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## Review Article

Traditional uses, phytochemistry and pharmacology of *allium cepa* LRaj Bala<sup>1</sup>, Hema Rani<sup>2</sup>, Rajwant Kaur<sup>3</sup>, Simranjeet Kaur<sup>4\*</sup><sup>1</sup>School of Pharmaceutical Sciences, RIMT University, Mandi Gobindgarh, Punjab, India<sup>2</sup>School of Pharmaceutical and Health Sciences, Career Point University Hamirpur, Hamirpur, Himachal Pradesh, India<sup>3</sup>University Institute of Pharma Sciences, Chandigarh University, Mohali, Punjab, India<sup>4</sup>Faculty of Pharmaceutical Sciences, PCTE Group of Institutes, Baddowal, Punjab, India

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## ABSTRACT

The common onion (*Allium cepa* Linn), one of the earliest cultivated plants in the Liliaceae family, is used as a seasoning and vegetable in cooking around the world. It's an essential element in many parts of Africa. Egypt is the first country to grow abstinent, despite the fact that it is mostly manufactured there. In addition to several minerals, vitamins, and secondary metabolites such as phenolic acids, flavonoids, thiosulfates, saponins, and phytosterols, it contains sulfur that contains amino acids. In addition to being primarily used as food, onions provide several other health benefits. Widespread pharmacological properties of onions, such as their antibacterial, antidiabetic, anticancer, and antioxidant cardiovascular effects, support their potential application in the treatment of a wide range of illnesses. The purpose of this review is to provide an overview of previous research on the beneficial benefits of this treatment on a number of co-morbidities, such as diabetes, obesity, hypertension, and hyperlipidemia.

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## 1. Introduction

Garlic-scented bulbous herbs or onion is allium belonging to the family Amaryllidaceae. Various allium vegetables are consumed mainly as spices for their characteristic flavors and their health-improving effects, like leek (*Allium ampeloprasum* var. *porrum*) onion (*Allium cepa*), and garlic (*Allium sativum*).<sup>1</sup> Harvest yield of onion (*Allium cepa* L.), was 93.1 million tons in 2016 and is among the most widely consumed vegetables.<sup>2</sup> The word “onion” is originated from the Latin word ‘unio’ which means ‘single’ or ‘one’ as it yields a single bulb.<sup>3</sup> It is a vegetable, also called the bulb onion or common onion that is cultivated for greater than 7000 years. The bulb shape is like a flattened globe or a globe, sometimes spindle-like or mostly cylindrical with a flat top.<sup>4</sup>

Different refines include onion juice concentrate, onion essential oil, dehydrated onion powder, and; are beneficial in flavoring and seasoning of foodstuffs.<sup>5</sup> Since ancient times, globally onion is the biggest economic graze and is used in medicine and food.<sup>6–9</sup> Geographical sources of onion are India the biggest cultivator, Turkey, China, Japan, USA Spain, Egypt, Poland and Brazil<sup>10</sup> and for Egypt, the yield is 2.4 million tons.<sup>11</sup> The plant onion is currently produced in 139 countries and has been cultivated for more than 4000 years.<sup>12</sup> After Americans (16 kg), Libyans utilize the maximum quantity of onion, for its worldwide consumption, and yield for a mean of 30 kg annually/capita.<sup>13</sup> Around, 13000 accessions of onion are kept in gene library globally with large gene variability in their physicochemical and morphological bulb traits such as weight, shape, scale color, flesh, dry matter content (DMC), firmness and pungency.<sup>14</sup> Onion cultivars are of

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**Figure 1:** Whole fresh bulbs of *Allium cepa* Linn.

three types: dehydrator types (>18% DMC), storage types (8 to 12% DMC) and fresh market types (5 to 9% DMC).<sup>15</sup> A characteristic odor of *Allium* species is because to the liberation of volatile organosulfur compounds on tissue destruction.<sup>16</sup> A species-specific pattern of S-alk(en)yl-cysteine sulfoxides (ACSOs) determines the aroma type of various *Allium* species.<sup>17</sup> The main predominant aromatic compound in onion is Isoalliin, along with slight amounts of propiin and methiin and traces of alliin.<sup>18</sup>

## 2. Chemical Constituents

Naturally, three subtypes of onion are reported; white, red and yellow. Generally, raw bulbs of onion have water (89%), sugar (4%), dietary fiber (2%), protein (1%), traces of fat (~100 mg/100 g), and minor amounts of vital nutrients, irrespective of the subtype. Therefore, onion has an insignificant caloric value of (~40 kcal/100 g).<sup>19</sup>

Additionally, to ACSO and carbohydrates, onion bulbs have major gene diversity seen for their flavonoid content, that is reflected among others in various colors ranging from dark red and yellow to white. Flavonol couples with isorhamnetin, quercetin, and kaempferol as aglycones and almost solely  $\beta$ -D-glucosyl moieties in 4'-O, 3-O, and/or 7-O position are the predominating flavonoids in colored onions. Cyanidin and peonidin conjugates are present in Red scaled onions, but white-scaled onions lack flavonoids.<sup>20</sup> In colored onions, Cyanidin and Quercetin are the major predominant anthocyanidin and flavonol species, respectively. Yellow- and red-scaled cultivars have quantitative differences in flavonoid content were also found.<sup>21,22</sup> Sapogenins, saponins, flavonoids<sup>23</sup> & fructooligosaccharides (FOSs).<sup>24</sup> are known major components in *A. cepa*. Total flavonoids from onion a peel was concentrated by Li et al. got 90.25% flavonoids content

extract.<sup>25</sup>

The external layer of the onion is a byproduct, a biological source with a high-value of various essential ingredients, and ought to be looked for different methods for their application.<sup>26</sup> The growth and yield of onion are increased with Indole acetic acid (IAA)-producing bacteria.<sup>27</sup> Spraying the extract of Spirulina, a herbicide, has a favorable effect on both chlorophylls a and b and carotene.<sup>28</sup> the plant biomass and height and elements of onion.<sup>29</sup>

Onions have been found to contain various phytochemicals<sup>30,31</sup> like quercetin glucosides, quercetin, kaempferol, thiosulfinates, anthocyanins, cepaenes and sulfur-containing compounds (e.g., S-allyl cysteine sulfoxide, methyl cysteine sulfoxide, dimethyl trisulfide, diallyl trisulfide) that affects human health.<sup>32,33</sup> Nowadays, onions have become a part of human food. The worldwide production of dried onion in China and India is 26% and 21% of the total global production, which is greater than 90 million tons.<sup>34</sup>

## 3. Uses

Since ancient times, onion has had a major role as a medicinal agent. This comprehensive health benefits are mainly due to organosulphur compounds which are a definite feature of garlic and all other *Allium* plants. There are some preservative correlations of onion and garlic in the treatment of cancers, especially cancers of the Gastrointestinal Tract, have been indicated by various studies since ancient times.<sup>35</sup>

To determine DNA destruction of each cell of pesticides, Root meristems of *Allium cepa* related comet assay have been widely used, because it is a completely simple, sensitive, reliable and relatively inexpensive technique when compared to various test systems and requires a small number of cells.<sup>36–40</sup> The *Allium cepa* test is also employed to govern the destructive effects of anaigenic and clastogenic chemicals because it is a very cheap and well-known method.<sup>41–43</sup> For the determination of clastogenicity of a compound, chromosomal aberration (ACs) and micronucleus (MN) tests are outstanding predictors, although mitotic index (MI) is also employed to detect the interferences in mitotic cell division.<sup>44,45</sup>

A perennial plant, Red onion (*Allium cepa* L.) with globe-like bulbs and opposite leaves which are originated from vast leaf bases enclosed in thin and dry skin,<sup>46</sup> is a major source of various phytonutrients. It has a typical pungent smell due to its sulfur-containing compounds and is a vital ingredient in kitchen dishes.<sup>47</sup> Onion is used as a folk medicine for numerous ailments like headaches, cardiovascular disease bites, tumors and worms.<sup>48</sup> *A. cepa* has been shown to possess many therapeutic activities like antioxidant,<sup>49</sup> anti-cancer<sup>50</sup>, anticoagulant,<sup>51</sup> anti-diabetic,<sup>52</sup> and anti-inflammatory activities.<sup>53</sup>

Draeos reported that onion extract is useful in ameliorating the beauty aspect of post-operative scars<sup>54</sup>. Because of has vital health-promoting phytochemicals and nutrients, onion possesses high nutritional and therapeutic potentialities and is widely used for flavoring food formulations.<sup>55,56</sup> In addition, onion has been used as a potent therapeutic agent for the treatment of cancer, anemia, cardiovascular disease, teeth disorders, thrombolytic activity, fibrinolytic, blood pressure, urinary disorders, headache, bleeding piles, and cataract.<sup>57–59</sup> It is used as an herbal remedy for anthelmintic, carminative and aphrodisiac and as an herbal tonic for the cure of bronchitis, bruises, hypertension, diabetes and other respiratory disorders and jaundice<sup>60,61</sup>

Also, onion possesses antidiabetic, antioxidant, anti-ulcer, antihypercholesterolemia, anti-platelet, antibrowning properties, a good appetizer and food digester.<sup>55,56,62,63</sup> Onion has antioxidant properties due to the presence of organosulfur compounds and flavonoids<sup>64</sup>. Daily consumption of onion has been found to decrease the chance of various neurodegenerative, cardiovascular disorders and cancers because of a major amount of antioxidants and thus it is gaining more attention.<sup>65</sup>

#### 4. Phytochemical Study

Upon extracting the external layer of *Allium cepa* with Methanolic hydroxide, a crude extract was found, and then it was screened with n-hexane, ethyl chloride, n-BuOH. 405g EtOAc fraction was segregated on silica gel and High-performance liquid chromatography. and new nine flavonoids were obtained which are cepaflavas A, cepaflavas B, cepadials A, cepadials B, cepadials C, cepadials D and cepabiflas A, cepabiflas B, cepabiflas C. Cepaflava A and B has molecular formula C<sub>19</sub>H<sub>18</sub>O<sub>9</sub>, is amorphous, pale yellow powder. Cepadials A, B and C were found has C<sub>22</sub>H<sub>14</sub>O<sub>11</sub> and C<sub>23</sub>H<sub>16</sub>O<sub>11</sub> as molecular formula respectively, and are amorphous brown powder. Cepadial D and Cepabifla A with molecular formula C<sub>38</sub>H<sub>24</sub>O<sub>18</sub> and C<sub>36</sub>H<sub>28</sub>O<sub>19</sub> respectively, are amorphous, bronze yellow powder. Cepabiflas B and C had a molecular formula of C<sub>36</sub>H<sub>28</sub>O<sub>19</sub>, is an amorphous, bronze-yellow Powder.<sup>26</sup> The structures of six previously known compounds were identified in the previous studies, quercetin,<sup>66</sup> kaempferol<sup>67</sup>, isorhamnetin,<sup>68</sup> quercetin 4'-O-β-D-glucopyranoside,<sup>66</sup> 1,3,11a-trihydroxy-9-(3,5,7-trihydroxy-4H-1-benzopyran-4-on-2-yl)-5a-[4-(β-D-glucopyranosyloxy)-3-hydroxyphenyl]-5,6,11-hexahydro-5,6,11-trioxanaphthacene-12-one<sup>69</sup> and 1,3,11a-trihydroxy-9-(3,5,7-trihydroxy-4H-1-benzopyran-4-on-2-yl)-5a-[1,3,11a-trihydroxy-5a-(3,4-dihydroxyphenyl)-5,6,11-hexahydro-5,6,11-trioxanaphthacene-12-on-9-yl]-5,6,11-hexahydro-5,6,11-trioxanaphthacene-12-one (15).<sup>70</sup>

#### 5. Pharmacological Activities of A cepa

*Allium cepa* is used as a potent medicinal agent and possesses antiviral, antibacterial, antiparasitic, antihypertensive, hypoglycemic, antifungal, antihyperlipidemic, and antioxidant, anti-inflammatory antiplatelet activity.

##### 5.1. Antiplatelet activity

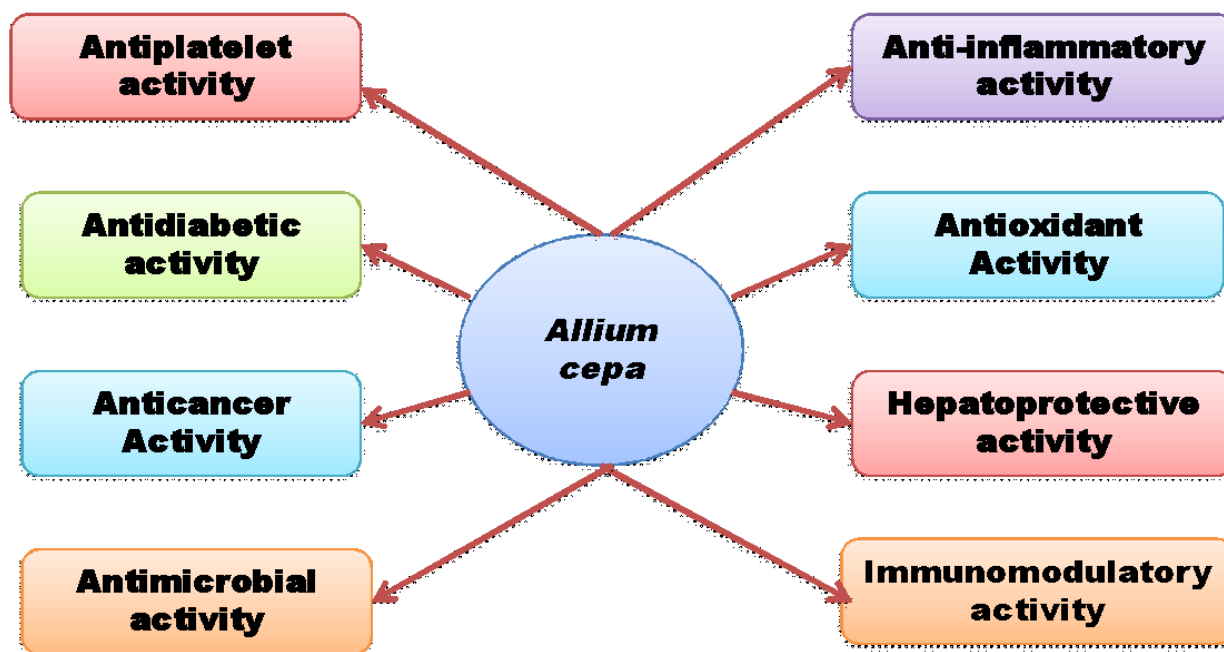
According to recent studies, the onion's pungency is linked to antiplatelet activity.<sup>71</sup> Sulfur compounds, chromium, and vitamin B6 all contribute to this. Platelet aggregation is also linked with atherosclerosis, cardiovascular disease, heart attack, and stroke.<sup>72</sup>

##### 5.2. Antidiabetic activity

Onion is used in the cure of diabetes and its associated complications.<sup>73,74</sup> Onion soup is used to cure diabetes mellitus type 2 and other lifestyle diseases.<sup>75</sup> Onions have been reported to possess anti-diabetic properties because of the presence of allyl propyl disulfide, which raises free levels of insulin.<sup>76</sup> In alloxan diabetic rabbits allyl propyl disulfide increased glucose tolerance. Onion contains S methyl cysteine sulfoxide which is responsible for anti-diabetic activity.<sup>77</sup> Chromium improves glucose tolerance by decreasing insulin levels, fasting glucose levels, and lowering blood cholesterol and triglycerides (TG) levels.<sup>78</sup> Quercetin in *allium cepa* facilitates glucose-mediated secretion of insulin by assisting phosphorylation of extracellular signal-regulated kinase and protecting pancreatic beta-cells and ultimately controls sugar-induced secretion of insulin, elevating the specific activity of several pancreatic islets and liver glucokinase (a carbohydrate enzyme) that facilitates improved glucose tolerance.<sup>79</sup>

##### 5.3. Anticancer Activity

The flavonoid quercetin contained in allium has been shown to have anticancer properties. It can stop cancer cells from growing. *Allium cepa L.* inhibits cancer cell proliferation and adipocyte proliferation by inhibiting the enzyme fatty acid synthase.<sup>73</sup> Ethanolic extract of this plant is beneficial for the treatment of breast tumors.<sup>80</sup> A flavonoid, Apigenin is found in onions, has shown to possess anticancer properties.<sup>81</sup> Sulfur compounds found in onions have been shown in studies to protect cells from mutation and induce apoptosis, preventing tumor growth and cancer production. In vitro studies show that onion extract inhibits mutagenesis/carcinogenesis,<sup>82</sup> modulates enzyme and cell signaling pathways,<sup>83</sup> scavenges free radicals,<sup>73,84,85</sup> induces apoptosis, and has immunomodulatory<sup>86,87</sup> and affects cell differentiation and cancer development.<sup>88</sup> The water leek extract of concentration (50 µg/ml) was the most important anticancer effect with a viability percentage



**Figure 2:** Schematic representation of different pharmacological activities of *Allium cepa*

of  $47.16 \pm 14.71$  after incubation for 3 days. As it contains entadamide A- $\beta$ -D-glucopyranoside it induces inhibition of MCF-7 cells. These findings predict the leek's potential being a regulator of food sources that can help increase antineoplastic activity.<sup>35</sup>

#### 5.4. Antimicrobial activity

Red and white varieties of *Allium cepa* have shown strong antimicrobial and antioxidant activities. Fresh cold water extract of onion has shown antibacterial activity against four isolates include *Staphylococcus aureus*, *E.coli*, *Streptococcus pneumoniae* and *Streptococcus pyrogenes* and has antimicrobial activity against *Vibrio cholerae*, *Pseudomonas aeruginosa*, *S. pneumoniae*, *E. coli*, *Staph. Aureus*, and *Staph. Aureus Salmonella typhi* and *E. coli*.<sup>89</sup> The biochemical analysis revealed that the three onion varieties are rich in therapeutic compounds. Onion extract possesses antimicrobial activity which revealed that they were effective against three Gram-positive bacteria (*S.aureus*, *B.cereus* and *L. innocua*), as well as *P. aeruginosa*; as a result, they may be a novel source of

biological antimicrobial agents.<sup>90</sup>

#### 5.5. Antioxidant Activity

Onions are high in quercetin, a strong antioxidant. Quercetin has been shown in a variety of studies to be a free radical scavenger and an inhibitor of LDL (low-density lipoprotein) oxidation. The red and white varieties of *Allium cepa* demonstrated antioxidant activity.<sup>91</sup> *Allium cepa*'s quercetin-3'-O-beta-D glycoside exhibits antioxidant properties.<sup>22</sup> In aged rats, peel and flesh of *allium cepa* improve antioxidant level.<sup>92</sup> In alloxan diabetic rats, SMCS obtained from onion had anti-diabetic and antioxidant effects when compared to standard drugs.<sup>93</sup> Flavonols in the diet defend diabetic human lymphocytes from oxidative DNA damage.<sup>94</sup>

#### 5.6. Hepatoprotective activity

Onion extracts were found to protect rats' livers from cadmium-induced oxidative damage<sup>95</sup>. Onion extract is preferred for dose-dependent hepatoprotection, as well

as preventing and protecting against cadmium-induced hepatotoxicity. Hepatoprotective action of an aqueous extract of *Allium cepa* bulb was found against ethanol-induced hepatotoxicity.<sup>96</sup>

### 5.7. Anti-inflammatory activity

Due to the flavonoid quercetin, onions have anti-inflammatory properties. Onions have anti-asthmatic properties<sup>53</sup> and are used to treat arthritis.<sup>97</sup> Ajoene is an anti-inflammatory natural product isolated from the *Allium* genus is known to possess anti-inflammatory activity.<sup>98</sup> The mechanism for the attenuation of atherosclerosis by fistula onion stalk extract involves the modulation of the local inflammatory response.<sup>99</sup>

### 5.8. Immunomodulatory effects

Various studies have also shown *A. cepa* constituents in cultured spleen cells stimulated with pokeweed (PWM) from *Blomia tropicalis*-sensitized BALB/c mice, quercetin (3.5, 7.5, 15 µg/mL) impeded the development of Th2 cytokines such as interleukin-4 (IL-4), IL-5, IL-13, and IgE.<sup>100</sup> The reviewed in vitro and in vivo studies reported that *A. cepa* and its constituents have modulatory effects on the immune system in a variety of immune dysregulatory disorders. The plant and its components, especially quercetin, decreased Th2 cytokines such as IL-4, IL-5, and IL-13, as well as IL-6, IL-8, IL-10, IL-1b, and TNF- $\alpha$  and IgE levels, while increasing CD4 cells, IFN- $\gamma$  levels, and the IFN- $\gamma$ /IL4 ratio (Th1/Th2 balance) in inflammatory disorders like asthma and breast cancer. However, in inflammatory conditions including LPS-induced osteoclastogenesis in RAW264.7 cells, *A. cepa* and quercetin decreased IL-6 and IL-1 $\alpha$  development while increasing IL-3 and IL-4 levels.<sup>101</sup>

## 6. Conclusion

*Allium cepa* is being used since ancient times and is still used today. *Allium cepa* have numerous beneficial properties but more needs to be done to bring into foreplay its other properties too. The presence of phytochemicals helps to cure diverse ailments marks out *Allium cepa* of great value to the food and pharmaceutical industry. Considering its usefulness more stress should be put in to make Nanoparticles and other dosage forms because of its n number of medicinal properties.

## 7. Source of Funding

None.

## 8. Conflict of Interest

None.

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