Active Constituents of Pomegranates (Punica granatum) as Potential Candidates in the Management of Health through Modulation of Biological Activities

Arshad Husain Rahmani, Mohamed Ali Alsahli, Saleh Abdulrahman Almatroodi

ABSTRACT
Pomegranates fruits have innumerable health benefits and its implication in diseases cure have been widely recognized since ancient time. Moreover, pomegranate fruits, seeds and peels are intensively used in traditional medicine as a natural therapy. It contains numerous valuable ingredients such as flavonoids, ellagitannin, punicalagin, ellagic acid, vitamins and minerals. The principal constituents including punicalagins and ellagitannin are responsible for immeasurable health benefits due to its strong antioxidant activity. Additionally, constituents of pomegranate show health promoting effect through the modulation of physiological and biochemical pathways. Recent evidences suggested that pomegranate fruits, peels and seeds illustrate therapeutics implications in health management via inhibition of free radical effect and modulation of enzymes activity linked with diseases development and progression. In this review, we summarize the therapeutic role of pomegranate fruits, seeds and peels in the health managements based on in vitro and in vivo studies.

Key words: Pomegranates, Anti-oxidant, Anti-inflammatory effect, Heptoprotective effect, Neuroprotective effect and anti-microbial effects.

INTRODUCTION
Plants and their products are commonly used in the cure of diseases since ancient time. Recent study demonstrated that medicinal plant shows therapeutic role in disease management through the modulation of biological activities. \(^1,2\) Recent finding based on in vitro and in vivo suggested that pomegranate has health-promoting effects mainly attributed due to its polyphenol content/antioxidant activity.

However, its health promoting effect has also been mentioned in the traditional medicines. Fruits, seeds, peel and leaves of pomegranate contain various types of valuable ingredients and such ingredients show therapeutics role in the disease cure. Pomegranate peel is a rich source of tannins, flavonoids and other phenolic compounds.\(^3\) Its juice also contains various constituents such as polyphenols, tannins, anthocyanins, including vitamin C, vitamin E, and lipoic acid\(^4\) and punicalagin bioactive constituent responsible for more than 50% of the antioxidant activity of pomegranate juice.\(^5\) Pomegranate fruits, peels and seeds have proven its role in diseases cure via modulation of biological activities. Earlier investigators demonstrated that pomegranate extract exhibited scavenging activity against hydroxyl (OH) and superoxide.\(^6\) Consumption of pomegranate extract potently delayed the onset and reduced the incidence of collagen-induced arthritis and severity of arthritis was significantly lower in pomegranate extract fed animals.\(^7\) In this review, we summarize the therapeutic role of pomegranate in the diseases managements based on in vitro and in vivo studies.

Chief Constituents of Pomegranate
Pomegranate fruits hold various types of constituents in different parts such as seeds, peels and arils. Such ingredients show therapeutic role in the health management through the modulation of various biological activities. Peels of the pomegranate covers around 60% of the fruit and they hold various types of ingredients including flavonoids, ellagitannins and proanthocyanidin compounds and minerals such as calcium, magnesium, phosphorus, potassium and sodium.\(^8\)

Pomegranate fruit arils contain huge amounts of organic acids, sugars, minerals, vitamins, and polyphenols that show antioxidant effect.\(^9\) Moreover, flavonoids are chief polyphenols of fruit, condensed tannins and hydrolysable tannins.\(^10,12\) Hydrolyzable tannins including ellagitannins and gallotannins consist of the common constituents present in pomegranate, and punicalagin is the major hydrolyzable tannin present in pomegranates.\(^13,14\) The juice of arils consist of water, sugars such as glucose, sucrose, and fructose,\(^15\) 1.5% pectin, organic acids including citric, malic, tartaric, succinic, fumaric and ascorbic acid.\(^16\) Pills also have hydroxybenzoic
acids such as gallic acid, ellagic acid and EA glycosides. Additionally, seeds hold constituents such as protein, crude fibers, vitamins, minerals, sugars, polyphenols, the phytoestrogen coumestrol estrone.

Pharmacological Activities of Pomegranate Antioxidant Activity

Medicinal plants make their importance in health management through antioxidant activity and inhibition of free radical effects. Antioxidant activities of plants have been proven by earlier studies. Pomegranate shows antioxidant activity due to abundance of compounds such as flavonoids, flavones, anthocyanins and catechins in different parts including fruits, seeds and peels [Table 1]. Experiment was made to explore the antioxidant activity of pomegranate peels and seeds result of the confirmed that extract of peels and extract of seeds showed antioxidant activity. Furthermore, methanol extract of peel demonstrated highest antioxidant activity among all of the tested extracts. Another study revealed that pretreatment of extract of peel followed by treatment of CCL, showed preservation of enzymes including catalase, peroxidase, and SOD. Additionally, lipid peroxidation was brought back by 54% as compared to control. The antioxidant activity of pomegranate peel powder and whey powder was evaluated and results showed that peel powder and whey powder exhibited antioxidant activity. Other previous report demonstrated that leaf and peel exhibited very strong antioxidant activity and extracts obtained from seeds exhibited various degrees of antioxidant activity and sour white peel had the highest potent antioxidant activity.

Anti-Inflammatory and Analgesic Effect

Non-steroidal anti-inflammatory agents are effective in the cure of inflammation. Non-steroidal anti-inflammatory based treatment exhibit adverse effect through the inhibition of arachidonic acid metabolism. However, treatments based on natural products are very effective in the cure of inflammation without any severe adverse effect on the arachidonic acid metabolism and cyclo-oxygenase enzyme activity. Several studies finding confirmed that pomegranate has role in the reduction of inflammation by modulation of various physiological activities [Table 1]. Anti-inflammatory and analgesic activities of of fruit rind, flower, and leaves was measured and it was observed that pretreatment with the dried extracts produced significant and dose dependent inhibition of edema when compared to the control groups. Topical anti-inflammatory and analgesic activities of a standardized pomegranate rind extract of which ellagic acid (EA) was assessed and finding reported that rind extract and the equivalent ellagic acid dose-dependently reduced the ear edema. Furthermore, Both rind extract and ellagic acid showed significant topical analgesic activities in the rat plantar punctate mechanical hyperalgesia test and in the mouse formalin test. Indomethacin-induced gastric injury was not observed in the presence of pomegranate, which also prove role in the protection against ethanol-induced gastric lesions and pomegranate methanolic extract exhibited potent analgesic and anti-inflammatory activity comparable to indomethacin. Wound healing activity of a rind extract and ellagic acid was investigated. Outcome of the study showed both rind extract and its equivalent amount of ellagic acid increased the tensile strength of the incision wound. Pomegranate extract and urothilin-A decreased inflammation markers (iNOS, cycloxygenase-2, PTGES and PGE (2) in colonic mucosa) and modulated favorably the gut microbiota.

Other study finding revealed that pomegranate fruit extract inhibited the IL-1beta-induced proteoglycan breakdown in cartilage explants. In addition, extract also inhibited the IL-1beta-induced phosphorylation of IkappaBalpha and the DNA binding activity of the transcription factor NF-kappaB in OA chondrocytes. Consumption of dietary supplements containing pomegranate extract potently delayed the onset and reduced the incidence of collagen-induced arthritis and severity of arthritis was significantly lower in extract fed animals.

Hepatoprotective Effect

Numerous plants including curcumin, green tea, dates fruits and ginger or plant based formulation shows very effective role in the prevention of liver damage and diseases related to liver. Investigators demonstrated that rats fed on diets supplemented with pomegranate peel powder, whey powder or their mixture showed a potential hepatoprotective effects compared to liver injury control group and feeding of rats with pomegranates powder showed protective effect against carbon tetra chloride toxicity. The effect of chronic administration of pomegranate peel extract on liver fibrosis was examined and results confirmed that plasma AOC and hepatic GSH levels were considerably depressed by bile duct ligation whereas increased back to control levels in the peel extract-treated bile duct ligation group.

Effect on Reproductive System

Several medicinal plants have established their role in reproductive system through the elevation of hormones and maintenance of spermatogenesis. In this concern, pomegranate also shows pivotal role in the elevation of hormones linked to reproductive system [Table 2]. Study results revealed that pomegranate juice showed elevation in testosterone, luteinizing hormone and follicle stimulating hormone depleted after the injection of carbon tetra chloride (CCL4). Moreover, result also demonstrated that degeneration of germ and Leydig cells along with deformities in spermatogenesis due to the CCL4 injections were restored with the treatment of pomegranate juice. Another finding confirmed that extract and ascorbic acid administration reduced the deleterious effect of lead acetate on daily sperm production and epididymal sperm number. Experiment was made to examine the effects of pomegranate juice consumption on sperm quality, spermatogenic cell density. Outcome of the study confirmed that juice consumption showed increase in epididymal sperm concentration, sperm motility and spermatogenic cell density. Long-term pomegranate juice intake increased intracavernous blood flow, improved erectile response and smooth muscle relaxation in erectile dysfunction.

Anti-Diabetic Activity

A range of studies evidences that medicinal plants or constituents of medicinal plants show role in the management of diabetes and its complication including Diabetic retinopathy. Ethanolic extract of leaves showed noteworthy antidiabetic activity and it is also found to be highly effective in managing the complications associated with diabetes mellitus. Another research was carried out to investigate the anti-diabetic, hypolipidemic and antioxidant activity and study results concluded that fruit peel and LPG has shown anti-diabetic and hypoglycemic activity. Administration of crude powder of Punica granatum husk decreased the concentration of glucose, triglycerides, cholesterol, LDL cholesterol and raised the level of HDL cholesterol and hemoglobin content in the blood of normal group and alloxan diabetic group treated rats. Study finding revealed that seed and rind extracts showed significant reduction in the rise in blood glucose.

Anti-Microbial Activity

Antibiotics are effective remedy in the inhibition of bacteria growth or growth of microorganism. On the other side, antibiotics resistance against microorganism is one of the major problems in the use of antibiotics against microorganism. Plants products or ingredients of seeds,
Anti-Bacterial Activity
Previous study based on pomegranate peel reported that peel has anti-
bacterial effect.\textsuperscript{51} Antimicrobial activity against some food-borne pathogens via various extracts of fruit peels was examined and finding confirmed that methanolic extract of peels was a potent inhibitor for \textit{Listeria monocytogenes}, \textit{S. aureus}, \textit{Escherichia coli} and \textit{Yersinia enterocolitica}.\textsuperscript{52} In vitro antibacterial activities of different extracts of fruit peels and arils were evaluated against food-related bacteria. Finding of the study showed that all pomegranate extracts contained high levels of phenolics and exhibited antibacterial activity against all bacteria tested.\textsuperscript{53} Extracts of pomegranate such as aqueous and methanolic demonstrated that good antibacterial activity against \textit{S. aureus} and \textit{P. aeruginosa}.\textsuperscript{54}

Anti-Viral Activity
Earlier investigators demonstrated that tannin from the pericarp is a very effective constituent against genital herpes virus (HSV-2) and effectively kills virus and block its absorption to cells.\textsuperscript{55} Other finding reported that acidity of juice and liquid extract solutions contributed to rapid anti-influenza activity.\textsuperscript{56}

Anti-Fungal Activity
Antifungal activities of pomegranate peel extract, seed extract, juice and whole fruit evaluated. Results confirmed that among the selected bacterial and fungal cultures, the highest antibacterial activity was noticed against \textit{Staphylococcus aureus} and among fungi high activity was observed against Aspergillus niger.\textsuperscript{57} Data obtained in research with substances of \textit{Punica granatum} established that antimicrobial capacity against yeast cells of \textit{Candida} genus.\textsuperscript{58}

Anti-Plasmodium Activity
Gallagic acid and punicalagins showed anti-plasmodial activity against \textit{Plasmodium falciparum} D6 and W2 clones.\textsuperscript{59} The protective role of pomegranate peel extract against \textit{plasmodium chabaudi}-induced spleen tissue damage was evaluated. Finding revealed that treated mice with pomegranate significantly showed reduction in parasitemia compared to untreated control.\textsuperscript{60} Another earlier study concluded that beneficial effect of the fruit rind for the treatment of malarial disease might be attributed to the anti-parasitic activity.\textsuperscript{61}

Table 1: Antioxidant and anti-inflammatory properties of pomegranate

<table>
<thead>
<tr>
<th>Plant Part</th>
<th>Activity</th>
<th>Outcome/Findings of the study</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peels</td>
<td>Antioxidant</td>
<td>Pretreatment of the rats with the methanolic extract of peel showed preservation of catalase, peroxidase, and SOD to values comparable with control values.</td>
<td>27</td>
</tr>
<tr>
<td>Seeds</td>
<td>Antioxidant</td>
<td>Seeds extract showed antioxidant activity.</td>
<td>27</td>
</tr>
<tr>
<td>Leaves, peel, seeds, and juice</td>
<td>Antioxidant</td>
<td>Leaf and peel exhibited very strong antioxidant activity.</td>
<td>30</td>
</tr>
<tr>
<td>Seed</td>
<td>Antioxidant</td>
<td>Pomegranate seeds extract using various solvents exhibited various degrees of antioxidant activity.</td>
<td>31</td>
</tr>
<tr>
<td>Fruit rind, flower and leaves</td>
<td>Anti-inflammatory and analgesic</td>
<td>Oral pretreatment with the dried extracts of P. granatum produced statistically significant and dose dependent inhibition of edema induced when compared to the control groups.</td>
<td>32</td>
</tr>
<tr>
<td>Rind</td>
<td>Anti inflammatory and analgesic</td>
<td>Standardized pomegranate rind extract and the equivalent EA dose-dependently reduced the croton oil-induced mouse ear edema.</td>
<td>33</td>
</tr>
<tr>
<td>Fruits</td>
<td>Anti-inflammatory</td>
<td>Both PE and UROA decreased inflammation markers (iNOS, cyclooxygenase-2, PTGES and PGE (2).</td>
<td>37</td>
</tr>
</tbody>
</table>

Anti-Diarrheal Effects
Experiment was carried out to evaluate the anti-diarrheal effects of the aqueous extract of peels and finding demonstrated that extract exhibited a concentration-dependent inhibition of the spontaneous movement of the isolated rat ileum and attenuated acetylcholine-induced contractions.\textsuperscript{62}

Photo-Protection Activity
Chronic UVA exposure can damage underlying structures in the dermis and cause premature photoaging of the skin.\textsuperscript{63} Evidences based on research demonstrated that pomegranate shows photo-protection activity [Table 2]. Previous finding revealed that pomegranate seed oil was shown to stimulate keratinocyte proliferation in monolayer culture. Furthermore, a mild thickening of the epidermis was observed in skin organ culture.\textsuperscript{64} Other findings revealed that pomegranate extract showed effective at protecting human skin fibroblasts from cell death after UV exposure.\textsuperscript{65} Pretreatment of epiderm with pomegranate-derived products showed inhibition of UVB-induced cyclobutane pyrimidine dimers.\textsuperscript{66}

Anti-Obesity Effect
Obesity is one of the risk factor for various diseases. Research was carried out to check the anti-obesity effects of the pomegranate leaf extract And study finding demonstrated that extract showed a significant decrease in body weight, energy intake and various adipose pad weight percents and serum, TC, TG, glucose levels.\textsuperscript{67}

Effect on Oral Health
Pomegranate juice is effective against dental plaque microorganisms decreasing the CFU. Additionally, there was significant reduction in the level of dental plaque microorganisms after the rinsing with pomegranate juice.\textsuperscript{68} Effect of the hydroalcoholic extract from fruits on dental plaque microorganisms was evaluated and finding showed that extract was effective against dental plaque microorganisms. Another research was performed to examine young adults for the effects of mouth rinsing with the pomegranate extract PomElla and this treatment changed salivary measures relevant to oral health including gingivitis.\textsuperscript{70}

Effect on Cardiovascular Diseases
Recent study based on pomegranates reported that pomegranates and its constituents shows various types activities including antioxidant, anti-inflammatory, anti-diabetic and in cardiovascular health.\textsuperscript{71} Chronic administration of pomegranate juice extract showed reduction in the...
mean arterial blood pressure and vascular reactivity changes to various catecholamines.\textsuperscript{75}

Other findings reported that pomegranate juice consumption decreased LDL susceptibility to aggregation and retention and increased the activity of serum paraoxonase.\textsuperscript{75} Study research suggests that pomegranate juice exert beneficial effects on the evolution of clinical vascular complications, coronary heart disease, and atherogenesis in humans.\textsuperscript{74} Consumption of pomegranate juice hold anti-atherosclerotic properties which might be associated to its powerful anti-oxidative characteristics.\textsuperscript{75}

Another study revealed that where ten patients were supplemented with pomegranate juice for 1 year and five of them continued for up to 3 years. Control group that did not take pomegranate juice, common carotid intima-media thickness (IMT) increased by 9% during 1 year, while, pomegranate juice consumption resulted in a significant IMT reduction after 1 year.\textsuperscript{76}

### Neuro-Protective Effect

Prior results reported that pomegranate juice extracts has neurotoxicity protective effect in primary human neurons in a dose-dependent manner by attenuating MPTP-induced increase in extracellular LDH activity.\textsuperscript{77} Membrane-bound enzymes were altered in the brain regions of Tg2576 mouse treated with control diet, and pomegranate supplementation restore the activities of enzymes to comparable values noticed in the controls.\textsuperscript{77} Experiment was made to examine the effects of ellagic acid in a rat model of parkinson’s disease and results reported that right medial forebrain bundle MFB-lesioned rats showed hyperalgesic responses to the stimulus in tail-flick and hot-plate tests and memory and learning deficit in cognitive tests.\textsuperscript{79}

### Nephro-Protective Effect

Extracts of pomegranate, mainly methanol peel extract is an effective nephro-protective agent on chronic renal failure.\textsuperscript{80} Fruit peel admin-

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**Table 2: Role of pomegranate in health management**

<table>
<thead>
<tr>
<th>Plant Part/extract</th>
<th>Activity/effect</th>
<th>Outcome/Findings of the study</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel powder</td>
<td>Hepatoprotective</td>
<td>Diets supplemented with 10% PPP, 10% WP or 10% of their mixture (PPWP) showed a potential hepatoprotective effects in rats.</td>
<td>29</td>
</tr>
<tr>
<td>Juice</td>
<td>Hormone elevation</td>
<td>Juice showed elevation in testosterone, luteinizing hormone (LH) and follicle stimulating hormone (FSH) those depleted by the injection of CCl4.</td>
<td>41</td>
</tr>
<tr>
<td>Ethanolic extract</td>
<td>Prevention of spermatogenic disruption</td>
<td>Ethanolnic extract of pomegranate prevented LA-induced spermatogenic disruption in rats.</td>
<td>42</td>
</tr>
<tr>
<td>Juice</td>
<td>Enhancement of sperm motility</td>
<td>Juice consumption showed increase in epididymal sperm concentration, sperm motility and spermatogenic cell density.</td>
<td>43</td>
</tr>
<tr>
<td>Juice</td>
<td>Improvement of erectile dysfunction</td>
<td>Long-term pomegranate juice intake increased intracavernous blood flow, improved erectile response</td>
<td>44</td>
</tr>
<tr>
<td>Leaves</td>
<td>Antidiabetic</td>
<td>Ethanolnic extract of leaves showed noteworthy antidiabetic activity.</td>
<td>45</td>
</tr>
<tr>
<td>Leaves and Fruit peel extract</td>
<td>Anti-diabetic, hypolipidimic and antioxidant</td>
<td>Leaves and fruit peel extract of P. granatum possesses significant anti-diabetic, hypolipidimic and antioxidant properties.</td>
<td>46</td>
</tr>
<tr>
<td>Seed and rind extract</td>
<td>Anti-diabetic</td>
<td>Seed and rind extract showed reduction the rise in blood glucose induced by alloxan, with the rind extract exhibiting significantly better activity than seed extract.</td>
<td>48</td>
</tr>
<tr>
<td>Peels extract</td>
<td>Anti-diarrheal</td>
<td>Peels extract caused a dose-dependent decrease of gastrointestinal transit and markedly protected rats against castor oil–induced diarrhea enteropooling.</td>
<td>61</td>
</tr>
<tr>
<td>Pomegranate extract</td>
<td>Skin health management</td>
<td>Pomegranate extract showed effective at protecting human skin fibroblasts from cell death following UV exposure.</td>
<td>65</td>
</tr>
<tr>
<td>Pomegranate-derived products</td>
<td>Skin health management</td>
<td>Pretreatment of epiderm with pomegranate-derived products resulted in inhibition of UVB-induced; collagenase gelatinase, stromelysin, marilsin, elastase and tropoelastin.</td>
<td>66</td>
</tr>
<tr>
<td>Leaf extract</td>
<td>Anti-obesity</td>
<td>Leaf extract-treated groups showed a significant decrease in body weight, energy intake and various adipose pad weight percents</td>
<td>67</td>
</tr>
<tr>
<td>Juice</td>
<td>Oral health management</td>
<td>Pomegranate juice is effective against dental plaque microorganisms</td>
<td>68</td>
</tr>
<tr>
<td>Fruit extract</td>
<td>Oral health management</td>
<td>Hydroalcoholic extract was effective against dental plaque microorganisms</td>
<td>69</td>
</tr>
<tr>
<td>Juice extract</td>
<td>Cardiovascular complications management</td>
<td>Juice extract showed reduction in the mean arterial blood pressure and vascular reactivity changes to various catecholamines</td>
<td>70</td>
</tr>
<tr>
<td>Juice</td>
<td>Cardiovascular complications management</td>
<td>Juice can exert beneficial effects on the evolution of clinical vascular complications, coronary heart disease</td>
<td>73</td>
</tr>
<tr>
<td>Pomegranate supplementation</td>
<td>Neuro-protection</td>
<td>Membrane-bound enzymes were altered in the brain regions of Tg2576 mouse treated with control diet, and pomegranate supplementation restore the activities of enzymes to comparable values noticed in the controls.</td>
<td>77</td>
</tr>
<tr>
<td>Fruit peel</td>
<td>Nephrotoxicity protection</td>
<td>Fruit peel administration showed a noteworthy amelioration of abnormalities related Cd-nephrotoxicity</td>
<td>80</td>
</tr>
<tr>
<td>Flower extract</td>
<td>Nephrotoxicity protection</td>
<td>Flower extract has protective role and ameliorate nephrotoxicity induced by gentamicin</td>
<td>81</td>
</tr>
</tbody>
</table>
Table 3: Anti-microbial activities

<table>
<thead>
<tr>
<th>Plant Part</th>
<th>Activity</th>
<th>Outcome/Findings of the study</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peel</td>
<td>Antibacterial</td>
<td>Zones of inhibition were significantly higher in pomegranate extract as compared to standard antibiotic discs used</td>
<td>51</td>
</tr>
<tr>
<td>Peel</td>
<td>Antibacterial</td>
<td>Methanolic extract of peels was a potent inhibitor for <em>Listeria monocytogenes</em>, <em>S. aureus</em>, <em>Escherichia coli</em> and <em>Yersinia enterocolitica</em>.</td>
<td>52</td>
</tr>
<tr>
<td>Peels and arils</td>
<td>Antibacterial</td>
<td>Pomegranate extracts exhibited antibacterial activity against all bacteria tested.</td>
<td>53</td>
</tr>
<tr>
<td>Fruit skin</td>
<td>Antibacterial</td>
<td>Extracts showed good antibacterial activity against <em>S. aureus</em> and <em>P. aeruginosa</em>.</td>
<td>54</td>
</tr>
<tr>
<td>Pericarp</td>
<td>Anti-viral</td>
<td>Tannin from the pericarp is a very effective constituent against genital herpes virus (HSV-2)</td>
<td>55</td>
</tr>
<tr>
<td>Juice (PJ), concentrated liquid extract (POMxl), and PP powder extract (POMxp)</td>
<td>Anti-viral</td>
<td>Acidity of PJ and POMxl solutions contributed to rapid anti-influenza activity.</td>
<td>56</td>
</tr>
<tr>
<td>Peel, seed, juice and whole fruit</td>
<td>Antifungal</td>
<td>Antifungal activity of different part of pomegranates was noticed with different potentiality.</td>
<td>57</td>
</tr>
<tr>
<td>Arils and seeds, pericarp, peels and whole fruit</td>
<td>Antifungal</td>
<td>Pericarp and peel showed activity against <em>Candida spp</em>.</td>
<td>58</td>
</tr>
<tr>
<td>Peel</td>
<td>Antimalaria</td>
<td>Treated mice with pomegranate significantly showed reduction in parasitemia as compared to untreated control.</td>
<td>60</td>
</tr>
<tr>
<td>Fruit rind</td>
<td>Anti parasitic</td>
<td>The beneficial effect of the fruit rind for the treatment of malarial disease may be attributed to the anti-parasitic activity.</td>
<td>61</td>
</tr>
</tbody>
</table>

**CONCLUSION**

The health promoting effect of pomegranates has also been mentioned in the traditional medicines. Fruits, seeds, peel and leaves of pomegranate contain numerous important ingredients and such ingredients show therapeutics importance in the disease cure. A large number of evidences based on laboratory research revealed that pomegranates shows effective role in diseases cure through the modulation of numerous biological activities. The allopast-based treatment including non-steroidal anti-inflammatory is expensive and also shows toxic effect on normal cells. Several studies based on animal model and clinical trials confirmed that the consumption of pomegranate is safe and not causes any side effects. However, more studies based on animal model should be warranted to explore its beneficial effect in health management.

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**CONFLICT OF INTEREST**

There is no conflict of interest.

**ABBREVIATION USED**

AOC: Antioxidant capacity; EA: Ellagic acid; PJ: Pomegranate juice; MPTP: 1-Methyl-4-phenyl-1,2,3,6-tetrahydropyridine; SOD: Superoxide dismutase; GSH: Glutathione Inducible nitric oxide synthase; INOS: Carbon Tetra chloride.

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Rahmani et al.: Role of pomegranate in the health management


**GRAPHICAL ABSTRACT**

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