



A Comprehensive Review on Antimicrobial Properties of Pomegranate (Punica Granatum L.)

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ABSTRACT

Plants have been in use for thousands of years to conserve food and treat health diseases. Many herb and spice extracts contained high levels of phenolics and exhibited antibacterial activity against bacteria. Gram-positive bacteria were generally more sensitive to the tested extracts than Gram-negative ones. Pomegranate (*Punica granatum L.*) is native to the region from northern India to Iran but it is also widely cultivated now in parts of Southwest America, Mexico and Africa. Pharmacological effects of pomegranate represent a long history and have been mentioned in the Greek and Egyptian documents. The pericarp (peels) of *Punica granatum* has been commonly employed as a crude drug in Indian traditional medicine for treatment of diarrhea as well as for use as an anthelmintic, diuretic, stomachic, cardiogenic. The increasing antibiotic resistance of some pathogens that are associated with foodborne illness is another concern. This review suggested consumption or using tannin-containing fruits especially Pomegranate, could cure or prevent various illnesses by mentioned effects of side effects.

Keywords: Antibacterial activity, Phenolic component, Pomegranate, Tannins.

ARTICLE INFO

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Article History

Received : 22 Mar 2019
Revised : 31 Mar 2019
Accepted : 12 April 2019
Published : 29 June 2019

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Citation: *Bhimana Sasidhar, et al. A Comprehensive Review on Antimicrobial Properties of Pomegranate (Punica Granatum L.). W. J. Pharm. Biotech., 2019, 6(1): 01-05.*

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1. Introduction

An antimicrobial is a substance that kills or inhibits the growth of micro-organisms such as bacteria, fungi, protozoans, etc. On the basis of mode of action, antimicrobials are classified into two broad categories as Microbicidal that kill microbes without leaving any option for their survival and Microbistatic that cease all the metabolic activities of microbes that are important for their survival so they are called as growth inhibitors of microbes. The history of antimicrobials begins with the observation of

Pasteur and Joubert who discovered that one type of microbe could prevent the growth of other. That growth inhibition was due to secretion of a compound that later got called as Antibiotic. Nowadays the term antibiotics is not confined to secretions of microbes only but also includes all those synthetic drugs that help body to get rid of any bacterial infection. The discovery of antimicrobials like Penicillin and Tetracycline paved way for better health of people in the world by curing diseases like Gonorrhea,

Strep throat and Pneumonia.[1] In ancient Greek mythology, pomegranates are known as the “fruit of the dead”, the substances available in Hades for its residents. Hades himself, the master, benefitted amorously when six pomegranate seeds from his realm sealed for him the betrothal of the beautiful daughter of Zeus and Demeter, fair Persephone.

The Babylonians regarded the seeds as an agent of resurrection. The Persians as conferring invincibility on the battle field and for ancient Chinese alchemical adepts, the bright red juice was mythopoeically regarded as a “soul concentrate”, homologous to human blood and capable of conferring on a person longevity or even immortality. Fruits are one of the oldest forms of food known to man. There are many references to fruits in ancient literature. Vedas state that fruits form the base of the Food of Gods. According to Qur’an, the fruits like grapes, date, fig, olive and pomegranate are gifts and heavenly fruits of God. The people in ancient times regarded fruits to be endowed with magic or divine properties. The pomegranate is an ancient fruit that has not changed much throughout the history of man. It was found in the Indus Valley so early that there is a word in Sanskrit for pomegranate. The pomegranate is also significant in Jewish, Christian and Muslim tradition. The pomegranate is native of Iran and Afghanistan known in ancient Egypt. Pomegranate belongs to Punicaceae family. It is one of the important horticulture fruit to the Mediterranean climate. The edible part of fruit contains considerable saccharides, polyphenol and important minerals. The physical and chemical properties of pomegranate have been evaluated in Turkey, Italy etc. The major class of pomegranate phytochemicals is the polyphenols that predominate in the fruit. Pomegranate polyphenols include flavonoids, condensed tannins and hydrolysed tannins. Hydrolyzable tannins (HTs) are found in the peels (rind, husk or pericarp), membranes and piths of the fruit. HTs are predominant polyphenols found in pomegranate juice and accounts for 92% of its antioxidant activity. [2]

Why Herbal Antimicrobials

The widespread use of commercially available antimicrobials led to the consequence of emergence of antimicrobial resistant pathogens that ultimately led to the threat to global public health. Since 1980 the introduction of new antimicrobials has declined due to the huge expense of developing and testing new drugs. All commercially available antibiotics with prolonged use may have negative effect on human health because they kill gut flora, so human beings need to take probiotics to replace the killed gut flora. All the above points make a clear way for herbal antimicrobials. The use of plants for treating diseases is as old as the human civilization. There are many plants which have been in use as traditional medicine, so they are called as medicinal plants. The use of plants for curing diseases was inevitable as is already proven by seeing the problems associated with synthetic antibiotics. Peels of some plants as *Punica granatum* (having antibacterial properties) which are generally treated as wastes are true antibiotics as they are available for no cost, have no side effects and the most

important benefit is that antibiotic resistant pathogens will be easily killed by these new and natural antimicrobials because they will take at least a few decades to get mutated and resistant to them.[3]

***Punica granatum*:**

Punica granatum Linn. (Pomegranate) is a member of family Punicaceae, is an ancient, beloved plant and fruit. Pomegranates are native to central Asia, but since the pomegranate tree is highly adaptive to a wide range of climates and soil conditions, it is grown in many different geographical regions including the Mediterranean basin, Asia, and California. Recent scientific findings corroborate traditional usage of the pomegranate as a medical remedy and indicate that pomegranate tissues of the fruit, flowers, bark and leaves contain bioactive phytochemicals that are antimicrobial, reduce blood pressure, and act against serious diseases such as diabetes and cancer. The fruits of *Punica granatum* (pomegranate) have been used to treat acidosis, dysentery, microbial infections, diarrhoea, helminthiasis, haemorrhage and respiratory pathologies.[4] These findings have led to a higher awareness of the public to the benefits of the pomegranate fruit and consequently to a prominent increase in the consumption of its fruit and juice. The widespread use of commercially available antimicrobials led to the consequence of emergence of antimicrobial resistant pathogens that ultimately led to the threat to global public health. Since 1980 the introduction of new antimicrobials has declined due to the huge expense of developing and testing new drugs. All commercially available antibiotics with prolonged use may have negative effect on human health because they kill gut flora, so human beings need to take probiotics to replace the killed gut flora.[5]

2. Chemistry of Phenolic components(Tannins)

Polyphenols components are found in all fruits and vegetables and play a major role in their color, flavor, texture as well as antioxidant[6] and antibacterial activities.[7] Phenolic compounds can denature enzymes[8] but they can also bind to substrates such as minerals, vitamins and carbohydrates making them unavailable for microorganisms.[9] Furthermore, phenols can be absorbed to the cell wall, resulting in a disruption of the membrane structure and function.[10] Tannins are high molecular weight phenolic compounds which are present in many plants, including pomegranate (*Punica granatum*.) fruit pericarp (peels). Tannins are water-soluble polyphenolic polymers of relatively high molecular weight and have capacity to form complexes mainly with proteins, to a lesser extent with carbohydrates due to the presence of a large number of phenolic hydroxyl groups. Tannins are usually divided into two major groups: Hydrolysable tannins (HTs) and Condensed tannins (CTs).[11]

Kinds of Tannin:

Hydrolyzable are gallic or ellagic acid esters of sugars. When they are consumed by human and ruminants, they can be degraded into gallic acid and be absorbed in the digestive tract.[12] Because they are readily absorbed, they have been considered responsible for causing toxic effects in herbivores. Condensed tannins are polyphenols of higher

molecular weight and consist mainly of oligomers or polymers of catechin (flavan-3-ols). When CTs get depolymerized, they produce mainly cyanidin or delphinidin and therefore have been further classified as procyanidins or prodelphinidins. Only a low degree of absorption of CTs by the digestive tract of herbivores has been reported. One of their most important chemical properties is the ability to form soluble and insoluble complexes with macromolecules, such as protein, fiber and starch. The affinity of CT for proteins is determined by the molecular mass and the molecular configuration of both the tannin and the protein. Tannin–protein binding is usually reversible: acid or alkaline pH, treatment with detergents (surfactants) or phenol or other organic solvents can result in the disassociation of the complexes. Condensed tannins have a particular affinity for proline-rich proteins such as gelatin, prolamine and proteins from seed coats.[13] Proline-rich proteins are also produced in the saliva of certain mammals (such as rat, mouse, goat and deer).

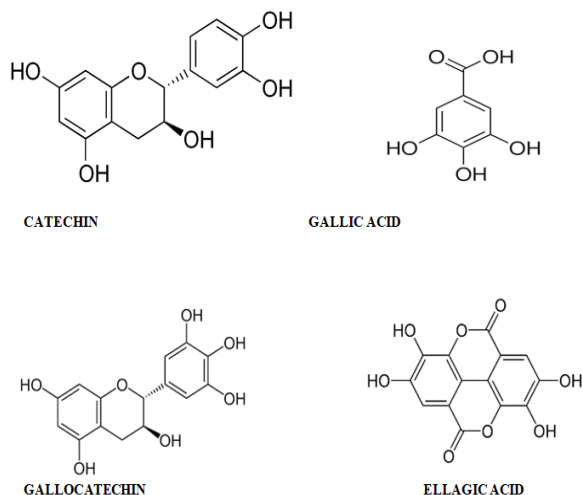


Figure 1

Table 1: Phytochemicals of Pomegranate

Plant Component	Constituents
Pomegranate Juice	Anthocyanins, Glucose, Ascorbic acid, Ellagic acid, Gallic acid, Caffeic acid; Catechin, EGCG, quercetin, Rutin; numerous minerals, particularly iron; amino acids.
Pomegranate seed oil	95-percent punicalic acid; other constituents, including ellagic acid; other fatty acids; sterols.
Pomegranate pericarp (Peel, rind)	Phenolic punicalagins; gallic acid and other fatty acids; catechin; EGCG; quercetin, rutin and other flavonols; flavones, flavonones; anthocyanidins.
Pomegranate leaves	Tannins (punicalin and punicalofolin); including luteolin and apigenin
Pomegranate flowers	Gallic acid, ursolic acid; triterpenoids, including maslinic and Asiatic acid; other unidentified

	constituents
Pomegranate roots and bark	Ellagitannins, including punicalin and punicalagin; numerous piperidine alkaloids

3. Benefits of Pomegranate

Pomegranate and Functional properties:

The primary phytochemicals in pomegranates are the polyphenols, including anthocyanin (ACN) pigments, flavonol glycosides, procyanidins, phenolic acids and ellagic acid derivatives. Due to their antioxidant properties, phenolic compounds including ACNs are thought to have preventive roles in a number of chronic diseases such as cardiovascular disease and cancers.[14] The primary antioxidative phenolics in pomegranate are punicalagins, followed by HTs, ACNs and ellagic acids. An attractive red color is the most important quality criteria for fruit juices containing anthocyanin, including pomegranate. ACNs are also responsible for the orange, red and blue colors of many fruits and vegetables. Unfortunately, ACNs are unstable and susceptible to degradation, leading to a brownish color during processing and storage. The primary color deterioration in fruit juices containing ACNs occurs as a result of the degradation of monomeric ACNs, polymerisation of ACNs and the subsequent formation of brown color. These color changes strongly affect consumer behavior and result in a loss of marketability of processed pomegranate products. Various factors affect the stability of ACNs, including the temperature of processing and storage, the chemical nature of ACNs (acylation or glucosylation), pH, ascorbic acid, hydrogen peroxide, sugars, light and metals. Clarification and pasteurization during the production of fruit juices also affect the stability of ACNs.

Antimicrobial Properties:

The use of chemical or synthetic agents with antimicrobial activity (as inhibitors, growth reducers or even inactivators) is one of the oldest techniques for controlling microorganism growth. The application of preservatives to foods is fundamental if their safety is to be maintained. Natural antimicrobials, whether of microbial, animal, or plant origin, which show bacteriostatic/fungistatic or bactericidal/fungicidal activity lengthen the useful life of foods and prevent, among other things, health-related problems, off-odors, unpleasant tastes, textural problems, or changes in color, which are basically caused by the enzymatic or metabolic systems of the principal microorganisms that lead to the alteration of foods. Alcohol extracts of pomegranate fruits showed antibacterial activity when tested against *S. aureus*, *E. coli* and *Shigella dysenteriae*. The extracts from pomegranate fruits possess in vitro antibacterial activity against many bacteria tested (*E. coli*, *Enterobacter cloacae*, *P. fluorescens*, *Proteus vulgaris*, *Alcaligenes faecalis*, *Serratia marcescens*, *E. aerogenes*, *S. aureus*, *Arthrobacter globiformis*, *M. luteus*, *B. cereus*, *B. subtilis*, *B. coagulans*, *Micrococcus roseus*, *M. phlei*, *M. rodochrous*, *M. Punicalagin* isolated from the fruit peel of pomegranate was reported to have antimicrobial activity against *Candida albicans*. Fungistatic activity of pomegranate peel varied with test organisms as it inhibited the growth of *Penicillium citrinum* for 8 days, *P. patulum*

for 4 days and *P. roquefortii* and *Aspergillusochraceous* for 3 days. Generally, antimicrobials have different concentration inhibition or inactivation thresholds. These thresholds depend on the specific targets of the antimicrobial substance, including cell wall, cell membrane, metabolic enzymes, protein synthesis, and genetic systems. The exact mechanism or target for food antimicrobials are

often not known or well defined. It is difficult to identify a specific action site where many interacting reactions take place simultaneously. For example, membrane-disrupting compounds could cause leakage of cellular content, interference with active transport of metabolic enzymes, or dissipation of cellular energy in ATP form.[15]

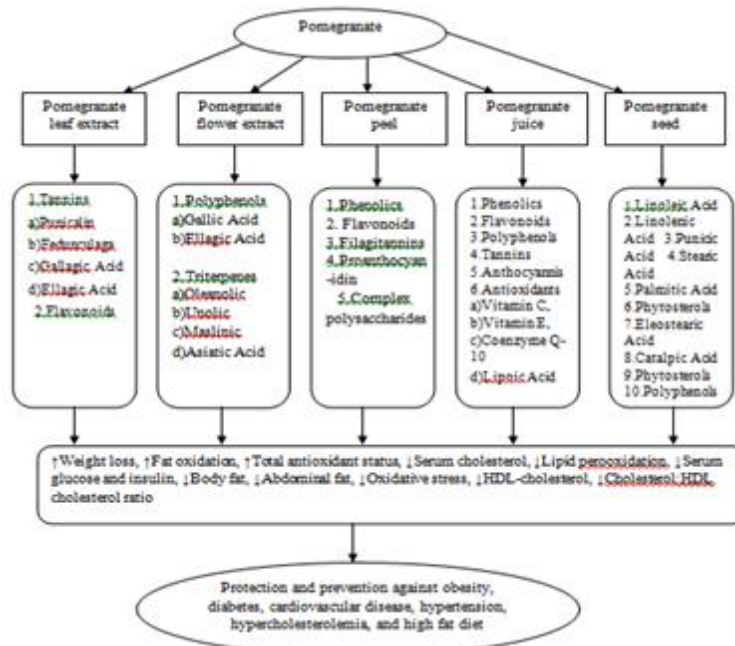


Fig 2: Other Benefits of Pomegranate

3. Conclusion

The pericarp (peels) of *Punica granatum* has been commonly employed as a crude drug in Indian traditional medicine for treatment of diarrhea as well as for use as an anti-helminthic, diuretic, stomachic, cardiogenic. The increasing antibiotic resistance of some pathogens that are associated with foodborne illness is another concern. This review suggested consumption or using tannin-containing fruits especially Pomegranate, could cure or prevent various illnesses by mentioned effects of side effects.

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