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# Medicinal applications of *Punica granatum* peel extract

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**Abstract**

The oldest fruit is Pomegranate (*Punica granatum L.*) which is endemic to the Mediterranean area and was widely utilised in national traditional medicine. They are a rich source of components with considerable biological activity verified. Pomegranate peel, covering around 30 to 40 percent of its weight, is nonetheless regarded as biological waste. The purpose of this work was to assess the potential of grenade extracts and to analyse the numerous biological activities and their significance. At room temperature each pomegranate peel was pulverised and extracted with ethanol, methanol and water for one hour. Methanol extracts' antibacterial activity has been investigated using a gram-positive and gram-negative approach. The pomegranate extracts include a very strong reduction power, high polyphenols and flavonoids. Pomegranate peel extracts revealed anti-proliferative effects on entirely distinct evaluated cell line proliferation. Pomegranate peels were extracted in the production of cot sticks. In total, the pomegranate peel has been verified as a useful source of bioactive substances to benefit numerous sectors.

**Keywords:** Anti-bacterial activities; DPPH; Anti-proliferative activity; Reduction of power; Polyphenols.

## 1 Introduction

Pomegranate is one of the most ancient and also endemic to the Mediterranean and has widely been employed in the folk medications of many nations. In India, arils are utilised or made into juice as such. Instead, the arils are utilised to make different added value goods such as concentrates, canned drinks, wine, jam and jelly. The latest fresh juice preparation has a little amount of cellulose, ascorbic acid and polyphenolic flavonoids. In addition, it belongs to the fruit cluster which have the most beneficial pharmacological effects, largely because of the extremely high concentration of several bioactive substances [1,2]. As a source of added-value biologically active chemicals for use in food matrices, Alexandre et al., for example, propose to extend inhibitor action and to reduce the risk of infectious contamination [3]. In yoghurt samples, the addition of pomegranate peel extracts has effectively been tested to boost the level of its antioxidant, enhance oxidative stability and protect it from mycotoxigenic fungus in meat products [4].

In recent years, there has been an accumulation of studies on tumours and multi-doping bacteria, and scientists gradually measure that they are specialised in natural substances with probable health impacts. Such biomass compounds, which are thought to be biological waste, would be of great significance, mainly because huge quantities of starting material would be easily accessible, whilst at the same time improving the management of biological waste. Nevertheless, pharmacology and the customer preferences for natural products have led to accumulation of interest within the U. Therefore, in recent years the value of natural antioxidants, especially those of plant origin, has significantly grown (Chidambara Murthy and others 2002). The loss of quality and safety is typically a charge for microbial activity, the main reason for a degradation in the numbers of foods [7].


There is a rising concern about infectious and spoilage bacteria in food because of the spread of foodborne illness outbreaks. There is now an increasing interest in employing natural medical medication ingredients, such as herbal extracts and food preservation spices [8,9]. Plant extracts have a distinctive taste and often have antibacterial properties as well. Many people who pomegranate the peel think that the peel is garbage and disposes of the environment. Previous analysts to make the advantages of pomegranate peel clear [10]. Botrus and other team members claim that the peels are also the area where biologically active chemicals are assembled for the manufacture of me-

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dicinal formulations. In addition, another investigator in 1998 had formulations of antifungals and antivirals comprised of grenade extract [11]. These compositions restricted the spread of plant life and viruses, but could not have a good effect on bacterial viability. Aerobic degradation of fat and oils in food is responsible for rancid smells and flavours and ends up reducing the quality and safety of organic processes owing to the creation of potentially harmful secondary chemicals. Usually, pomegranate peel is used as an associated animal feed once an industrial procedure. Given the strong nutritional qualities of pomegranate peel [12], research indicate that pomegranate peel feeding animals greatly enhances livestock nutrition and improves their health [13]. Pomegranate peel, though, might have an outstanding broader purpose.

This study examined the preparation of *Punica granatum* peel, because they have a high level of biological process and of nutritional quality, and their antimicrobial activity is assessed against gram-positive and gram-negating bacteria, DPPH Radical scavenging activity, anti-oxidant properties of pomegranate peel extracts and determina tion to reduce the number of pomegranate peel extracts.

**Preparation of Powder from *Punica granatum* Peel**

Firstly, in nearby regions, fresh pomegranate fruits were obtained on the public market (to organise modern extraction). With the aid of the Sharp Knife the fresh pomegranate peels have been separated and gathered and dried with sun-dried or oven-dried at 33° C for one week. The totally dried peels were ground in a plastic suitcase in an electric grinder. The peel powder (25g) was removed at 2000 rpm with 100 mL of ethanol at room temperature for 1 hour using hotplates and magnetic agitator. The extract was filtered with Whatman No.1 filter paper or filter paper to remove the particles from a Buchner funnel. The residue is extracted again with 50 ml of ethanol. The extracts were collected and evaporated in a flash evaporator at a minimum pressure of 40°C, recovering over 90% of the solvent. It was further dried in a vacuum constant weight desiccator (Figure 1). Further evaluations of their antibacterial, antifungal, antioxidant activities were addressed to the specimens.

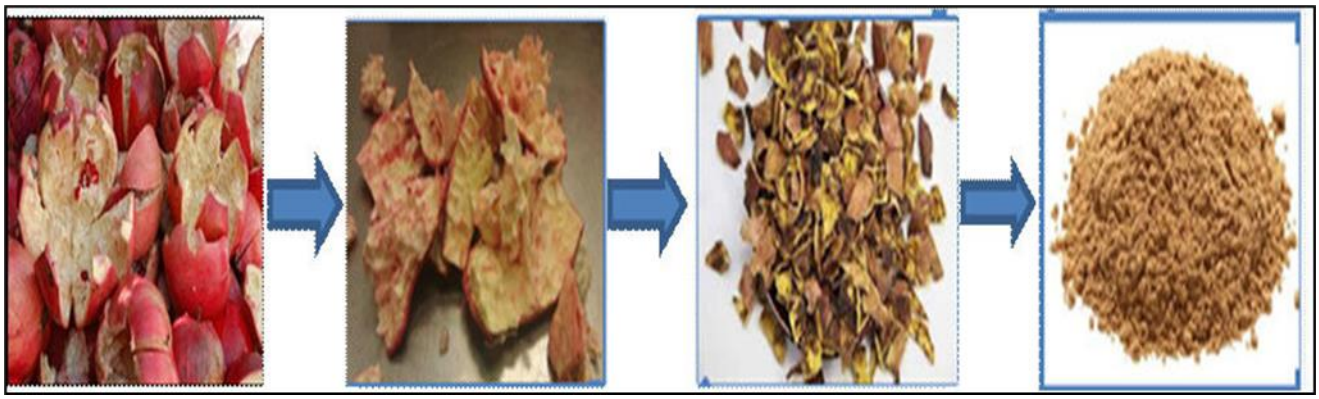

**Figure 1: Preparation of *Punica granatum* Peel**

**ACTIVITY OF PUNICAGRANATUM PEEL POWDER:**

**Antibacterial Activity**

In addition, several microbiological, agricultural and other institutes have received the most important bacterial cultures: *Bacillus cereus, Bacillus coagulans, Bacillus subtilis, Staphylococcus aureus, Escherichia Coli* and *Pseudomonas aeruginosa.* The growing microbe is produced at room temperature in enriched nutrient agar media. Each strain was transmitted from 4 to 5°C keeping slants to 10 ml of nutrient broth and was grown overnight. One ml of this cultivation was put to the nine ml broth and cultured at 37°C for two days. After activity (1200 µg 5 min), the bacterial cells were extracted, washed and suspended in saline solution [14]. Ketone, methyl acetate, and water extracts of pomegranate peels were evaluated against several bacterial microorganisms for antibacterial efficacy.

Totally different quantities of unknown item were added to flasks containing 20 ml of liquified nutritional agar in propylene glycol. In the case of control, propylene glycol similar amount was added. Every single bacterial microbe to be studied has injected one hundred L (about 103 CFU/mL) in the fibres below the shrinking environment [15]. The media were then spilled over in triplicate and incubated into sterilised or decontaminated petri plates at room temperature for 20 to 24 hours. In nutritional media the colonies were then produced, incubation was counted (Figure-2). The minimum inhibitory concentration (MIC), the minimal concentration of the drug that may block entire growth of the tested bacteria, has been established and reported [16].

**DPPH Radical Scavenging Activity:**

Pomegranate peel with radical activity was examined by Choi and other methods of high performance, 2-diphenyl-1-picrylhydrazyl liquid chromatography (2000). Appropriate number of extracts of pomegranate peel were transferred to entirely distinct tubes in a 1:1 (i.e., equal) quantitative ratio of methyl acetate to water to get good final concentrations of 5, 10, 25 and 50 ppm. The quantitative value of the methyl acetate was changed to 200 L. The 0.5 mM 2.2-diphenyl-1-picrylhydrazyl-methyl-acetate solution (1 mL) and 100 mM Tris Hydrochloric acid tapes (800 L) pH 7.4 were then incubated at room temperature in the dark for 20 minutes. The reaction mixture was then

analysed in a high-performance liquid chromatography reverse stage. Colour measuring system consists of a High-performance HP 1100 series Hewlett Packard Liquid Chromatography model equipped with a Waters - Bondapak TM, column C18 (300 to 4,6 mm I.D). The apparatus was employed as a 20 L sample loop during the injection time [17]. The free radical-scavenging effects of pomegranate peel minerals and butylates were examined using a variable wavelength detector in HP 1100 series utilising the maximum area of the 2.2-diphenyl-1-picrylhydrazyl radical at 517 nm (Figure 3). The ensuing calculation determined the radical-scavenging activity: percentage of radical-scavenging activity = (1 – top space or control area BHA/speak) = 100.

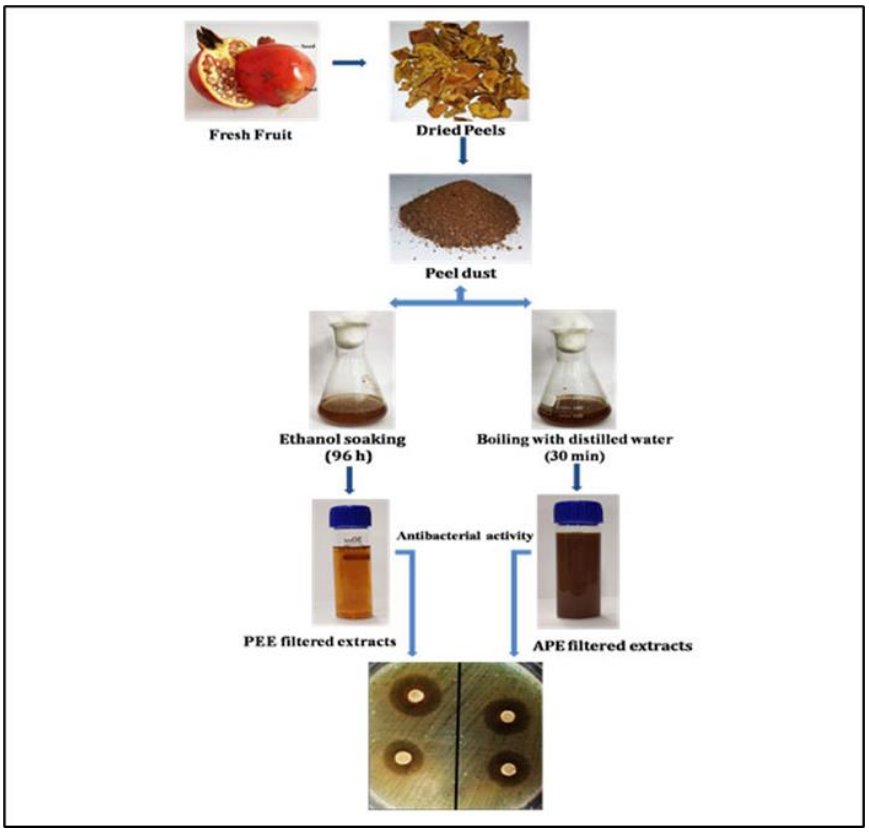


**Figure 2:** Antibacterial activity of *Punica granatum* Peel

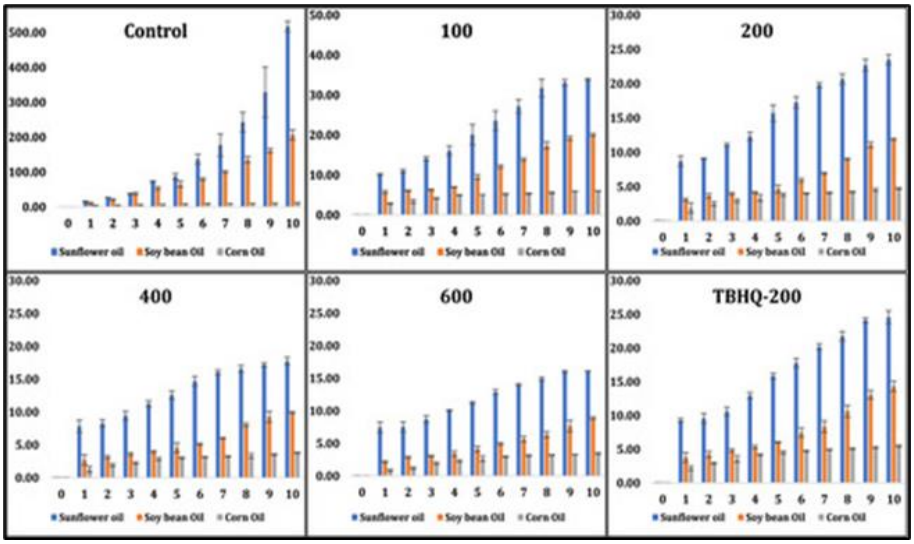


**Figure 3:** DPPH Radical Scavenging activity *Punica granatum* Peel

**Determination of Reducing Power:**

The reduction in the evaluation samples was determined using the usual approach. *Punica granatum* peel powder can be extracted to determine power reduction. In general, in one cubic centimetre of methanol, the following different concentrations of pomegranate peel extracts (the levels 50.100, 200 and 400 ppm) were combined with 2.5 mL common phosphate tampons (0.2 M, pH 6.6) and 2.5

mL of one Chronicles potassium ferricyanide, in a 10 mL test tube [19]. The blends were incubated at 50 °C for 20 minutes. At the very top of the incubation, 2.5 mL of ten percent trichloroacetic acid was added and centrifuged for five minutes at 5000 revolutions. The upper layers (2.5 mL) were blended together with 0.5 cubic centimetres, 0.5 mL, ferric chloride and absorption at 700 nm [20]. The power reduction experiments were performed three times. An increase in reaction absorption reflected the reduction in power of the varied sample values (Figure-4)

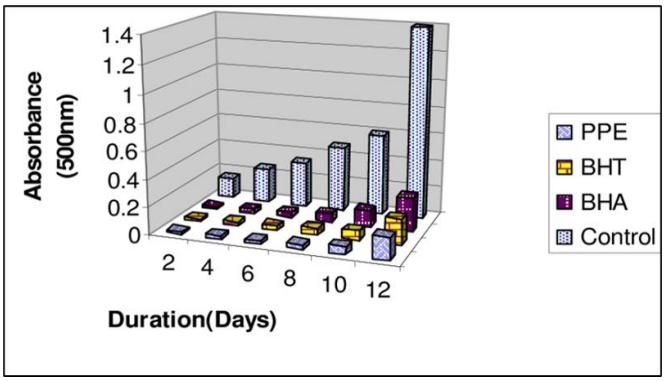


**Figure 4:** Reducing Power of Punica granatum Peel

**Determination of Total Polyphenols Content:**

The Folin–Ciocalteu test was the best technique of identifying total polyphenol levels with minor adjustments [21] (Singleton et al., 1999). This test was used to analyse the total polyphenol content from sample extraction. Dissolved into one ml of dissolved water, 0.1 mg Pomegranate peel powder extract. In 500 µL sample were then added 5 ml of ten percent Folin–Ciocalteu reagent and 4.5 ml of sodium carbonate solution (7.5 percent w/v). The final resolution preparation was twice agitated in the dark and the absorption was measured at µ = 765 nm (Figure 5). Triplicate analyses were conducted, which resulted in a concentration of total polyphenols as gallic acid equivalents (GAEs)/100 g of grenadine extract [22].

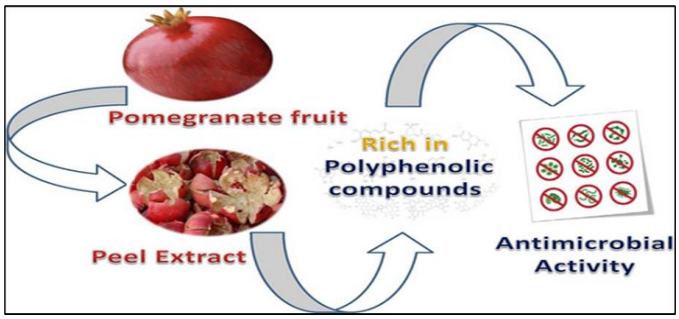


**Figure 5:** Total Phenolic Content of *Punica granatum* Peel

**Antiproliferative Effects:**

Selection of selective crops from the vitro studies were tested and confirmed in the vitro studies: the antiproliferative effects of ethanol corkscrew of the *Punica granatum* peels on WI-38 (normal human fibroblasts), Hela (cervical carcinoma), SW620 (colorectal carcinoma, metastatic), MCF-7 (breast animal tissue carcinoma, metastatic) and CFPAC-1 (pancreatic carcinoma derived from pathological treatments of the liver).

Previous analyses documenting the most effective influence of grenade peel on cell lines of growth provided strong explanations for investigating antiproliferative activity [24,25]. In all in-vitro experiments, anti-proliferative effects were found. Ethyl alcohol extract of pomegranate peels was shown in these investigations Additionally, the repressive effects of IC50 varied between zero.162 and 0.303 mg/mL on the growth of MCF-7 cancer cells.

In agreement with the results reported by Nazeam et al., whenever IC50 is used, there were zero.249, 0.285 and 0.179 mg/mL for liquid, fifty nothing methanolic, and 100% methanol fractions of pomegranate husk, severally [26.27]. The repressive concentrations of Pomegranate peel extracts analysed for cervical malignant neoplastic disease (HeLa) range from zero.141 to 0.212 mg/mL, which is likely to be correlative with ellagic acid in the literature wherever pomegranate ellagic acid has a promising repressive effect on the expansion of cervical malignant' human diseases. Although Pomegranate peel extracts analysed have shown antiproliferative activity on totally distinct examined cell lines, more tests necessary to clarify the molecular processes behind the antiproliferative activity identified (Figure 6).

**Cod Stick Preparation:**

Five days of ready and explicitly kept cod fillets, changing the water every day. On the sixth day cabbage fillets were rinsed for roughly half an hour to get rid of more than water molecules, and the skin was also removed. Then fillets (about 67 w/w and a simple proportion of w/w of sodium chloride) were cut in approximately 12 grams of sticks [32,33]. There were two mixes prepared: no-active (non-active) mixture and active. Non-active mix including 1:1 magnitude breading with fish seasonings and potato flakes and active mixture ready with 1:1 magnitude Pinegrove peel powder and non-active mixture(Figure-7). Four different samples were ready (i.e., Con, A, B and C). The sample control (Ctrl) was obtained as follows: when it was dipped in a very high water and milk resolution (1:1), the sample was breaded in the no-active mix twice after the passage. This sample had then been handing compacted, padded above a food receptor and packed into air using a high-barrier film bag (Nylon/Polyethylene multilayer film) with 150 µm thickness, delivered by the study, pomegranate peel by products was included in the cod stick breading so that the end product quality could be improved from the nutritional standpoint (Figure 8). The pomegranate powdered cod sticks were analysed and validated by the analysis of phenolic components, flavonoid concentration and antioxidant activity. The microbiological growth overcame peel powder throughout cold storage although its sensory qualities were not adversely sterilised. In the fresh food business, the use of pomegranate peel can, finally, be a sustainable approach to decrease the environmental effect and expense of the disposal of by-products with significant advantages to product quality and time.

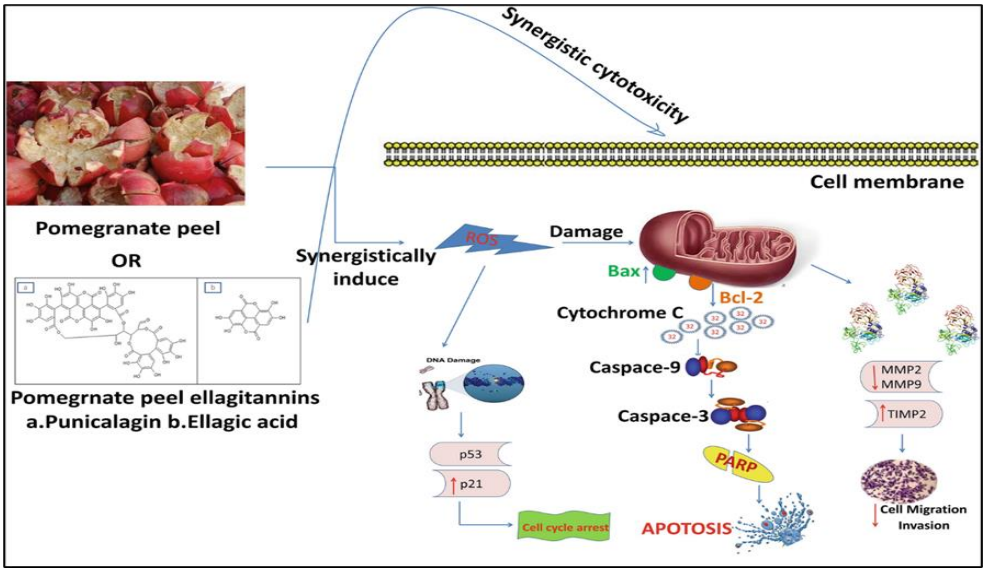


**Figure 6:** Antiproliferative Effects of *Punica granatum* Peel

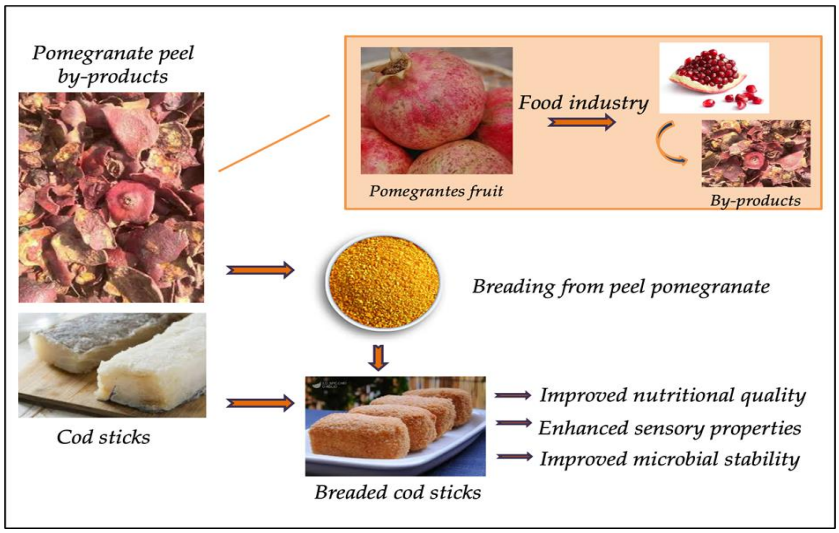


**Figure 7:** Cod Sticks Preparation

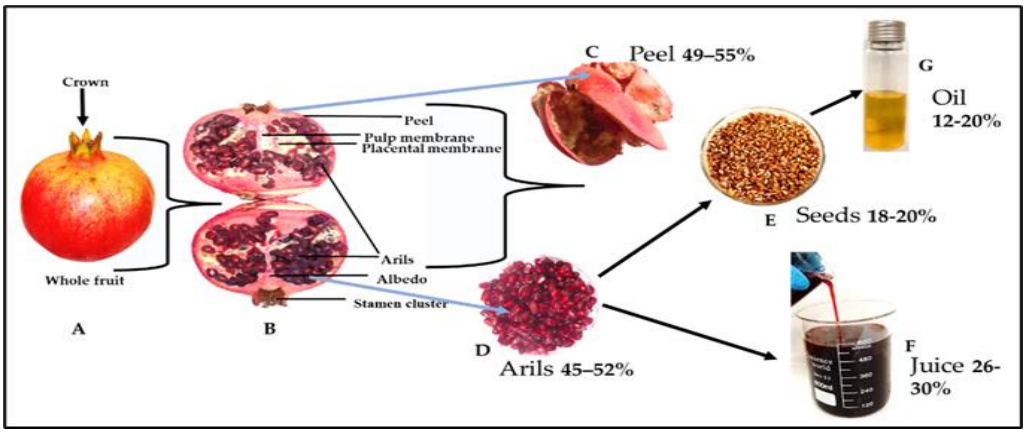


**Figure 8:** Nutritional Properties of Pomegranate (*Punica granatum L.*)

## 4 Conclusions

The grenade peels have large qualities and various activities in comparison with seeds, fruits, leaves etc., and are commonly employed in all industrial applications including nutrition industries. Pomegranate peel ethanol extraction shows a promising antimicrobial activity against grammatically and grammatically-negative bacteria, DPPH Radical activity of scavenging, antioxidant properties of pomegranate peel extracts, power reduction, anti-

proliferation effects identifying total polyphenolic contents and mainly pomegranate peel are used to help identify antiproliferative effect. The aforesaid results contribute much to the acquisition of the understanding of grenade peels, either as a source of small molecules for biological use or in various sectors.

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**References**

[1] Sheela, K.., Madhusudhanan, J., Thirumagal, J., Niti chawala, S., Jagannathan., Ahamed, M.I.N., Biosynthesis and Biomedical applications of cerium oxide nanoparticles. Annals of R.S.C.B., Vol.25, Issue 6,2021, pp 203-213.

[2] Zarfeshany, A.; Asgary, S.; Javanmard, S.H. Potent health effects of pomegranate. Adv. Biomed. Res. 2014, 3, 100.

[3] Sheela, K., Ragul, V., Ahamed, M.I.N., Systematic review on biological properties and biomedical application of cerium oxide nanoparticles. Journal of functional materials and biomolecules J. Funct. Mater. Biomol. 4(2) (2020) pp 410 – 415.

[4] Shabtay, A.; Eitam, H.; Tadmor, Y.; Orlov, A.; Meir, A.; Weinberg, P.; Weinberg, Z.G.; Chen, Y.; Brosh, A.; Izhaki, I.; et al. Nutritive and Antioxidative Potential of Fresh and Stored Pomegranate Industrial Byproduct as a Novel Beef Cattle Feed. J. Agric. Food Chem. 2008, 56, 10063–10070.

[5] Brighenti, V.; Groothuis, S.F.; Prencipe, F.P.; Amir, R.; Benvenuti, S.; Pellati, F. Metabolite fingerprinting of Punica granatum L. (pomegranate) polyphenols by means of high-performance liquid chromatography with diode array and electrospray ionization-mass spectrometry detection. J. Chromatogr. A 2017, 1480, 20–31.

[6] Russo, M.; Fanali, C.; Tripodo, G.; Dugo, P.; Muleo, R.; Dugo, L.; De Gara, L.; Mondello, L. Analysis of phenolic compounds in different parts of pomegranate (Punica granatum) fruit by HPLC-PDA-ESI/MS and evaluation of their antioxidant activity: Application to different Italian varieties. Anal. Bioanal. Chem. 2018, 410, 3507–3520.

[7] Alexandre, E.M.C.; Silva, S.; Santos, S.A.O.; Silvestre, A.J.D.; Duarte, M.F.; Saraiva, J.A.; Pintado, M. Antimicrobial activity of pomegranate peel extracts performed by high pressure and enzymatic assisted extraction. Food Res. Int. 2019, 115, 167–176.

[8] El-Batawy, O.I.; Ashoush, I.S.; Mehanna, N.S. Impact of mango and pomegranate peels supplementation on quality characteristics of yoghurt with or without whey powder. O.I. El-Batawy, I.S. Ashoush Nayra Sh. Mehanna 2014, 9, 57–65.

[9] Firuzi, M.R.; Niakousari, M.; Eskandari, M.H.; Keramat, M.; Gahruie, H.H.; Mousavi Khaneghah, A. Incorporation of pomegranate juice concentrate and pomegranate rind powder extract to improve the oxidative stability of frankfurter during refrigerated storage. LWT 2019, 102, 237–245.

[10] Alotaibi, M.A.; Tayel, A.A.; Zidan, N.S.; El Rabey, H.A. Bioactive coatings from nano-biopolymers/plant extract composites for complete protection from mycotoxigenic fungi in dates. J. Sci. Food Agric. 2019, 99, 4338–4343.

[11] Singh, B.; Singh, J.P.; Kaur, A.; Singh, N. Phenolic compounds as beneficial phytochemicals in pomegranate (Punica granatum L.) peel: A review. Food Chem. 2018, 261, 75–86.

[12] Calani, L.; Beghè, D.; Mena, P.; Del Rio, D.; Bruni, R.; Fabbri, A.; Dall'asta, C.; Galaverna, G. Ultra-HPLC-MS(n) (Poly)phenolic profiling and chemometric analysis of juices from ancient Punica granatum L. Cultivars: A nontargeted approach. J. Agric. Food Chem. 2013, 61, 5600–5609.

[13] Rajah, K.K. (Ed.) Fats in Food Technology, 2nd ed.; Wiley-Blackwell: Chichester, UK, 2014; p. 386. ISBN 978-1-4051-9542-3.

[14] Sentandreu, E.; Cerdán-Calero, M.; Sendra, J.M. Phenolic profile characterization of pomegranate (Punica granatum) juice by high-performance liquid chromatography with diode array detection coupled to an electrospray ion trap mass analyzer. J. Food Compos. Anal. 2013, 30, 32–40.

[15] Mena, P.; Calani, L.; Dall'Asta, C.; Galaverna, G.; García-Viguera, C.; Bruni, R.; Crozier, A.; Del Rio, D. Rapid and comprehensive evaluation of (poly)phenolic compounds in pomegranate (Punica granatum L.) juice by UHPLC-MSn. Molecules 2012, 17, 14821–14840.

[16] Jayaprakasha GK, Tamil Selvi A, Sakariah KK. 2003. Antimicrobial and antioxidant activities of grape (Vitis vinifera) seed extracts. Food Res Int 36:117– 22.

[17] Jayaprakasha GK, Singh RP, Sakariah KK. 2001. Antioxidant activity of grape seed (Vitis vinefera) extracts on peroxidation models in vitro. Food Chem 73:285–90.

[18] Gazivoda, T.; Plevnik, M.; Plavec, J.; Kraljevi´c, S.; Kralj, M.; Paveli´c, K.; Balzarini, J.; De Clercq, E.; Mintas, M.; Rai´c-Mali´c, S. The novel pyrimidine and purine derivatives of l-ascorbic acid:

Synthesis, one- and two-dimensional 1H and 13C NMR study, cytostatic and antiviral evaluation. Bioorg. Med. Chem. 2005, 13, 131–139.

[19] Jurica, K.; Gobin, I.; Kremer, D.; Cepo, D.V.; Grubeši´c, R.J.; Kara˘conji, I.B.; Kosalec, I. Arbutin and its ˘ metabolite hydroquinone as the main factors in the antimicrobial effect of strawberry tree (Arbutus unedo L.) leaves. J. Herb. Med. 2017, 8, 17–23.

[20] Peršuri´c, Ž.; Safti´c, L.; Mašek, T.; Kraljevi´c Paveli´c, S. Comparison of triacylglycerol analysis by MALDI-TOF/MS, fatty acid analysis by GC-MS and non-selective analysis by NIRS in combination with chemometrics for determination of extra virgin olive oil geographical origin. A case studies. LWT 2018, 95.

[21] Mena, P.; Calani, L.; Dall'Asta, C.; Galaverna, G.; García-Viguera, C.; Bruni, R.; Crozier, A.; Del Rio, D. Rapid and comprehensive evaluation of (poly)phenolic compounds in pomegranate (Punica granatum L.) juice by UHPLC-MSn. Molecules 2012, 17, 14821–14840.

[22] Gómez-Caravaca, A.M.; Verardo, V.; Toselli, M.; Segura-Carretero, A.; Fernández-Gutiérrez, A.; Caboni, M.F. Determination of the major phenolic compounds in pomegranate juices by HPLC–DAD–ESI-MS. J. Agric. Food Chem. 2013, 61, 5328–5337.

[23] Fischer, U.A.; Carle, R.; Kammerer, D.R. Identification and quantification of phenolic compounds from pomegranate (Punica granatum L.) peel, mesocarp, aril and differently produced juices by HPLC-DAD-ESI/MS(n). Food Chem. 2011, 127, 807–821.

[24] Pham-Huy, L.A.; He, H.; Pham-Huy, C. Free radicals, antioxidants in disease and health. Int. J. Biomed. Sci. 2008, 4, 89–96.

[25] Malenica Staver, M.; Ratkaj, I.; Brozni´c, D.; Jerkovi´c, I.; Marijanovi´c, Z.; Željezi´c, D.; Kraljevi´c Paveli´c, S. Bioactivity of Satureja montana L. honey extracts and their profile screening. RSC Adv. 2014, 4, 47329–47340.

[26] Kim, N.D.; Mehta, R.; Yu, W.; Neeman, I.; Livney, T.; Amichay, A.; Poirier, D.; Nicholls, P.; Kirby, A.; Jiang, W.; et al. Chemopreventive and adjuvant therapeutic potential of pomegranate (Punica granatum) for human breast cancer. Breast Cancer Res. Treat. 2002, 71, 203–217.

[27] Jeune, M.A.L.; Kumi-Diaka, J.; Brown, J. Anticancer activities of pomegranate extracts and genistein in human breast cancer cells. J. Med. Food 2005, 8, 469–475. Molecules 2020, 25, 5916 12 of 13

[28] Deng, Y.; Li, Y.; Yang, F.; Zeng, A.; Yang, S.; Luo, Y.; Zhang, Y.; Xie, Y.; Ye, T.; Xia, Y.; et al. The extract from Punica granatum (pomegranate) peel induces apoptosis and impairs metastasis in prostate cancer cells. Biomed. Pharmacother. 2017, 93, 976–984.

[29] Dikmen, M.; Ozturk, N.; Ozturk, Y. The antioxidant potency of Punica granatum L. fruit peel reduces cell proliferation and induces apoptosis on breast cancer. J. Med. Food 2011, 14, 1638–1646.

[30] Adams, L.S.; Seeram, N.P.; Aggarwal, B.B.; Takada, Y.; Sand, D.; Heber, D. Pomegranate juice, total pomegranate ellagitannins, and punicalagin suppress inflammatory cell signaling in colon cancer cells. J. Agric. Food Chem. 2006, 54, 980–985.

[31] Nair, V.; Dai, Z.; Khan, M.; Ciolino, H.P. Pomegranate extract induces cell cycle arrest and alters cellular phenotype of human pancreatic cancer cells. Anticancer Res. 2011, 31, 2699–2704.

[32] Bopitiya, D.; Madhujith, T. Efficacy of pomegranate (Punica granatum L.) peel extracts in suppressing oxidation of white coconut oil used for deep frying. Trop. Agric. Res. 2014, 25, 298–306.

[33] Ibrahium, M. Efficiency of pomegranate peel extract as antimicrobial, antioxidant and protective agents. World J. Agric. Sci. 2010, 6, 338–344.

[34] Konsoula, Z. Comparative efficacy of pomegranate juice, peel and seed extract in the stabilization of corn oil under accelerated conditions. World Acad. Sci. Eng. Technol. Int. J. Nutr. Food Eng. 2016, 10, 556–563.

[35] Andrade, R.M.S.; Ferreira, M.S.L.; Gonçalves, È.C.B.A. Development and characterization of edible films based on fruit and vegetable residues. J. Food Sci. 2016, 81, 412–418.