



## Nutritive Value and Biological Properties of Indian Plant *Punica granatum* – A Perspective Review

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### ABSTRACT

This review is based on the anti-bacterial, anti-fungal, anti-cancer, antioxidant, anti-diarrheal activity of *Punica granatum*. It includes the complete summary of the ability of the various extracts of pomegranate peel, juice, leaf against bacterial infection, fungal infection, cancer cells, inflammation, and diarrhea. Pomegranate's anti-obesity activity is also discussed. The phytochemical components present in *Punica* are responsible for the various properties and activities. Its role against atherosclerosis, diabetes, hypoxia ischemia is also focused in this review.

**Keywords:** *Punica granatum*; Alzheimer's disease; hypoxia-ischemia; Atherosclerosis.

### INTRODUCTION

The globally cultivated pomegranate is also known as Anar. It is a deciduous shrub or tree of 5-8 meter in height. The leaves are evergreen (Fig.1) hence it is grown for its fruit as well as ornamental plant. It belongs to the family lythricea, also known as punicae. It is of two species namely punica protopunica and *Punica granatum*. The genus *punicae* is native to Persia. The plant can survive dry environment hence cultivated in other countries namely California, Arizona and also cultivated in Iraq, India etc.



Figure 1: Leaves of *Punica granatum*



Figure 2: Fruit of *Punica granatum*



Figure 3: Seed of *Punica granatum*

The fruit (fig.2) is covered by a leather pericarp within which contains numerous arils and each seed is surrounded by a sack filled with juice. The membrane which are thin, acid tasting extends into the inner portion of the fruit from the pericarp thus it looks like a lattice work in which the arils are suspended.

The fruit has three parts namely seeds (fig.3) (3% of total fruit weight), oil (20% of weight) and juice (30% of weight) and rest is contributed by the pericarp. Apart from fruit leaves stem bark root are useful<sup>1</sup>.

Medicinal plants are resource of new drugs. Studying medicinal plants helps to understand plant toxicity and protect human and animals from natural poisons. Green plants synthesis and preserve a variety of biochemical products, many of which can be extracted and used as medicines.<sup>2</sup>

In this review, the various composition of *punica granatum* and its various properties such as antibacterial, antifungal, anticancer, antioxidant, antidiarrheal, anti-inflammatory activities are discussed.

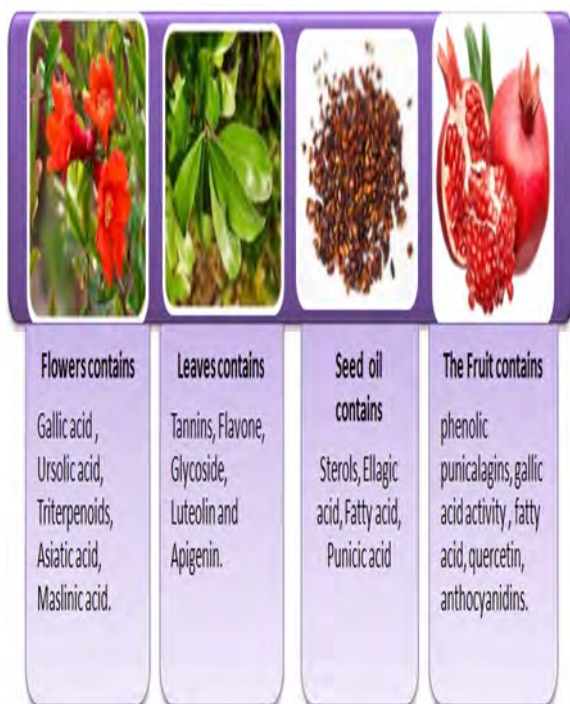
Pomegranate leaf extract (PLE) show the immense effect and thus the pomegranate leaf, peel ,fruit, seed etc., has a significant role in medical field.

## Phytochemical Constituents

According to the literature, ellagic acid, flavonoids, anthocyanin,  $\beta$ -carotene, phenolic compounds, phosphorus, calcium, Punic acid are present in pomegranate. There is a clear evidence to show that pomegranate is rich in lipids, protein (in seed portion), Carbohydrates, ascorbic acid. Apart from that zinc, magnesium, sodium is also present. In the peel hydrolysable tannins are found. Gallic acid, citric acid, chlorogenic acid. The Table 1 shows the concentration of various components present in pomegranate<sup>3</sup>.

**Table 1:** Concentration of various components present in *Punica granatum*

| COMPONENTS    | CONCENTRATION  |
|---------------|----------------|
| MOISTURE      | 78%            |
| FAT           | 0.1%           |
| MINERALS      | 0.7%           |
| FIBRE         | 5.1%           |
| CARBOHYDRATES | 100%           |
| PROTEIN       | 1.6%           |
| VITAMIN C     | 16mg           |
| VITAMIN B     | Trace elements |
| CALCIUM       | 10mg           |
| PHOSPHORUS    | 70mg           |
| ALKALOIDS     | ++             |
| FLAVANOIDS    | ++             |
| TANNINS       | ++             |
| PHENOLS       | +++            |



**Figure 4:** The importance of plant parts of *Punica granatum* and its constituents



**Figure 5:** Pharmacological properties of *Punica granatum*  
**Pomegranate Plant Parts and its Constituents<sup>4</sup>**

The importance of plant parts of *Punica granatum* and its constituents were represented in fig.4. The Roots and barks contains ellagitannins, punicalin, punicalagin, numerous piperidine, alkaloids. The Flowers contains gallic acid, ursolic acid, triterpenoids, asiatic acid and maslinic acid. The Leaves contains tannins, flavone, glycoside, luteolin and apigenin. The Pericarp contains phenolic punicalagins, gallic acid, fatty acid, quercetin, anthocyanidins. Seed oil contains sterols, ellagic acid, fatty acid, punicic acid and the juice contains anthocyanins, glucose, ascorbic acid, amino acid, iron, minerals, quercetin. Gas phase plasma and pasteurization treatment has an effect on phenolic content in pomegranate juice. It has an effect on phenolic content in pomegranate juice. It was noted that on treatment the total phenolic content was hiked by 29.55% and 33.0% respectively<sup>5</sup>. It was discovered that phellatin or amurensin (isomer), flavanol-glycoside were present in pomegranate juice<sup>6</sup>. Total phenolic and total flavonoid content was determined from pomegranate peel flour. The main component was punicalagin<sup>7</sup>.

Tocopherols and linolenic acid was abundant in pomegranate seed oil. 50% acetone extract was well suited for analyzing phenolics and flavonoids 80% methanolic extract was suitable. Depending upon the cultivars the flavanoid, phenolics, proanthocyanidins, antioxidant property varies<sup>8</sup>. From pomegranate peel, mesocarp and arils 48 different phenolic compounds were identified. It was noted that ellagitannins were present in higher concentration in pomegranate and its derived products<sup>9</sup>.

Three different solvents such as ethanol, aqueous and chloroform was used to prepare pomegranate peel, seeds and whole fruit extracts. From the extracts it was identified that the peel, seeds and fruit of pomegranate contained vitamin C, carbohydrates, tannins, steroids, alkaloids, saponins, glycosides, flavonoids<sup>10</sup>.

### Pharmacological Properties of Pomegranate

The different pharmacological properties of *Punica granatum* were represented in fig.5.

#### Anticancer Property

Different extracts of *punica granatum* were used on cancer cell lines and it showed marked anticancer property and also interface with various cell signals mainly on the pathways namely MTOR, PI3K, BCL etc<sup>7</sup>.

Ellagitannins (ET) in pomegranate juice hydrolyzed into ellagic acid which is further converted to its derivatives. Ellagitannins from pomegranate juice were injected into c57b/6 which is a mild type male mouse and found out that the ET metabolites are present in increased concentration in mouse prostate, intestine tissue, and colon. When the same was administered in SCID (severe combined immunodeficiency) mice which were injected with human CAP cells (LAPC-4) *in vitro*. It was observed that extract inhibited the cell cycle of CAP, thus it may be considered to have anti-cancerous property<sup>11</sup>. Pomegranate cold pressed oil or seed oil, polyphenols from pericarp, polyphenols from fermented juice were used against human prostate cancer cell xenograft growth *in vivo* and *in vitro* experiments were conducted. It was found out that the pomegranate seed oil, pericarp polyphenol had the ability to bring apoptosis and also inhibited cell proliferation<sup>12</sup>.

#### Antimicrobial Activity

*Staphylococcus aureus*, *E. coli*, etc., are few organisms known for causing diseases especially food borne diseases. Different extract of pomegranate fruit peels showed an increased anti-microbial activity. Among various extract methanol extract (80%) showed a high potent of anti-microbial activity. The combined form of pomegranate juice and polyphenols showed activity against infection caused by virus/food borne). Food borne viral surrogates were used to prove the animal activity.

#### Anti-Inflammatory Activity

SPRE (standard pomegranate rind extract) was used to check its anti-inflammatory property by inhibiting the production of nitric oxide (NO) by macrophage CRAW 264.7 cells. It has efficient anti-inflammation property<sup>13</sup>. Experiments were conducted and found out that pomegranate extract contained Urolithins A and ellagitannins related fraction.

In a normal healthy individual, urolithins A acts an anti-inflammatory agent and in the case of colon inflammation ellagitannin related fractions acted as anti-inflammatory agents<sup>14</sup>. Time response reduction in polymorph nuclear leukocyte priming, protein oxidation, inflammation, lipid oxidation were exhibited by pomegranate juice<sup>15</sup>. Granatin B isolated from *Punica granatum linne* can be used as a standard marker for anti inflammatory effect. It can be used as anti pyretic analgesic against inflammation<sup>16</sup>.

### Anti-Obesity Activity

Experiment was conducted using male and female ICR mice. Mice were fed with high fat diet to induce obesity and treated with 400/800 mg/kg/day of pomegranate leaf extract (PLE) for 5 weeks. After 5 weeks, triglycerides, total cholesterol, high density lipoprotein were estimated. With the study it was proved that PCE inhibits obesity and hyperlipidemia. It can be a significant appetite suppressant that has effect obesity occurring to a high fat diet<sup>17</sup>. Experiment was conducted on mice to find out the role of pomegranate extract on atherosclerosis. It was found out that the flavonoids in pomegranate juice significantly decreased the development of lesions caused by atherosclerosis and also gave protection of LDL against oxidation<sup>18</sup>. Pomegranate juice decreases risk factors of cardiovascular disease and prevents atherosclerosis.

#### Anti Diarrheal Activity

Isolated rat ileum, gastrointestinal motility *in vivo* and on castor-oil, induced diarrhea in rats. The results showed that the peel extract of pomegranate has bio-components that showed anti-diarrheal effects and used as medicine for gastrointestinal disorders<sup>19</sup>. Growth of *Entamoeba histolytica* and *E. invadens* was inhibited by alkaloid and tannins obtained from pomegranate roots<sup>20</sup>. *Punica granatum L.* can be used as antihelminthic, astringent, laxative, diuretic, against diarrhea. It is also effective against bacterial strains which cause gastro intestinal tract infections<sup>21</sup>.

#### Antioxidant Activity

Pomegranate peel and seeds extracts were prepared with water, methanol, ethyl acetate. The extracts were used to perform various antioxidant properties such as DPPH,  $\beta$ -carotene-linoleate etc, of which the methanol extract showed increased antioxidant activity. Various experiments were also conducted to establish its effect against lipid peroxidation, hydroxyl radical scavenging activity and LDL oxidation<sup>22</sup>.

To check the antioxidant property, the pomegranate ethanolic hull extract and commercial hull extract sample was used to treat a damaged (peroxidatively) liposomal membrane. It showed a remarkable protection against the liposomal membrane damage. It was also observed that the ethanolic extract of pomegranate seed exhibited low antioxidant property<sup>23</sup>.

Studies were done with athletes. Oxidative stress in the blood of endurance based athletes was the parameter considered. Three group of athletes were selected in which one group were given pomegranate juice, the second group with diluted pomegranate juice which was in the ratio 1:1 with water and third group was the control group which did not consume pomegranate juice. Malondialdehyde, carbonyls, sE selectin, C- reactive proteins were the stress markers of the cell. The experiment was conducted for 21 days. As a result, it was



noticed that the group which consumed pomegranate juice, pomegranate diluted juice had decreased level of malondialdehyde, carbonyls, sE selectin, C-reactive proteins when compared to the control group, thus pomegranate juice can be used to decrease stress in cell and act as antioxidant<sup>24</sup>.

By using LC-PDA-QTOF/MS identified 35 derivatives of ellagic acid and quantified using UPLC-DPA techniques. The antioxidant activity was low in ripe fruits than in thinning fruits. The thinning fruits had higher amount of ellagic acid<sup>25</sup>.

The antioxidant capacity is proportional to the concentration of phenolic compounds in pomegranate<sup>9</sup>. Pomegranate wine which has an abundant phenolic antioxidant property can be consumed with a surfeit of health – nurturing functions<sup>26</sup>. Antioxidants were highest in peels when compared to pomegranate seed. Flowers and leaf also had a considerable amount of antioxidants than seed<sup>27</sup>.

### Role of Pomegranate against Alzheimer's Disease

The experiment was conducted to prove that polyphenols in pomegranate juice has high neuro-protective in model systems. Experiment was conducted on mice and the result suggested that the pomegranate juice presented accumulation of soluble A $\beta$ 42 and amyloid in the hippocampus when compared to control mice. Pomegranate juice decreases amyloid load and improves behavior in a mouse model of Alzheimer's disease<sup>28</sup>.

### Anti Diabetic Property

The ethanolic extract of pomegranate seed and hull were compared with commercial sample in the treatment of diabetes based on the inhibition of aldose reductase. Aldose reductase is an enzyme which plays a major role in the etiology of diabetic complications. The commercial and test hull extract of pomegranate showed a significant role in inhibiting aldose reductase than the ethanol extract of pomegranate seed. Thus it can be used in diabetic treatment<sup>23</sup>. Pomegranate flower (PGF) was used to treat zucker diabetic fatty rats. Experiments were conducted and the gene profiles were analyzed. It was found out that PGF had great significant role in lowering fatty lines and controlling ameliorates diabetics and obesity<sup>29</sup>. Pomegranate seed oil and berberine were given to mice which was affected with diabetes mellitus type II, after the treatment the changes in plasma phospholipid was analyzed<sup>30</sup>.

### Effect against Hypoxia-Ischemia

Insufficient blood supply to all the cells and due to which the normal biological functioning is affected is known as hypoxia-ischemia, the oxygen level is also too low.

Experiments were conducted on neo-natal mouse brain. The polyphenol present in the pomegranate juice was mixed with water and given to its mother mouse bearing the child. Investigations were carried out using neonatal

H.I model and found out that polyphenol in pomegranate juice had more significant role in decreasing brain injury due to neonatal H-I<sup>31</sup>.

### CONCLUSION

The phytochemical components present in the pomegranate leaf, juice, peels etc., are responsible for its various activities. Due to its varied properties such as antibacterial, anticancer etc., pomegranate can be used as medicinal plant. By extracting and isolating biochemical components medicines can be prepared and used for treating various diseases and disorders like atherosclerosis, diabetes etc. It is also proved that pomegranate can be used against hypoxia-ischemia.

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