WORLD JOURNAL OF PHARMACEUTICAL RESEARCH
SJIF Impact Factor 8.084
Volume 12, Issue 17, 81-95. Review Article ISSN 2277– 7105

STUDIES ON EXTRACTION, DEGRADATION AND UTILIZATION OF FUNCTIONAL COMPONENTS FROM POMEGRANATE PEEL

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Article Received on
10 August 2023,

Revised on 31 August 2023,
Accepted on 20 Sept. 2023

DOI: 10. 20959/wjpr202317-28686

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ABSTRACT

The study aimed to investigate the stability of color pigment under different pH levels and temperatures and evaluate the sensory attributes of jelly formulations containing the extracted functional components. To collect the samples, pomegranate fruits were obtained from a local market and their peels were carefully peeled off and stored at low temperature. Beneficial components were removed by homogenizing the thawed strips and exposing them to different fixed salt corrosion regimes. The resulting extracts were filtered and concentrated for further analysis. The stability tests examined the impact of pH and temperature on the color pigment. The pH stability test involved evaluating the degradation of functional components at different pH levels using appropriate analytical techniques. Similarly, the temperature stability test assessed the degradation of functional components under varying temperatures and light conditions. The extracted functional ingredients were also used to create different formulations by varying pH and concentration. Sensory evaluations were conducted to assess the effects of the functional components on attributes such as color, appearance, texture, flavor, taste, and overall acceptability. Analysis of the data revealed that the stability of color pigments was affected by pH value and concentration. At 2% concentration, the color pigment demonstrated relatively stable behavior across all pH levels, while at 10% concentration, the stability varied significantly. The aggregation values indicated the stability of the color pigment under different temperatures, with lower values indicating better stability. In terms of sensory evaluations, sample III consistently received higher average

scores across all attributes, suggesting its superior sensory characteristics compared to samples I and II. Overall, this study provides insights into the extraction, stability, and utilization of functional components from pomegranate peel. The findings can contribute to further research, optimization, and development of products using pomegranate peel extracts for various applications.

KEYWORDS: Pomegranate peel, Functional components, Extraction, Solvent extraction, Supercritical fluid extraction, Microwave-assisted extraction, Degradation.

1. INTRODUCTION

The pomegranate plant (Punica granatum L.) is one of the major plants cultivated by humans. However, its use has generally been limited due to the difficulty of collecting the fleshy kernels.[1] Starting from the beginning of the twenty-first 100 years, pomegranate creation and utilization have expanded because of the developing number of logical examinations about its wellbeing benefits. New and handled pomegranate organic product, principally as juice, oil, wine, and jam, are undeniably polished off. High concentrations of various phytochemicals, such as phenolic acids, flavonoids, and tannins, are known to exist in both the fruit and its peel. It is believed that phytochemicals' varied properties account for their strong antioxidant capacity and positive health effects.[2] During processing, hides are converted into a significant number of by-products, some of which are known to contain high levels of hydrolyzable tannins (HT).[3] In particular, pomegranate peel extract (PPE) has recently received more attention due to its scientifically proven medicinal effects such as antioxidant, antibacterial, anticancer, antiulcer, and anti-inflammatory effects.[4,5] Numerous research studies have shown that PSA improves post-harvest food shelf life and exhibits potent antibacterial activity against many foodborne illnesses.[6,7]

1.1. Pomegranate ingredients and their functionality

1.1.1 Pomegranate Peel

An incredibly nutritious result of pomegranate natural products is pomegranate strip. As indicated by[8,9], and different analysts, it contains restorative abilities like antibacterial, cell reinforcement, against disease action, antiatherosclerosis, and wound recuperating properties. It is an extraordinary wellspring of minerals (calcium, phosphorus, nitrogen, potassium, magnesium, sodium) and composite of polysaccharide.[10] In contrast with other pomegranate organic product parts, the strip has the most elevated cell reinforcement action.

1.1.2 Pomegranate Seeds

Pomegranates include seeds in the part that can be eaten. They can weigh between 40 and 100 g/Kg and are crucial components of the pomegranate fruit.[11] They are lipid, fatty, and protein-rich. An excellent source of unsaturated fatty acids is pomegranate oil. The therapy of different disorders and diseases involves the use of physicochemical chemicals.[12] Pomegranate seeds are a decent wellspring of juice and oil; they contain 12-20% of the organic product's all out weight in oil. Pomegranate seed oil is an extraordinary wellspring of polyunsaturated unsaturated fats and lipids like linoleic, oleic, and linolenic acids as well as punicic, palmitic, and stearic acids. As per[13], it likewise contains gelatin, unrefined strands, minerals, nutrients, sugars, protein, sex steroid, polyphenols, and isoflavones.

1.1.3 Pomegranate Juice

Water, natural acids (ascorbic corrosive, citrus extract, and malic corrosive), sugar (glucose and fructose), gelatin, and other phenolic exercises are bountiful in pomegranate juice. Pomegranate arils are handled to get the juice. It is a noticeable wellspring of phenolic compounds, flavonoids mixtures, for example, anthocyanin, glucose, natural corrosive, caffeic corrosive, ascorbic corrosive ellagic corrosive, ETs, gallic corrosive, Rutin, Quercetin, Catechin, and minerals. As indicated by[14], it has extraordinary calming and cell reinforcement properties.

1.2. Functional Properties of Pomegranate Fruit

Consumers consume pomegranate fruit in a variety of ways, including fresh fruit, juice, extracted seeds, grenadine, wine, seeds, tea, and other products. Pomegranate fruits are also utilized to make beauty goods in the cosmetics business. According to[15], all portions of the pomegranate have exceptional abilities to treat a wide range of illnesses, including hypertension, prostate cancer, infectious disorders, heart disease, and atherosclerosis. Pharmaceutical companies frequently employ ellagitannins, one of the phenolic chemicals found in pomegranate fruits, for plastic surgery. Due to their antioxidant activity, they prevent the death of skin flaps. The main polyphenols that are present in the pomegranate fruit's peel, seed, and juice are punicalagin and punicalin. Because of the presence of phenolic and flavonoids, the pomegranate natural products have the ability to diminish provocative markers (growth putrefaction factor-alpha) and show cancer prevention agent movement. Pomegranate products of the soil constituent parts serious areas of strength for have and preventive properties, and these properties are essential for the overwhelming majority

restorative medicines like looseness of the bowels, loss of motion, leucorrhea, colic, and migraine. Because of their cell reinforcement, hostile to hypertension, and against mutagenic properties, they might have positive wellbeing impacts. Because of their additive and cancer prevention agent exercises, they might be utilized in the drug business. As per concentrates by[16], pomegranate organic products additionally display activity against coronary illness, HIV-I, prostate malignant growth, and osteoarthritis. The ability of pomegranate natural products to enhance proteins that lower cardiovascular risk factors has been described by.[17] Rich in ellagic acid derivatives such as anthocyanins, gallic acid, ascorbic acid, minerals, glucose, caffeic acid, catechins, amino acids, rutin, punicalagin, quesertin, pelargonidin-3-glucoside, cyanic acid, 3,5-diglucoside, and delphinidin. It is with pomegranate juice. These substances decrease lipid oxidation and can search free revolutionaries. The level of ellagic corrosive, punicic corrosive, and sterols in pomegranate seed oil is 95%. Gallic corrosive, tannins, catechin, punicalagin, flavones, and anthocyanidins are only a couple of the phenolic substances that can be found in overflow in the pomegranate strip. Pomegranate natural product juice has strong cancer prevention agent and against atherogenic properties, as per in-vitro research. By employing the DPPH and -carotene-linoleate model systems, additional research has shown that pomegranate peel has stronger antioxidant activity than seed.

Due to their therapeutic and pharmacological qualities, pomegranates are considered to have useful capabilities in all of their components. They contain gainful natural parts. Pomegranates, their subsidiaries, and their useful and remedial characteristics, including their antibacterial, mitigating, against disease, cancer prevention agent, antiviral, hostile to hepatotoxic, and against diabetes properties, have been the subject of a few examinations. It also helps improve skin and cardiovascular health, sperm quality, and effectiveness in preventing Alzheimer's disease. In vitro studies show that the improvement of S. mutans ATCC 25175 and R. dento cariosa Rd1 can be suppressed by removing (peeling, squeezing) the pomegranate's natural products, which plaque experts use as enemies. You can also. Because of its antiviral and antibacterial characteristics, it can likewise inactivate foodborne contaminations.

1.3. Antioxidant Activity

The main issue that causes food to lose a considerable amount of its nutritional content is oxidation. It lessens the look and organoleptic qualities of food products. When compared to synthetic antioxidants in the agro-food sector, pomegranate fruits and their derivatives have

high antioxidant activity. Pomegranate health benefits include the ability to prevent inflammatory, cardiovascular, and other disorders. High concentrations of flavonoids such as cyanidin, pelargonidin and delphinidin, polyphenols and anthocyanins are found in the pomegranate fruit and its downstream components oil, peel and juice. There are some reports that pomegranate juice contains antioxidants. According to[18], pomegranate fruit extract has free radical scavenging properties against anions (superoxide) and radicals (hydroxyl). Additionally, studies have shown that pomegranate peel has the highest antioxidant activity among methanol extracts as measured by the FRAP, DPPH and CUPRAC tests. Pomegranate and its components' antioxidant properties are helpful for disease prevention both in vivo and in vitro. Pomegranate juice consumption has been shown to reduce hepatic oxidative stress, inactivate carcinogens through CYP expression (CYP1A2 and CYP3A), and protect against UV-A and UV-B-induced cell damage increase.

1.4. Biochemical Composition of Pomegranate Peel

Pomegranate strips are rich in phytochemicals. Reportedly, PSA contains large amounts of bioactive substances, mainly phenolic acids, flavonoids, and hydrolyzable tannins. Ellagic corrosive, gallic corrosive, caffeic corrosive, chlorogenic corrosive, syringic corrosive, ferulic corrosive, vanillic corrosive, p-coumaric corrosive, and cinnamic corrosive are the significant phenolic acids found in PPEs.[19-23] Phenolic acid content generally varies between species and is strongly influenced by ecological variables such as region, weather conditions, and cultivation methods. The strip tone was featured as one of the key elements characterizing the grouping of phenolic acids, with assortments with dull red tone answered to have bigger convergences of phenolic acids than the light-hued types. PPEs are an extraordinary wellspring of flavonoids notwithstanding phenolic acids. Despite the fact that it was likewise found that the natural product formative stage impacts the flavonoid content and piece, flavonoid content and synthesis are known to change enormously among assortments and developing circumstances.

1.5. The Extract Process of Pomegranate Peel

The methanol extraction strategy described in[24] is one of the most commonly used methods for the extraction of pomegranate stripes. In this method, first a fine streaky powder is made in an electric mixer, then in a grill he is dried at 40 ° C he for 24 hours. After the powder is sieved through a 24-mesh sieve, 250 ml of 80% methanol and 10 g of the powder test are mixed and allowed to infuse at room temperature (approximately 25° C.) for 24 hours. Then

sift and apply the final concentrate. When using a concentrate, dilute 10 g of the powder sample with 100 ml of purified water. Some additional studies specified a drying temperature and time of 48 hours at 50 °C.

Other solvents reported to be used instead of methanol for pomegranate strip extraction include water, ethanol, and CH3)2CO. The methanol extraction strategy is recommended as superior to other strategies in most distributed studies on different extraction techniques/solvents in view of the widespread prevalence of excess phenolic compounds and cancer preventatives.

PSA biochemical cosmetics are said to be greatly influenced by the extraction method. Conventional techniques typically result in low extraction yields and require enormous amounts of solvent. It has also been found that the concentrate degrades when used at elevated temperatures. High-pressure extraction has recently emerged as a valuable strategy that yields results without compromising bioactive synthetic compounds. Being an environmentally friendly strategy, high-pressure extraction is quick and yields high.

2. LITERATURE REVIEW

Pomegranate (Punica granatum L.) is a historical fruit for which much information is available (Damania, 2005).[25] The pomegranate fruit is said to be one of his five crops that were first domesticated in history, along with olives, figs, grapes and dates. Pomegranate domestication began between 3000 and 4000 BC. It spread to Iran, Afghanistan, and Turkey, and from there spread to various parts of the world, including the Mediterranean, India, and China.

2011 (Arjmand).[26] The pomegranate fruit is revered as a holy fruit in many cultures and religions. Greek mythology attributes it to life, regeneration, and marriage; Judaism links the 613 pomegranate seeds to the Bible's 613 commandments; Buddhism attributes it to the essence of beneficial influences; Chinese pottery attributes it to fertility; Christianity attributes it to resurrection and everlasting life; and Islam attributes it to four gardens with springs, shade, and fruits like the pomegranate.

The pomegranate plant is used to make juice, colours for ink, tannins for leather, and medicines for a variety of illnesses. Pomegranate fruits have a lengthy shelf life at room

temperature, which has allowed people to transport them on long voyages and use them extensively as a source of water and food in arid regions (Langley, 2000).[27]

2.1. Botanical background of pomegranate

Berry is the botanical classification of pomegranate fruit. Pomegranate trees grow to a height of 4 to 10 meters. The fruit has a rough, leathery exterior with a diameter that can range from 6 to 12 cm. The pomegranate fruit developed from a synchronous pistil with two whorls of the lower ovary and the basal carpel within the vessel. The outer carpels gradually slanted up and overlaid as the ovary develops (Still, 2006).[28]

2.2. Pomegranate phytochemicals

Most of the phytochemicals in pomegranates are polyphenols, which are phenolic rings with numerous hydroxyl groups. Flavonoids (flavanols and anthocyanins), bound tannins (proanthocyanidins), and hydrolyzable tannins (ellagitannins and gallotannins) are a wide range of polyphenols found in pomegranate. As indicated by Seeram et al. (2006)[29], the pomegranate likewise contains natural and phenolic acids, sterols and triterpenoids, unsaturated fats, fatty oils, and alkaloids. There is a sizable global market for polyphenols. For instance, in 2009 Leather Head Food Research estimated that the global market for polyphenols was worth about $200 million. Grapes, apples, olives, and green tea are the main sources of polyphenols that are extracted for use in functional foods or for sale as nutraceuticals.

The flavonoids include anthocyanins found in the arils and flavonols found in the peel extract, including luteolin, quercetin, and kaempferol (Elswijk et al., 2004).[30]

The energetic red hue of PJs is caused by the water-soluble pigment anthocyanins (Hernandez et al., 1999; Santagati et al., 1984).[31,32]

The natural product's strips (skin, husk, or pericarp), layers, and substances all contain hydrolyzable tannins (Seeram et al., 2005).[33]

Most phytochemicals, including polyphenols from seeds, seeds and skins, are removed along with the juice in commercial pomegranate juice, which is made by hydrostatically squeezing the whole natural product. Water-soluble punicalagins are degraded in the juice during hydrostatic pressing and enhance the cell-enhancing effects of pomegranate juice (Gil et al., 2000).[34]

3. RESEARCH METHODOLOGY

3.1. Collection of Sample

- Pomegranate fruits can be purchased at the neighborhood market in Amritsar, India.
- Rinse the fruits with distilled water after gently washing them twice with tap water.
- Peel the fruit's skin before storing it at 4°C for later use.

3.2. Extraction of Functional Components

- Pomegranate peel should be defrosted at room temperature.
- Make the peel homogeneous with a mortar and pestle.
- Gather the extract and combine it with two different water (2.0% and 10%) hydrochloric acid concentrations (mg/ml) overnight at room temperature.
- Use Whatman No. 1 filter paper to filter the sample.
- Concentrate the filtrate at reduced pressure and 40°C, then keep it chilled (2–8°C) for next experiments.

3.3. Stability Test

a. pH Stability

- At various pH levels, gauge how quickly functional components that were isolated from pomegranate peel degrade.
- By adding 1N HCl and 1N NaOH, create buffer solutions with pH values of 5, 7, and 9, respectively.
- Determine the functional components' retention at various wavelengths.
- Utilizing the proper analytical techniques, determine the degradation of functional components.

b. Temperature Stability

- Test the stability of the functional components by subjecting the extract to different temperatures (25, 50, 75, and 100°C) for specific durations.
- Evaluate the degradation of functional components under light and dark conditions for a defined period.
- Analyze the changes in functional components using suitable analytical techniques.

3.4. Utilization of Functional Components

- Utilize the functional ingredients that were isolated from pomegranate peel to create a variety of compositions.

- To investigate the effects on the stability and characteristics of the functional components, change the formulations' pH (for example, to pH 5, 7, and 9).
- To evaluate the effects of the functional components in the formulations, figure out their concentration (for example, 2% and 10%).
- To assess the utility and effectiveness of the functional components in the formed products, conduct sensory evaluations, bioactivity assays, or other pertinent studies.

3.5. Determination of End Point

- Conduct experiments for end-point determination that focus on how the formed goods use functional components.
- To evaluate the desirable characteristics of the finished products, for instance, carry out sensory assessments, texture analyses, or particular assays.

3.6. Jelly Method

Functional components were added to jelly using the jelly approach. Jelly was prepared as follows:

- Dissolve the desired concentration of gelatin powder in distilled water to make a gelatin solution.
- Gently heat and whisk the gelatin solution until dissolved.
- Add concentrated pomegranate peel functional component extract to gelatin solution.
- Stir well to distribute functioning components.
- Adjust the combination pH to reach the formulation pH.
- Set the mixture in molds or a bigger container.
- Cool and set the jelly at room temperature or in the fridge for the required time.
- After solidifying, the jelly can be analyzed.

4. Data Analysis

Table 1: The stability test for color pigment pH results were positive.

Aggregation	pH		
	4	7	10
2%	25.4	19.45	24.36
10%	19.6	8.65	32.7

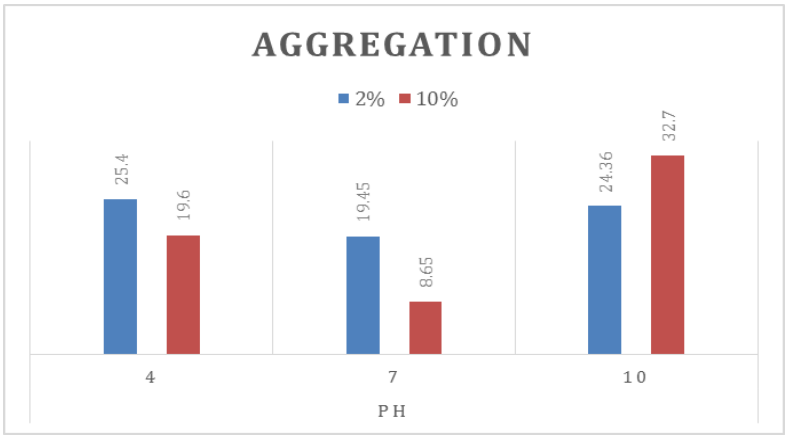

Figure 1: The figure shows the pH value stability test of color pigments.

The findings of the stability test for the pH of color pigment are displayed in Table 1. The values for two different color pigment concentrations (2% and 10%) and three different pH levels (4, 7, and 10) are shown in the table.

The pH level and concentration have an impact on how stable a color pigment is. The color pigment was generally stable at 2% concentration across all pH ranges, with stability values ranging from 19.45 to 25.4. However, the stability of the color pigment varied greatly at a concentration of 10%. The color pigment's stability value was 8.65 at pH 7, which indicates that it is more susceptible to deterioration or other factors at this pH level and concentration. The color pigment had the best stability value of 32.7 at pH 10 and 10% concentration, indicating superior resistance to degradation or alterations in this environment.

Table 2: Results demonstrated the impact of stability on temperature.

Aggregation	Temperature(^{o}C)			
	30	60	90	120
2%	0.79	0.73	0.53	0.84
10%	0.97	0.51	0.86	0.62

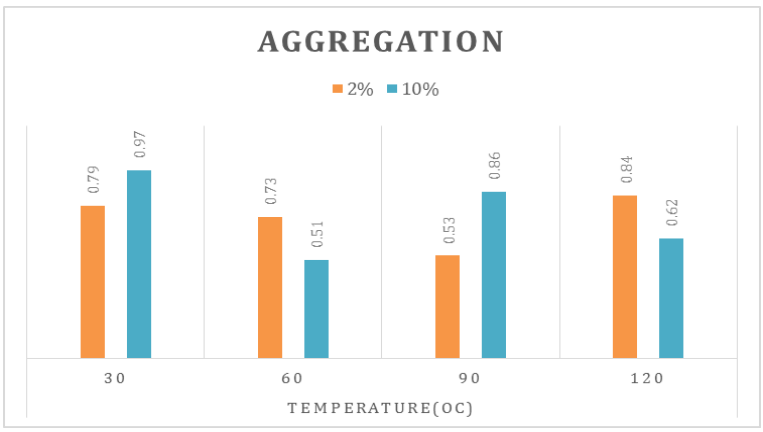

Figure 2: Figure showed that Stability effect on Temperature.

The stability test findings for the color pigment's response to temperature are shown in Table 2. Values at various temperatures (30°C, 60°C, 90°C, and 120°C) and two levels of color pigment (2% and 10%) are shown in the table.

The table's aggregation values show how stable or likely a color pigment is to aggregate at various temperatures and concentrations. Higher levels suggest a greater propensity for the color pigment to agglomerate, whereas lower values generally denote better stability.

Table 3: The average score of the sensory assessment of the jelly was revealed.

Observation	Sensory Attributes					
	Colour	Appearance	Texture	Flavor	Taste	Overall Acceptability
I	7.5	6.7	6.4	6.3	6.7	6.6
II	7.5	6.6	6.8	6.5	6.8	6.9
III	7.7	8.2	8.2	7.8	8.9	8.5

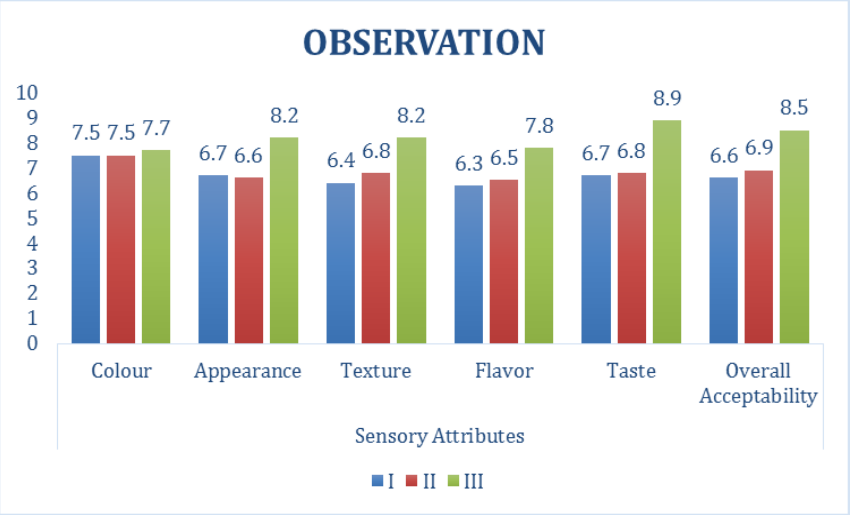

Figure 3: Figure showed that Average score of Sensory Evaluation of Jelly.

The average ratings of jelly's sensory evaluations based on its color, look, texture, flavor, taste, and general acceptability are shown in Table 3. The observations for the I, II, and III samples are shown in the table.

The average scores show how the jelly samples were perceived by the senses based on several characteristics. In comparison to samples, I and II, sample III generally earned higher average ratings across all sensory qualities. The fact that Sample III received higher ratings for its color, appearance, texture, flavor, and general acceptability suggests that the evaluators preferred it more. Samples I and II scored much lower than Sample III, indicating that their sensory qualities may not have been as appealing as those of Sample III.

5. CONCLUSION

pH values and concentrations had an impact on the color pigment's stability, with a higher concentration of 10% exhibiting more instability variance. There was no discernible pattern in the stability of the color pigment at different temperatures. In terms of sensory qualities, Sample III of the jelly formulation was preferred better; it continuously received higher average0 ratings for color, appearance, texture, flavor, taste, and overall acceptability. These results can be useful for further study, optimization, and product development by assisting in the comprehension of the stability and sensory characteristics of the color pigment and jelly composition.

6. REFERENCES

1. I Kahramanoglu, "Trends in pomegranate sector: production, postharvest handling and marketing," International Journal of Agriculture Forestry and Life Sciences, 2019; 3(2): 239–246.
2. I Kahramanoglu and S. Usanmaz, Pomegranate Production and Marketing, CRC Press Taylor & Francis Group, Boca Raton, FL, USA, 2016.
3. X. Wu, G. Cao, and R. L. Prior, "Absorption and metabolism of anthocyanins in elderly women after consumption of elderberry or blueberry," 2e Journal of Nutrition, 2002; 132(7): 1865–1871.
4. V. Sorrenti, C. L. Randazzo, C. Caggia et al., "Beneficial effects of pomegranate peel extract and probiotics on pre-adipocyte differentiation," Frontiers in Microbiology, 2019; 10: 660.
5. D. Surendhiran, C. Li, H. Cui, and L. Lin, "Fabrication of high stability active nanofibers encapsulated with pomegranate peel extract using chitosan/PEO for meat preservation," Food Packaging and Shelf Life, 2020; 23: ID 100439.
6. B. A. Wafa, M. Makni, S. Ammar et al., "Antimicrobial effect of the Tunisian Nana variety Punica granatum L. extracts against Salmonella enterica (serovars Kentucky and Enteritidis) isolated from chicken meat and phenolic composition of its peel extract," International Journal of Food Microbiology, 2017; 241: 123–131.
7. F. Licciardello, S. Kharchoufi, G. Muratore, and C. Restuccia, "Effect of edible coating combined with pomegranate peel extract on the quality maintenance of white shrimps (Parapenaeus longirostris) during refrigerated storage," Food Packaging and Shelf Life, 2018; 17: 114–119.

8. Adhami VM, Mukhtar H. Polyphenols from green tea and pomegranate for prevention of prostate cancer. Free Radical Research, 2006; 40(10): 1095-1104.
9. Rajan S, Mahalakshmi S, Deepa VM, Sathya K, Shajitha S, Thirunalasundari T. Antioxidant Potentials of Punica granatum Fruit Rind Extracts. International Journal of Pharmacy and Pharmaceutical Sciences, 2011; 3(3): 82-88.
10. Mirdehghan SH, Rahemi M. Seasonal changes of mineral nutrients and phenolics in pomegranate (Punica granatum L.) fruit. Scientia Horticulturae, 2007; 111(2): 120-127.
11. Fadavi A, Barzegar M, Aziz H. Determination of fatty acids and total lipid content in oil seed of 25 pomegranate varieties grown in Iran. Journal of Food Composition and Analysis, 2006; 19(6-7): 676-680.
12. Kyralan M, Gölükcü M, Tokgöz H. Oil and conjugated linolenic acid contents of seeds from important pomegranate cultivars (Punica granatum L.) grown in Turkey. Journal of the American Oil Chemists' Society, 2009; 86(10): 985-990.
13. Syed DN, Afaq F, Mukhtar H. Pomegranate derived products for cancer chemoprevention. Seminars in Cancer Biology, 2007; 17(5): 377-385.
14. Newman RA, Lansky EP, Block ML. Pomegranate: The Most Medicinal Fruit. Laguna Beach, California: Basic Health Publications. A Wealth of Phytochemicals, 2007; 120.
15. Holland D, Hatib K, Bar-Yaakov I. Pomegranate: botany, horticulture breeding. In: Journal of Janick (Edition) Horticultural Reveiws, 2009; 35: 127-191.
16. Sumner MD, Elliott-Eller M, Weidner G, Daubenmier JJ, Chew MH, Marlin R. Effects of pomegranate juice consumption on myocardial perfusion in patients with coronary heart disease. The American Journal of Cardiology, 2005; 96(6): 810-814.
17. Dhinesh KV, Ramasamy D. Pomegranate Processing and Value Addition: Review. Journal of Food Processing & Technology, 2016; 7: 565.
18. Guo S, Deng Q, Xiao J, Xie B, Sun Z. Evaluation of antioxidant activity and preventing DNA damage effect of pomegranate extracts by chemiluminescence method. Journal of Agricultural and Food Chemistry, 2007; 55: 3134-3140.
19. W. Elfalleh, N. Tlili, N. Nasri et al., "Antioxidant capacities of phenolic compounds and tocopherols from Tunisian pomegranate (Punica granatum) fruits," Journal of Food Science, 2011; 76(5): C707–C713.
20. E. A. Elsherbiny, B. H. Amin, and Z. A. Baka, "Efficiency of pomegranate (Punica granatum L.) peels extract as a high potential natural tool towards Fusarium dry rot on potato tubers," Postharvest Biology and Technology, 2016; 111: 256–263.

21. K. B. Arun, P. Jayamurthy, C. V. Anusha, S. K. Mahesh, and P. Nisha, "Studies on activity guided fractionation of pomegranate peel extracts and its effect on antidiabetic and cardiovascular protection properties," Journal of Food Processing and Preservation, 2017; 41(1): e13108.
22. E. M. C. Alexandre, S. Silva, S. A. O. Santos et al., "Antimicrobial activity of pomegranate peel extracts performed by high pressure and enzymatic assisted extraction," Food Research International, 2019; 115: 167–176.
23. Stojanovic, K. Savikin, N. Djedovic et al., "Pomegranate peel ˇ extract ameliorates autoimmunity in animal models of multiple sclerosis and type 1 diabetes," Journal of Functional Foods, 2017; 35: 522–530.
24. S. S. Dahham, M. N. Ali, H. Tabassum, and M. Khan, "Studies on antibacterial and antifungal activity of pomegranate (Punica granatum L.)," American-Eurasian Journal of Agricultural & Environmental Sciences, 2010; 9(3): 273–281.
25. Damania, A. Plant genetic resources and traditional knowledge for food security. Indian Journal of Plant Genetic Resources, 2005; 18(2): 154-163.
26. Arjmand, M. Pomegranate (Punica granatum L.). In Postharvest Biology and Technology of Fruits, Vegetables, and Flowers, 2011; 217-243. John Wiley & Sons.
27. Langley, P. The pomegranate: A modern view. Horticultural Reviews, 2000; 24: 379-415.
28. Still, D.W. Pomegranate: Botany, Horticulture, Breeding. Horticultural Reviews, 2006; 32: 127-191.
29. Seeram, N.P., Aviram, M., Zhang, Y., et al. Comparison of antioxidant potency of commonly consumed polyphenol-rich beverages in the United States. Journal of Agricultural and Food Chemistry, 2006; 54(22): 8865-8871.
30. Elswijk, D.A., Schobel, U.P., Lansky, E.P., et al. Rapid quantitative analysis of luteolin, quercetin, and apigenin in human plasma using a liquid chromatographic tandem mass spectrometric method. Cancer Epidemiology, Biomarkers & Prevention, 2004; 13(6): 840-845.
31. Hernandez, F., Melgarejo, P., Tomas-Barberan, F.A., et al. Evolution of juice anthocyanins during ripening of new selected pomegranate (Punica granatum) clones. European Food Research and Technology, 1999; 210(1): 39-42.
32. Santagati, N.A., Salerno, L., Attaguile, G., et al. Cyanidin 3-O-glucoside and cyanidin 3,5-O-diglucoside as primary phenolics in flowers of Punica granatum. Journal of Natural Products, 1984; 47(6): 916-917.

33. Seeram, N.P., Adams, L.S., Henning, S.M., et al. In vitro antiproliferative, apoptotic and antioxidant activities of punicalagin, ellagic acid, and a total pomegranate tannin extract are enhanced in combination with other polyphenols as found in pomegranate juice. Journal of Nutritional Biochemistry, 2005; 16(6): 360-367.
34. Gil, M.I., Tomas-Barberan, F.A., Hess-Pierce, B., et al. Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. Journal of Agricultural and Food Chemistry, 2000; 48(10): 4581-4589.