Pakistan.
**Corresponding Author: Muhammad Zubair; Email: Zubairm955@gmail.com*

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ABSTRACT

Background: Pomegranate arils juice is renowned for its nutritional qualities, which are influenced by various storage conditions and varietal characteristics. This study explores the physico-chemical properties and mineral content of three distinct pomegranate varieties—Ghandhri, Bedana, and Tarnab Gulabi—under different storage conditions.

Objective: The primary goal of the research was to examine the impact of storage on the TSS, pH, acidity, and mineral content (iron, zinc, and calcium) of pomegranate arils juice from three regional varieties.

Methods: The study was conducted at the Human Nutrition and Agriculture Chemistry laboratory at the University of Agriculture, Peshawar, and the Food Science division of the Agriculture Research Institute Tarnab. Fresh and stored juices from the three varieties were analyzed to assess changes in physico-chemical properties and mineral content.

Results: Storage led to an increase in the levels of zinc and iron, with recorded increases in zinc to 0.568±0.04 ppm in Ghandhri and iron peaking at 0.19±0.2 ppm in Tarnab Gulabi. However, calcium content decreased during storage, with a notable reduction to 3.13±2.93 ppm in stored juices. TSS was highest in Ghandhri and Tarnab Gulabi at 15.6±1.02, while acidity was highest in Ghandhri at 2.139±0.19.

Conclusion: The study confirms that storage significantly alters the physico-chemical properties and mineral content of pomegranate arils juice, with detrimental effects on calcium levels but beneficial impacts on zinc and iron content. Notable varietal differences were observed, with Tarnab Gulabi displaying the highest phenolic content.

Keywords: Acidity, Calcium, Iron, Mineral content, Physico-chemical, Pomegranate arils juice, Zinc.

INTRODUCTION

The pomegranate, scientifically known as Punica granatum, is classified within the Punicaceae family and thrives in semi-arid, mild, or subtropical environments. This plant can develop into a small tree or a large shrub, bearing a fruit often considered a large berry due to its structure. The fruit is notable for its encasing of numerous arils, each enveloped by a juice-filled sac, and is surrounded by a coarse pericarp. Globally, there are over 550 species of pomegranates, which are consumed in both fresh and processed forms such as juices, jams, jellies, vinegars, wines, and various pharmaceutical products (1).

The edible portion of a pomegranate comprises about 55–60% of the fruit, of which 80% is juice and 20% is seed. The arils extract predominantly consists of water (85%), with the remainder comprising sugar, pectin, and ascorbic acid (1). A detailed analysis reveals that fresh pomegranate juice contains 85.4% moisture, 10.6% total sugar, 1.4% pectin, and 0.1 g/100 ml total acidity (expressed as citric acid). It also provides 0.7 mg/100 ml of ascorbic acid, 19.6 mg/100 ml of free amino nitrogen, and 0.05 g/100 ml of ash (2). The fruit's nutritional value is significantly influenced by its mineral content—including calcium, iron, zinc, and sodium—and its rich assortment of polyphenols (3).

Polyphenols, classified into flavonoids and non-flavonoids, are crucial secondary metabolites in fruits. Flavonoids encompass various subcategories such as flavonols, flavones, catechins, flavanones, isoflavonoids, and anthocyanidins, whereas non-flavonoids include stilbenes, phenolic acids, and alcohols (4). Tannins, another group of phenolic substances, can bind with glucose and amino acids to form composites. These are subdivided into proanthocyanidins, hydrolyzable tannins, phlorotannins, and complex tannins (5). Additionally, anthocyanin, a water-soluble and pharmacologically active pigment, contributes to the fruit's vibrant red color and plays a role in fruit maturation; over 550 varieties of anthocyanins have been identified in fresh juice (6, 7).

The objective of this examination is to delineate the comprehensive nutritional and biochemical composition of the pomegranate and its derivatives, highlighting its potential benefits and applications in the medical and dietary fields. This research aims to further our understanding of the pomegranate's unique properties and its contributions to health and wellness, setting a foundation for future exploratory and applied studies in nutritional science.

MATERIAL AND METHODS

Samples of three pomegranate varieties—Ghandhri, Bedana, and Tarnab Gulabi from the Tarnab variety—were acquired from local markets in Khyber Pakhtunkhwa. All fruit samples were verified to be free from pests and diseases. In the human nutrition laboratory, the calyx and surface scars of the fruits were meticulously removed using a stainless-steel knife. Following this, the fruits were washed with tap water after a sterilization process involving a 5-minute immersion in a 2% potassium permanganate solution. The cleaned fruits were then processed to separate the arils from the mesocarps and epicarps, while the seeds remained intact. Using a domestic juicer, the arils were squeezed to extract the juice, which was subsequently centrifuged at 4000 rpm for 10 minutes to separate the supernatant. The resulting fresh juices from each variety—referred to as Juice from Arils of Tarnab Gulabi (JATG), Juice from Arils of Bedana (JAB), and Juice from Arils of Ghandhri (JAG)—were labeled and stored at 4°C for further analysis.

For the preparation of storable juice, 2 g of potassium metabisulfate and 5 g of citric acid were added to 1 liter of each type of fresh juice (8). These mixtures were preserved at room temperature for two months, periodically filtered through Whatman filter paper, and subsequently labeled as storable juice from Tarnab Gulabi (SJTG), storable juice from Bedana (SJB), and storable juice from Ghandhri (SJG). These processed juices were then stored at-4°C until further testing.

Physicochemical analyses were conducted to determine the total soluble solids (TSS), pH, and percentage of acidity. TSS was measured using a digital refractometer and expressed as a percentage. The percentage of acidity was determined according to the AOAC (2012) method no. 967.21. A stock solution was prepared by dissolving a 5 ml sample in 50 ml of oxalic acid, from which a 10 ml aliquot was taken, treated with phenolphthalein, and titrated against the dye until a persistent bright pink color appeared for 15 seconds.

The mineral content of the juices was assessed using atomic absorption spectrometry. Samples underwent mineralization by adding 10 ml of nitric acid and 4 ml of perchloric acid to 5 ml of juice in digestion tubes, which were then heated for 2 to 3 hours (9). After cooling, the digested sample was diluted to 100 ml with distilled water in a volumetric flask. Specific lamp cathodes for calcium, iron, and zinc were used for the measurements.

Statistical analysis was performed using SPSS version 16. The data were presented as means and standard deviations. A two-factorial design was employed, and statistical significance was assessed at a p-value of 0.005. This rigorous methodology ensured the reliability and validity of the results, contributing to a comprehensive understanding of the physicochemical properties and mineral content of the pomegranate juices studied.

RESULTS

The study evaluated the physicochemical properties, including total soluble solids (TSS), pH, and acidity, of juices extracted from three different varieties of pomegranates—Ghandhri, Bedana, and Tarnab Gulabi. The analysis indicated a higher concentration of TSS in preserved juices compared to their fresh counterparts, with Ghandhri, Bedana, and Tarnab Gulabi preserved juices registering average TSS values of 15.6 ±1.02, 13 ±0.63, and 15 ±1.02, respectively. This observation aligns with findings by Ben and Gaweda (1985), emphasizing the potential impact of preservation methods on sugar concentration.

Further analysis revealed that fresh juices generally exhibited higher pH levels (3.91±0.08a) than preserved juices, a phenomenon consistent with prior research by Shafique et al. (10), which reported an inverse relationship between juice pH and titratable acidity in mango juice. The increase in pH and concurrent decrease in acidity during storage were attributed to the use of organic acids in respiration processes. However, during storage, the acidity of the preserved juices increased (1.193 ±0.76a), likely due to enzymatic glycolysis and associated gas production from rising CO_2 levels and declining O_2 concentrations (Znidarcic, 2010; Ahmad and Tariq, 2014). Among the varieties, Ghandhri exhibited the highest acidity (1.869 ±0.39a), whereas Bedana showed the lowest (0.5466 ±0.25b).

The mineral content analysis, particularly focusing on zinc and calcium, presented notable differences between fresh and preserved juices. Preserved juices were found to contain significantly higher levels of zinc, potentially due to the added citric acid, which can

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dissociate the bonds between tannins and phytic acid, enhancing zinc's bioavailability (Hallberg, 1984). Conversely, fresh juices had higher calcium content (8.42 ±1.88a) compared to preserved juices (3.13 ±2.93b). Among the different varieties, calcium levels varied, with Ghandhri (7.415 ±2.13a) and Bedana (6.680 ±4.68a) showing higher values compared to Tarnab Gulabi (3.212 ±4.43b). These variations could be influenced by differences in climate and fruit varieties (6), highlighting the complex interaction between environmental factors and mineral composition in pomegranate juices.

Table 1: TSS, pH and % Acidity of three pomegranate varieties.

Varieties	TSS(°brix)		Means	pH		Means	% Acidity		Means
	Fresh	Stored		Fresh	Stored		Fresh	Stored	
Ghandhri	11.6 ±0.9bc	15.6 ±1.02a	13.6 ±2.83a	3.86 ±0.36a	2.35 ±0.39b	3.11 ±1.08a	1.7 ±0.2b	2.138 ±0.18a	1.869 ±0.39a
Bedana	10.3 ±0.63c	13 ±0.63b	11.7 ±1.98b	3.9 ±0.34a	2.64 ±0.29b	3.28 ± 0.89a	0.38 ±0.13e	0.723 ±0.17cd	0.5466 ±0.25b
Tarnab Gulabi	10.3±1.14c	15 ±1.02a	12.9 ±2.97a	3.982 ±0.48a	2.68 ±0.69b	3.34 ±0.93a	0.59 ±0.16de	0.985 ±0.175c	0.7826 ±0.29b
Means	10.84 ±0.66b	14.51 ±1.33a		3.911 ±0.08a	2.547 ±0.19b		0.95 ±0.66b	1.193 ±0.76a	
P value	0.000		0.0102	0.000		0.649	0.314		0.000

LSD value for TSS, pH and %acidity content at < 0.05.

Table 2: Means of Iron, zinc and calcium for three different varieties.

Verities	Iron (mg/100ml)		Means	Zinc (mg//100ml)		Means	Calcium (mg//100ml)		Means
	Fresh	Stored		Fresh	Stored		Fresh	Stored	
Ghandhri	0.095 ±0.02ab	0.16 ±0.07ab	0.123 ±0.04ab	0.063 ±0.02c	0.569 ±0.05a	0.316 ±0.37a	8.918 ±1.39a	5.912 ±0.7b	7.415 ±2.13a
Bedana	0.06 ±0.03c	0.079±0.02bc	0.065 ±0.041b	0.037 ±0.005c	0.304 ±0.02b	0.17 ±0.19b	9.987 ±1.49a	3.373 ±0.48c	6.680 ±4.68a
Tarnib. G	0.080 ±0.03bc	0.19 ±0.2a	0.1346 ±0.08a	0.055 ±0.009c	0.257 ±0.15b	0.156 ±0.15b	6.342 ±0.76b	0.082 ±0.004d	3.212 ±4.43b
Means	0.075 ±0.02a	0.14 ±0.08a		0.052 ±0.02b	0.39 ±0.18a		8.42 ±1.88a	3.13 ±2.93b	
P value	0.0739		0.0890	0.000		0.0011	0.000		0.000

P value <0.05

DISCUSSION

The physicochemical analysis of pomegranate juice, both fresh and preserved, revealed insights into the impact of storage and variety on its quality attributes. The increase in total soluble solids (TSS) in preserved juices is aligned with observations by Echevemia and Valich (11), who noted that TSS levels rise during storage due to moisture loss and the conversion of starches into simpler sugars. Furthermore, these changes are amplified by sugar synthesis from organic acids and the hydrolysis of cell walls, which are significant during the storage process. The highest TSS values were observed in Ghandhri and Tarnab Gulabi juices, with Bedana juice showing the lowest TSS, suggesting varietal differences in the biochemical processes affecting juice composition during storage (12, 13).

In terms of acidity and pH, preserved juices displayed lower pH and higher acidity, supporting the hypothesis that organic acid metabolism during storage contributes to these changes (14). The formation of levulinic and formic acids from hydroxymethoxyfurfural at elevated storage temperatures further exacerbates the reduction in pH. This finding underscores the robust influence of storage conditions on juice quality, as also evidenced by previous studies (13, 15).

The discussion on mineral content highlights a complex interaction between preservation methods and mineral bioavailability. The observed increase in zinc levels in preserved juices can be attributed to the breakdown of complexes between tannins and phytic

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acid, facilitated by added citric acid, which enhances zinc availability (16). Conversely, calcium levels were higher in fresh juices, possibly due to the degradation of binding agents during storage. The comparative analysis of the three varieties indicated that Ghandhri juice had higher zinc content, while Tarnab Gulabi juice showed superior iron levels, illustrating the significant varietal effects on mineral composition in pomegranates (18-20).

The strengths of this study lie in its comprehensive approach to analyzing multiple varietal responses to storage, providing a nuanced understanding of how storage conditions affect juice quality. However, limitations include the potential variability in fruit maturity and initial quality, which were not controlled for and could affect the generalizability of the findings.

Overall, the research contributes valuable insights into the physicochemical and mineral composition of pomegranate juices, emphasizing the influence of variety and storage on these parameters. The findings serve as a foundation for further studies aimed at optimizing storage conditions to preserve the nutritional quality of pomegranate juices, thereby enhancing their health benefits. This study also underscores the importance of considering varietal characteristics when assessing fruit juice quality, which is crucial for both consumer satisfaction and industrial applications.

CONCLUSION

The study revealed that stored pomegranate juices from Ghandhri, Bedana, and Tarnab Gulabi varieties exhibited higher total soluble solids (TSS) and acidity compared to fresh juices, indicating significant changes due to storage. Ghandhri and Tarnab Gulabi had the highest TSS, while Ghandhri also displayed the highest acidity. Although storage enhanced the iron and zinc content in the juices, it adversely affected the calcium levels. Notably, Ghandhri juice had the highest zinc concentration, and both Ghandhri and Bedana showed superior calcium content. Tarnab Gulabi juice exhibited the highest iron levels among the varieties. These findings underscore the impact of storage on nutritional quality, highlighting the need for optimized storage practices to preserve and enhance the health benefits of pomegranate juices.

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