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An Overview of the Therapeutic Properties of Pomegranate Peel

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ABSTRACT

Pomegranate (Punica granatum) is a Punicaceae fruit whose name comes from the Latin term Malum granatum, which means "granular apple." Pomegranates are native to India and Iran, but their culture has spread over the Mediterranean and South-Western America. Almost 46% portion of the Pomegranate fruit produces juice, and the rest is considered as waste. Pomegranate peel is the major waste component and comprises of almost 43% of fruit, and the rest of 11% comprises seed portion. It is observed that the Peel portion contains bioactive substances like flavonoids, complex polysaccharides, minerals, and hydrolyzable tannins including punicalagin, ellagic acid, and gallic acid, among others which are found to have therapeutic properties. Besides this the peel of pomegranate is high in dietary fibre and pectin. This review gives an overview of the Therapeutical properties of pomegranate peel and potential health benefits.

Keywords: *Pomegranate Peel; Nutraceuticals; Therapeutic properties; Health Benefits.*

INTRODUCTION

Pomegranate (*Punica granatum*) is a nutrient-rich fruit-bearing deciduous shrub belonging to the Punicaceae family. It is one of the major table-serving fruits in many countries because of its pleasant taste and excellent health-benefiting properties. Over the last decade, a remarkable rise in the area and production of pomegranates is reported around the whole world. This marked shift towards the worldwide production and consumption of pomegranate is attributed to its several nutritive, nutraceutical, and medicinal properties. All the medicinal and health benefits of pomegranate are attributed to its chemical composition. Pomegranate fruit is mainly consumed either in juices, jams, wines, or as isolated fresh arils. Pomegranate processing companies utilize the edible and juicy aril part and discard the rest of the fruit, including peels and seeds. Pomegranate peel accounts for about 40-50 % of the total fruit weight and contains a substantial number of phytochemicals responsible for its disease-remedying quality (Marra et al., 2022).

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Pomegranate peels contain a variety of chemical compounds with significant biological and nutraceutical value, such as hydrolyzable tannins (punicalagins and punicalins), condensed tannins (proanthocyanidins), anthocyanins phenolic acids (gallic acid and ellagic acid), and flavonoids (quercetin, catechin) having antioxidant, anti-inflammatory, antimicrobial, anti-cancer, anti-cardiovascular activities (Alexandre et al., 2019; Aviram & Rosenblat, 2012; El-Hadary & Ramadan, 2019; Mastrogiovanni et al., 2019; Singh et al., 2018; & Usha et al., 2020). They are also rich in minerals like sodium, potassium, magnesium, iron, and phosphorus (Caruso et al., 2020). **Table 1** presents the Phyto-constituents of different parts. These compounds in pomegranate peel has conferred therapeutic effects against diabetes (Stojanović et al., 2017), prostate cancer (Ma et al., 2015), obesity (Harzallah et al., 2016), osteoporosis (Spilmont et al., 2015), giardiasis (El-Kady et al., 2021), encephalomyelitis (Vallarino et al., 2022). The abundance of these compounds and their efficacy against a wide range of diseases makes pomegranate peel an inexpensive and potential source of nutraceuticals. As a result, the peel which was considered an agro-industrial waste, has now aroused considerable research interest, and several studies are reported in the scientific literature regarding the investigation of functional and therapeutical properties of pomegranate peel and its applicability against several critical diseases.

Table1. Phyto-constituents of Plant Parts

Plant Part	Constituents
Juice	Anthocyanins, glucose. Ascorbic acid, ellagic acid gallic acid, catechin, minerals, aminoc acids, rutin, quercetin
Seed oil	Ellagic acid, sterols, 95% punic acid
Peel and pericarp	Phenolic punicalagin, gallic acid, catechin, flavanones, anthocyanidins
Leaves	Tannins, flavone. glycoside, luteolin, apigenin
Flowers	Gallic acid, ursolic acid, triterpenoids including maslinic and Asiatic acid
Roots and bark	Ellagitannins, piperidine alkaloids, punicalagin and punicalagin

2. Therapeutical properties of pomegranate peel

2.1. Antioxidant Activity

Reactive oxygen species (ROS)-mediated oxidative stress, if not refuted by natural enzymatic and non-enzymatic reactive response mechanisms, may give rise to certain non-communicable diseases, such as neurodegenerative disorders, various types of cancers, atherosclerosis, arthritis, and type 2 diabetes (Kurutas, 2016; & Nita & Grzybowski, 2016). Several researchers have proved the inhibition of ROS by the use of antioxidants. Pomegranate peels exhibit high antioxidant activity, which is attributed to the presence of phenolic acids, flavonoids, and tannins. Quercetin, ellagitannins, catechin, kaempferol, ellagic, gallic, and ferulic acid are some of the antioxidants found in pomegranate peel extract. Abid et al. (2017) investigated the phenolic contents of Tunisian pomegranate peels which showed that the acetone extract of *Acide* ecotype had the highest values for tannins (292.23 mg gallic acid equivalent/g), polyphenol (304.6 mg gallic acid equivalent/g), flavonoids (15.46 mg Quercetin/g), and anthocyanins (54.51 mg cy-3-glu/100 g). A study carried out to determine the antioxidant property of *Akko* pomegranate peel extracts showed that both acetone and methanolic extracts exhibited a significant DPPH scavenging activity, with an IC_{50} value of 0.58 ± 0.6 μg ml−1 for acetone extract, which is 1.5-fold lower than that for the standard Trolox (0.89 ± 0.14 μg ml−1). A low IC_{50} value corresponds to a strong ability of the extract to act as a DPPH scavenger. Both extracts possessed an in vitro ROS scavenging activity and were able to protect 3T3-L1 murine fibroblasts and Hek-293 human embryonic kidney epithelial cells from

menadione-induced oxidative stress (Fazio et al., 2018).

2.2. Antidiabetic Activity

Diabetes mellitus is a metabolic disorder characterized by elevated glucose levels in the blood (hyperglycemia) and insufficient insulin production caused by oxidative stress. Consumption of dietary antioxidants can be used to treat diabetes by regulating glucose metabolism, protection, and reduction of β-cell apoptosis, stimulating insulin secretion and ameliorating diabetic complications (Fazio et al., 2018; & Suresh et al., 2021). As a result, bioactive phytochemicals, particularly those derived from plant sources with antidiabetic potential, are receiving a lot of attention in treating and preventing diabetes. (Okumuş & Bakkalbaşı, 2021) studied the antidiabetic activity of different varieties of pomegranate peels. They reported that α-amylase and α-glucosidase inhibitory activities of the peels ranged from 0.06 to 0.14 mg/L and 3.01 to 3.64 mg/L, respectively. The results concluded that all the peels exhibited higher antidiabetic activity as compared to acarbose, an antidiabetic drug for type 2 diabetes. Another study conducted by Šavikin et al. (2018) showed a greater inhibitory effect on α -glucosidase (IC50 = 0.26-4.57 g/mL) than on α -amylase (IC50 = 23.6-284.3 g/mL). (Ahmed et al. (2014) carried out a study to examine the antidiabetic effects of pomegranate peel extract against diabetic renal complications in streptozotocin-induced diabetic rats. The findings demonstrated that treated rats had a positive effect on the renal parenchyma in diabetic kidneys as well as a marked improvement in blood glucose, triglycerides, and cholesterol levels.

2.3. Antimicrobial Activity

Pomegranate peel has demonstrated a wide spectrum antimicrobial activity against both Gram-positive and Gram-negative bacteria. The abundance of phenolic compounds in peels exerts a synergistic effect against microorganisms (Kharchoufi et al., 2018). Alsataf et al. (2021) investigated the antimicrobial activity against six microorganisms. Pomegranate peel extract demonstrated antimicrobial activity against all of the reference strains tested except for *A. brasiliensis*. The highest antimicrobial activity was observed against *E.coli* while the lowest activity was against *C.albicans*. Malviya et al. (2014) conducted a similar study on four bacterial strains that showed excellent antibacterial activity against all reference bacterial strains. The maximum antibacterial activity was found in the order *S. aureus*>*S. typhi*>*E. aerogenes*>*K. pneumonia*. Several studies have demonstrated that the presence of tannins (punicalagin) in pomegranate peel is responsible for controlling fungal growth. *In-vitro* methanolic pomegranate peel extract monitoring showed antifungal activity against *Penicillium digitatum*, *Saccharomyces cerevisiae*, and *Pseudomonas putida* along with morphological changes in the shape of *P. digitatum hyphae* (Kharchoufi et al., 2018). Pomegranate peel is also effective against Aspergillus flavus and other opportunistic pathogens (Singh et al., 2019).

2.4. Anti-cancer Properties

Cancer is one of the most common causes of death worldwide. As a result, proper preventive measures and early detection are critical in cancer treatment. Punicalagin and ellagic acid have significant anticancer activity. Numerous studies have shown the effectiveness of pomegranate peel and its extract against various types of cancer. (Deng et al., 2017) studied the effect of pomegranate peel against prostate cancer cells. It was found that pomegranate peel extract inhibited the growth of prostate cancer cells and downregulation of matrix metalloproteinase-2 (MMP2)/ matrix metalloproteinase-9 (MMP9) and upregulation of (Tissue inhibitor of metalloproteinase 2) TIMP2 was observed. Li et al. (2016) investigated effect of pomegranate peel on thyroid carcinoma. Results showed that peel extract induced cancer cell apoptosis, impaired thyroid cancer cell migration and invasion by down-regulating expression of MMP-9.

2.5. Skin health application

Pomegranate peel and seed oil may be used in skin care products, showing how biowaste can

be turned into high-value goods. Ellagic acid and punicalagin, two bioactive pomegranate rind components, block tyrosinase and initiate anti-inflammatory and anti-fungal activities on the skin. Punicic acid is abundant in seed oil, giving it preventive and anti-inflammatory properties against UV-induced radiation. Furthermore, seed oil can block ageing-induced glycation, a mechanism that causes skin elasticity to deteriorate. Pomegranate has one of the highest amounts of ellagic acid (EA). EA is a phenolic compound that protects the skin from oxidative damage. Due to its capacity to chelate copper ions found in tyrosinase enzymes, which are the principal enzymes accelerating the synthesis of melanin, EA is now authorized as a lightening agent for cosmetic products. The antioxidant EA present in pomegranates is effective in treating UVB-induced hyperpigmentation. The extract taken orally had a comparable whitening effect to L-ascorbic acid (vitamin C), which is a known tyrosinase inhibitor on UV-induced pigmentation, and reduced the number of DOPA-positive melanocytes, whereas L-ascorbic acid did not.

Pomegranate extract also has an anti-ageing effect by reducing wrinkles and improving skin suppleness. PSO may help with striae distensae, a skin disorder characterized by a lack of suppleness. It was tested in an oil-in-water cream containing Croton lechleri resin, which improved dermis thickness, hydration, and elasticity. Pomegranate extract, donkey milk, and UV filters were used to create another topical oil-in-water emulsion. In addition to reducing brown pigmentation, the emulsion showed anti-ageing effects on the skin, including a 32.9 per cent drop in wrinkle count, a 9.6 per cent decrease in wrinkle length, and a 9.6 per cent improvement in skin firmness and elasticity. This shows that the benefits are related to the formulation's constituents' synergistic efficacy. Pomegranate EA, in particular, can prevent UVB-induced thickening of the dermis, a process that can lead to skin wrinkling.

CONCLUSION

Pomegranate peel proved to be a rich source of polyphenols which includes bioactive compounds such as punicalagin, which is a major contributor to the potent antioxidant activity of the peel, punicalin, ellagitannin, gallic acid catechin. All these compounds are found to have antibacterial, antiviral, antioxidant, and antidiabetic activities. Pomegranate peel can serve to develop novel drugs from natural compounds. The present data shows that pomegranate peel could be a promising drug candidate for treating various diseases/disorders, including cancer, diabetes, cardiovascular diseases, skin-health issues, etc. Therefore, the peel can be used as a multifunctional ingredient and a rich source of nutraceuticals. Furthermore, cost-effective approaches are needed for extracting nutritional and bioactive components from pomegranate biowaste and larger-scale investigations. These actions will improve our understanding of pomegranate waste disposal procedures but will also boost skin health and food science studies.

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