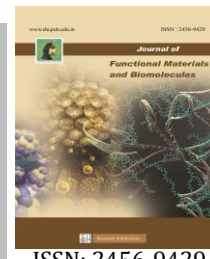




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A NOVEL TRENDS ON ETHNOMEDICINAL AND INDUSTRIAL USES OF POMEGRANATE PEEL

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Abstract

The pomegranate is an old plant that is now grown all over the world. For thousands of years, it has been utilized as a traditional medicine and a culinary remedy in the Middle East. Although pomegranate peel makes up around 50% of the entire fruit, it was once thought of as trash. Due to their bioactive components, these peels provide a number of functional and nutraceutical benefits, such as lowering blood pressure, reducing oxidative stress, lowering cholesterol, and restoring heart health. Pomegranate peels are utilized as an addition in a range of food applications that exhibit a variety of biological impacts, including the ability to efficiently resist pathogenic bacteria. The current review concentrates on the nutritional and useful qualities of the peel, as well as their roles as additives to food and health advantages.

Keywords: Bioactive compounds, CPSO, Pomegranate peels, industrial uses, MCF-7, and SKOV3.

1. Introduction

The pomegranate, or *Punica granatum* L., is a fruit crop with great agro-climatic adaptability. It is a Punicaceae family member and a tiny tree or shrub that bears fruit. Iranians are the original cultivators of the pomegranate fruit, which is mostly grown in Tunisia, Turkey, Spain, Egypt, Morocco, the USA, China, India, Argentina, Israel, and South Africa [1]. The pomegranate tree is regarded as a medical plant, and the fruit is more popularly referred to as nature's power fruit and is renowned throughout the world for its delicious flavor and superior health advantages [2]. Pomegranate production and consumption have rapidly expanded as people's understanding of the fruit's exceptional therapeutic benefits has grown [3]. It is an antioxidant-rich fruit with a variety of significant bioactive phenolic components that are recognized to have positive effects on health. It is a grenade-shaped fruit consisting of numerous deep red color juice-containing arils enclosed in a glossy and leathery pericarp (peel) crowned with a persistent calyx. This fruit can be consumed fresh (raw or as juice) or as beverages along with other food products (jams and jellies). The health benefits of pomegranate fruit are not only limited to the edible part (arils) but also to the non-edible parts (mainly the peel) that contain more biologically active compounds than the edible part [4]. It has also been widely accepted

that pomegranate fruit as well as its extracts are safe for utilization from a toxicological viewpoint.

The interest in pomegranates as a functional food with considerable health-promoting effects was sparked by the presence of significant amounts of chemicals such as polyphenols, which are tannins, and anthocyanins [5]. Numerous studies have been done on the biochemical characteristics of these components in the literature [6]. According to research, phenolic compounds from pomegranate juice and the pericarp greatly slowed down lipid oxidation, which results in the development of off-flavors and, ultimately, a reduction in the nutritious value of food. Additionally, it has been shown that the phenolic chemicals in pomegranate juice, seeds, and pericarp have potent antioxidant effects. Pomegranate peel (PoP) and many other fruits and dried fruits contain tannins, including ellagic & gallic acid [7]. Numerous studies have shown that the pomegranate plant's various parts are abundant in bioactive micro-constituents and phytochemicals, and can be used to obtain several products such as jellies, juice, and beverages [8]. However, pomegranate peel is commonly discarded by the food industry without any valorization process. Peel itself represents approximately 50% of fruit weight and is reported to contain stronger antioxidant activity compared to juice (Figure 1).

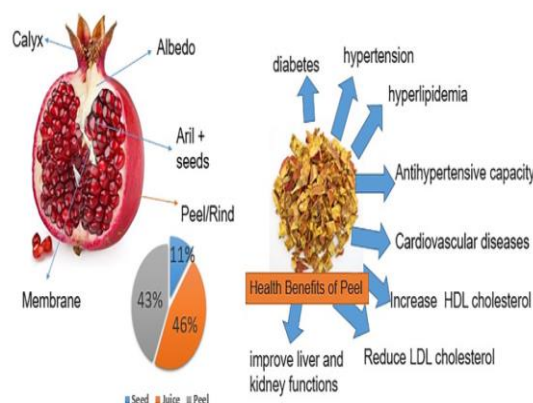


Figure 1: Pomegranate Fruit and therapeutic benefits

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In addition, ellagic acid, punicalagin, and urolithin A found in pomegranate have powerful antioxidant activities, which decrease oxidative or inflammatory stress, increase the protective signaling phenomena, and inhibit lipase, α -glucosidase, and dipeptidyl peptidase-4 in a dose-dependent manner [9]. Similarly, cold-pressed pomegranate seed oil (CPSO) exhibits preventing lipoxygenase and cyclooxygenase activities in vitro. Cyclooxygenase is a key enzyme that conveys the conversion of arachidonic acid to prostaglandin. CPSO prevented 37% activity of lipoxygenase and catalyzed the conversion of arachidonic acid to leukotrienes [10]. Based on in vivo studies on breast cancer, pomegranate seed oil acts as an inhibitor of the biosynthesis of active estrogen (17- β -estradiol) which is catalyzed by 17 β -hydroxysteroid dehydrogenases.

In addition, pomegranate seed oil prevents the invasion of cancer cells and attenuates apoptosis [11]. Some other recent investigations showed that there is a growing interest in the application of fruit by-products to be used in food or feed. For example, pomegranate by-products added in poultry feeding up to 2% supplementation were associated with improved feed efficiency up to 12% in broilers [12].

1.1 Elements in Pomegranate

Muhammad Rahim et al. reported heavy metals like Cr, Co, Ni, Cd, and Pb in pomegranate, Khyber Pakhtunkhwa, Pakistan. The average concentration was 0.0750 mg/kg, 0.0095 mg/kg, 0.0538 mg/kg, 0.0083 mg/kg, and 0.0830 mg/kg respectively. The overall result was below the WHO permissible limit. Another study conducted in India on heavy metals in pomegranate indicated 22.4 μ g/g of Cr, and 82.2 μ g/g of Cu while Cd was indicated as absent. The levels of both Cr and Cu have crossed the permissible limit (2.3 μ g/g) and (40 μ g/g), respectively, given by WHO. A research study conducted in Iraq reported 100ppm of Cr, 57ppm of Cu, 28ppm of Pb, and 0.12ppm of Cd. Chromium was reported to be in the range of permissible limits of WHO/FAO (1984). The lead source is fuel incinerators and solid industries waste. If this lead is inhaled, it is mixed with blood and decreases the hemoglobin in the blood. Also, lead may cause kidney, immune problems etc. even it can become the cause of coma increment and death. At the same time, the source of copper is the dissolved salts of copper. It is very toxic and seriously influences the respiratory system [13-14].

2. Ethnomedicinal Uses of Pomegranate Peel

2.1 Type-II Diabetes

Diabetes is possibly the main pandemic-persistent metabolic sickness on the planet [15]. Diabetes is sometimes characterized by hyperglycemia that ends up in disorders of carbohydrate, lipid, and macromolecule metabolism. The antioxidant-rich PoPs and seeds have antecedently shown protection against diseases regarding aerophilous stress, together with diabetes [16].

The anti-diabetic impact of the active ingredient of PoP is closely related to the inhibition of α -glucosidase and the

increase of aldohexose absorption. The active ingredients in PoP have also been shown to cut back polygenic disorder-related cardiomyopathy by inhibiting beta-lipoprotein oxidation. The acetate fraction (F5) within the crude alcohol extract of PoP has innovative inhibitor and antidiabetic activities that are equivalent/better than the quality used. It is used as a nutritional health product for the interference and treatment of a pair of diabetes and its connected complications [17].

2.2 Alzheimer's disease

The disease might be a reformist neurodegenerative problem and hence the most overarching assortment of derangements described by a reformist decrease in memory, conduct, and mental component capacities inside the matured populace. It influences people and has become a critical clinical and social weight in nonindustrial nations. It is accepted that Alzheimer's is a complex multifactorial sickness, and there are no successful restorative specialists to moderate or forestall the improvement of the infection [18].

Alzheimer's sickness might be a persistent illness that has not been treated until late. Momentum treatment strategies downsize sickness movement, are costly, rarely cause aspect impacts, and are poorly designed for the patients [19]. In Alzheimer's infection, oxidative pressure is fundamental literature. The concentrates from the shell showed more significant levels of phenols related to cell reinforcements, which is why they were picked as likely inhibitors of acetylcholinesterase, which might be a key impetus worried inside the advancement of Alzheimer's disease. The engineered sap compounds in the pomegranate strip show a harsh effect on acetylcholinesterase, which relies on the grouping of phenol [20].

2.3 Oral cavities

Get the first profit from pomegranate peel because agricultural waste is tooth glue framed from peel squander, financial and ecological insurance. PoP is a rich wellspring of polyphenols, including penicillin, punicalagin, and ellagic corrosive, yet it is viewed as rural waste. Reports indicate that pomegranate-determined items have various medical advantages, including antibacterial properties [21]. Pomegranate has significant utilization in the field of dental well-being. Clinical reports have affirmed that this current cancer prevention agent is dissolving the underlying driver of tooth rot with its force at the biochemical level. The extract is a promising strategy for the treatment of oral thrush. Because of its viability, oral thrush tends to be used as a characteristic substitute (Table 1). Pomegranate can hinder *Streptococcus mutans* because of its tannic corrosive antimicrobial properties so it could be a potential enemy of caries specialists. It can keep different microorganisms from clinging to the oral hole [22].

Table 1: Composition of polyphenol compounds and total phenol of pomegranate peel extract

Polyphenolic compounds (mg/g)	Source: Ibrahim (2010)	Source: Gullón et al. (2020)
Punicalagin	296	–
Delphinidin	34	–
Cinnamic acid	42	2.5
Punicalin	15	–
Pelargonidin	21	–
Coumaric acid	32	0.91
Ellagic acid	18	12.56
Quercetin	40	–
Ferulic acid	28	–
Gallic acid	71	2.5
Kaempferol	62	–
Sinapic acid	17	–
Cyanidin	26	–
Luteolin	33	–
Caffeic acid	11	–
Chlorogenic acid	–	1.56
Total phenolic compounds	867 mg/g	mg/g

2.4 Human cancer cells

As indicated by reports, the work of peel has been hostile to tumor impacts, along with the annihilation of tumor cell expansion, cell cycle, intrusion, and angiogenesis. Pomegranate strip separation has appeared to moderate cell expansion in different neoplastic cell lines. Pomegranate strip affects the extension of carcinoma cells of arranged subatomic subtypes. The counter-proliferative properties of pomegranate strip extricate are outlined in shifted human malignancy cells (human non-little cell carcinoma A549, human PC-3 glandular disease cells, SKOV3 testicle malignant growth cells, and SKOV3 malignant growth cells).

Carcinoma (MCF-7) It has been discovered that MCF-7 bosom adenocarcinoma cells are the preeminent touch. The counter-estrogen movement of polyphenols and flavonoids in pomegranate strips can meddle with aromatase action by disturbing the estrogen blend, which may be found in cells with six chemical receptors (e.g., MCF-7 and SKOV3).

Its capacities as a development factor. Although SKOV3 female inside regenerative organ malignancy is not estrogen-reliant, as opposed to elective steroid-and

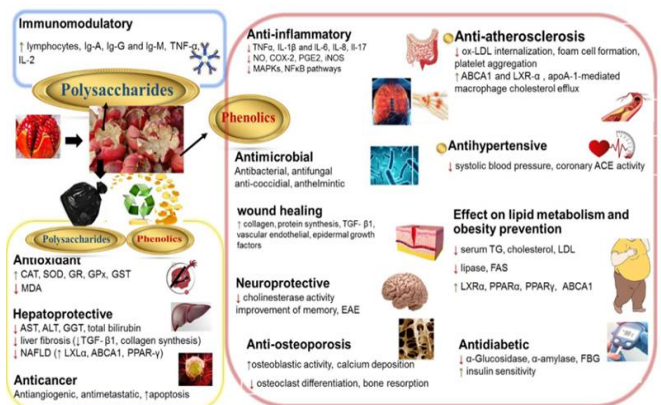


Figure 2: Pomegranate peel health benefits with the underlying mechanisms

androgen-touchy disease cells, these cells are less delicate to the antiproliferative movement of pomegranate strip removal (Figure 2). Furthermore, the counter-proliferative effect of pomegranate strip separation seems, by all accounts, to be tumor-explicit because chemical ward malignancy cells are horrendously touchy to the counter-tumor impacts of those concentrates [23].

3. Industrial uses of Pomegranate Peel

It is possible to take advantage of pomegranate by-products, as they are a rich source of bioactive compounds such as flavonoids, antioxidants, phenols, polyphenols, and anthocyanins. It is facial scrub and exfoliating while also containing sun-blocking agents that offer protection from the sun's harmful UV rays. Therefore, there is a need to highlight all the wastes related to the food and food industry so that awareness can be created among the public and their utilization can be improved.

3.1 Animal feed

It is an abundant source of ellagitannins (antioxidants); therefore, it is used to prevent and reduce farm animal diseases and improve meat products, creating a pretty part of animal feed. Recent studies have additionally shown that increasing the antioxidant content of the beef diet will facilitate the cleaning of the pomegranate. Industrial waste potable can be recycled using tannins; therefore, the remaining by-products (such as solid waste on the skin) can be produced as feed additives at a low-cost price. These additives are rich in helpful nutrients. Pomegranate by-products have a high value as feed. For recent skin, this study clearly shows that consumption positively influences the expansion of calves and the accumulation of R-tocopherol within the plasma. Nutrients are directly concerned with the inhibitor system. However, this does not mean that adding them to the diet will improve animal health. However, whenever used legally, the bioavailability of minerals, nutrients, and polyphenols in new and kept extract could have a supportive preventive impact. The selected peel affects the daily nutrient intake throughout the Karadi Lamb digestion test. Compared with alternative treatments, the typical biological process worth of lambs

fed with 1% PoP was increased to the lower phenol content in lambs fed with 1% PoP [24].

3.2 Meat industry

Owing to the antimicrobial and antifungal properties of PoP can be used as an effective and natural option for synthetic preservative agents to preserve the quality of food during storage. As poultry items are prone to lipid and protein oxidation and are perishable, the industry is in constant search of synthetic-free additives that help in retarding the oxidation process, leading to the development of healthier and shelf-stable products. The peel extract is a superb variety of artificial antioxidants. PoP extract inhibits the lipid chemical reaction and also the decomposition of meat pigments, serving to prevent rancidity and stabilize the flesh color of meat and meat product and their shelf life and improve the quality and functional characteristics. It is a good antioxidant that will enhance the alpha-tocopherol content of broilers because adding 200 and 300 mg/kg of PoP extract to the diet can increase the antioxidant potential and assess the breast muscle quality of broilers [25].

3.3 Cookies

Adding Pomegranate peel of biscuits will improve the organic process worth of the product. It has been found that adding PoP to flour can extend the period of cookies to realize high inhibitor potential. Similarly, in cookies with additives, the content of calcium, potassium, iron, and atomic number 30 also magnified significantly. In this exploration, a fresh plastic new fixing material made of extra organic product squash was created to typify pomegranate strip removal. Furthermore, the unrefined concentrate showed the best expansion in shading boundaries all through capacity, while the inhibitor movement inside the braced treats was kept at a significant level. All through the entire stockpiling time, the degree of the executives' treatment has been extensively improved. Different treats are frightfully steady regarding oil oxidation. As a food additive, PoP extract can improve the quality and taste of food and the sensory properties of cookies [26].

3.4 Bakery products

The utilization of dried powder improves the dietary and medical advantages of biscuits because the substance of β -carotene, fiber, and polyphenols in dried PoP powder is higher, which changes the surface, rheology, and tangible properties of the biscuits. The powder is a decent wellspring of naturally dynamic food fixings, yet its monetary worth is little, and it has been used to make biscuits. The expansion of PoP powder brought about a critical expansion in the aggregate and insoluble fiber, Mg, Ca, K, total phenols, and all-out cancer prevention agent action in the biscuits.

4. Conclusion

Pomegranate peel recycling not only overcomes its bio-waste problems but also provides a valuable source of

ethnomedical uses, with several health benefits additionally, they are involved in industrial applications. PoP is an economic source of bioactive phenolic compounds having immense possibilities for future investigations related to their utilization as recovery. They can be applied to animal feed to improve feed efficiency. The application of PoP has a promising result as an antioxidant in the food industry. They prevent diabetes, especially breast cancer, Alzheimer's disease, and cardiovascular diseases. Punicalagin and ellagic acid in PoP have chemopreventive effects against prostate cancer, breast cancer, and colon cancer, partly associated with the ellagic acid-derived metabolite urolithin. In the case of industry, peel has shown great results by enhancing food products' nutritional properties, taste, texture, flavor, and shelf life. Conclusively, pomegranate peel has much promise for health benefits and various industrial uses, its stability, research into new formulations, and enhanced delivery systems.

Conflict of Interest

The authors declare that there is no conflict of interest

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