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Onion: A review of its global benefits to health

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Abstract

Allium cepa has been cultivated throughout the world and used for thousands of years for food flavoring, essential oil applications and in traditional medicine. Onion is characterized by their high contents of odoriferous sulphur compounds. The cysteine sulphoxides are mainly accountable for flavor of onion which also causes eye irritation. Onion has many uses ranging from culinary to medicine. Essential oil and crude extract of several *Allium* species have antibacterial, antifungal, antioxidant and cytotoxic activities. Onion in combination with a variety of other herbs is used to increase its value and gain enormous benefits to food and health. Onion is an essential component of several industrial applications that range from food to pharmaceutical products. More applications and uses of onion by-products are continuously added. Best way to maximize the onion yield requires better harvesting techniques, post-harvest, and optimum preservation technologies.

Key words: *Allium cepa*, quercetin, thial-S-oxide, volatile oil

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1. Botany

1.1. Introduction

Onion is the product of *Allium cepa* L. plant, the most cultivated specie of Alliaceae family. Genus *Allium* contains about 700 species of perennial plants consisting of underground storage rhizomes or bulbs [1]. These species are widely distributed in North Africa, Europe, Asia, and North American regions. The key species of *Allium* family are *Allium cepa* and *Allium sativum*, which are well-known for their tearing (Lachrymatory) effect, and pre-requisite flavor in cooking. Onion is major food component of various food cuisines [2]. It is known by different vernacular names in different regions of world. It is known as Onion (English), Oignon (French), Zwiebel (German), Cipolla (Italian), Basal (Arabic), Palandu/ Pyaj (Hindi), Choong (Chinese), Piyaz (Urdu).

1.2. History

Allium species have been cultivated in about 175 countries, since 5000 years. Wild varieties of onion are thought to be originated from Central Asia. According to ancient Egyptians, "spherical bulb of onion is a symbol of universe" [3]. The name is derived from Latin word "unun" meaning "one". Onions have been considered a food source from millennia. Ancient Greece athletes believed that eating large quantities of onions would lighten their blood. In the middle ages, the onions were used by people for paying rents. Columbus introduced onions to America in 1942, and is now cultivated in world's temperate regions.

1.3. Demography/Location

Onion is a cool weather crop. It thrives best at low temperature because high temperature causes "bolting". Onions are resistant to frost injury. China, India, and United States are three leading onion producing countries. Onions are also cultivated in Egypt, Pakistan, Iran, Turkey, Brazil, Russia, and Korea. In Pakistan, onions are mainly cultivated in Southern part of Punjab (Vehari, Khanewal, Okara, Dera Ghazi Khan, Rahim Yar Khan and Bahawalpur), Sindh (Ghotki, Nawabshah, Nausherhroferoze, Sanghar, Shikarpur, Hyderabad and Mirpur Khas), Baluchistan (Dir and Swat), and KPK (Chagai and Kalat) [4].

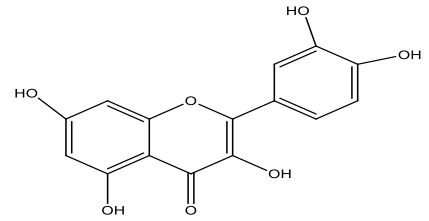
1.4. Botany, Morphology, Ecology

Allium cepa is an annual plant, having fleshy bulb growing below the soil. Plant contains white or purple colored tiny flowers. Onion has shallow root system. A short, hollow, green, fattened stem is present at the base of plant, which can attain height of one meter (3ft). Leaf are green, hollow, and cylindrical. Thickening of the leaf bases forms a bulb, after certain period of growth [5]. Well-drained, loamy, and stone free soils; proper sunlight; appreciable quantities of essential minerals including nitrogen, potassium, and phosphorous, are necessary for growth of onions. Temperature also plays crucial role in

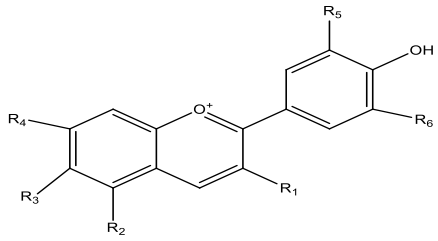
onions growth. Onions growing in hotter regions produce more sulfur compounds and in turn more pungent odor [6].

2. Chemistry

Onions are richest source of water, proteins, vitamins (ascorbic acid and pyridoxine), fatty acids, carbohydrates, fibers, potassium, flavonoids (anthocyanine, quercetin), and trace minerals (chromium). Pungent odor of onions is because of presence of sulfur compounds (allyl propyl disulphide). Many researchers reported that antioxidant potential of onions is due to the presence of terpenes, flavonoids, carotenoids, phytoestrogens, polyphenols, and secondary metabolites (volatile constituents). GCMS analysis is generally used for characterization purpose of aromatic plants oil [7-13]. Structures of important chemical found in onion are shown in figure 1. The lachrymatory principal is propane thial-S-oxide, which has bitter taste and easily degrades into volatile constituents responsible for characteristic aroma of onion [14]. Bulb of *Allium cepa* contains small amounts of some anti-nutrients, which don't cause any toxic effect. It has high percentage of minerals, therefore, used to cure various disorders including hypertension, rickets, and osteomalacia.



Quercetin



Anthocyanins

Fig. 1. Structures of some important phytochemicals found in *Allium cepa* L.

3. Postharvest technology

Post-harvest technology includes all the processes from harvesting of onion to its sale in market. General state and maturity of the bulb is indicated by the condition of onion plant leaves. Onion bulbs should be matured completely before harvesting, as these are needed to be stored. Bulbs usually get mature in 3-4.5 months after sowing, depending upon climate and cultivar. Spring onions mature after 30 to 45 days of sowing. Cleaning of bulbs should be done after harvesting either manually or by using air to remove soil and other foreign particles. Bulbs should be allowed to cure and ripen in sunlight. It may take 2 weeks and is considered complete when bulbs necks become hard and skin screams when held in hand. Curing reduces the chances of shrinkage and sprouting during storage. Onions can be packed or stored in a variety of containers like cartons, plastic bags, wooden boxes, bulk bins, and stretch-wrapped trays. Mostly, 25kg bags are used for transporting crop from store to the market. Type of packing material depends upon size of crop, storage time, and marketing necessities.

4. Processing

Onions are usually chopped to obtain desired shapes and sizes with knife or commercially available devices. Onions are blended with other ingredients to obtain the desired taste.

5. Value addition

Typical value added products of onion include mouth re-freshener, onion hot/sweet flakes, onion sauce, onions friers, onion ketchup, onion chutney, onion oil, onion pickle, onion puree, and toasted onions.

6. General uses

Onion consumption is effective for the treatment of many diseases including common cold, cough, allergy, laryngitis, and toothaches. It has been used externally as well as internally for healing purpose. A tint of onion is used in homeopathy to cure various ailments like hay fever, trauma, hernia, facial paralysis, and pneumonia [20]. It has also been used for the treatment of respiratory conditions such as asthma, bronchitis, and whooping. Mixture of onion and rue is used to relieve digestive tract from parasites. It increases appetite; lowers blood levels of cholesterol and in turn reduce arteriosclerosis. Onion juice is used to cure snakebites, promote hair growth, and to strengthen muscles [22, 23]. Allins found in onion prohibit the growth of infectious cells. Onions have capacity to prevent cardiovascular conditions [5].

7. Pharmacological uses

7.1. Anti-diabetic activity

A study was conducted to examine the anti-diabetic potential of *Allium cepa* and *Ocimum sanctum*, using male albino rats. Oral administration of *Allium cepa* or *Ocimum sanctum* at the dose level of (0.25 g/kg w.r.t. body weight) significantly decreased the blood level of sugar in both fastend and fed animals. Both extracts does not produced any adverse effect at dose of 0.25g/kg w.r.t. body weight. In another study, onion fraction (ether soluble) showed significant decrease of blood glucose level, when orally administrated at dose level of 0.25mg/kg, in rabbits [15]. A sulfur compound (S-methyl cystein sulphoxide) isolated from onion extract showed remarkable hypoglycemic effect at concentration of 0.2g/kg (w.r.t. body weigth), in alloxan induced diabetic animals [16]. S-allyl cystein sulphoxide (isolated from *Allium cepa*) lowered glucose level of blood, in dose dependent manner, in hypoglycemic rats [17].

7.2. Hepatoprotective activity

The hepatoprotective effect of *Allium sativum* and *Allium cepa* was studied against Cd (cadimium) induced hepatic damage in rats. Cadmium sulfate ($3CdSO_4.8H_2O$) was orally administrated at dose of (1.5mg/kg daily), to induce hepatic damage. Cd caused sharp increase in glutathione S-transferase and lipid peroxidase. While, liver levels of superoxide dismutase, catalase, and glutathione

were lowered. *Allium sativum* (moderate dose level) and *Allium cepa* (high dose level) extracts significantly reduced lipid peroxidation and stimulated antioxidant defence in rats liver [18]. In another experiment, the dehydrated onion powder was investigated for its hepatoprotective potential using hypercholesterolemic rats. Administration of varied doses of onion powder for six weeks significantly attenuated the serum cholesterol and LDL (low density lipoprotein) levels. Whereas, blood levels of vitamin C, vitamin E, and Glutathione were elevated [19]. Another study was conducted to examine the hepatoprotective activities of onion extracts (fermented) against 2,2'-azobis (2-amidinopropane) dihydrochloride (AAPH) induced oxidative stress, in Sprague-Dawley rats. Chromatographic (RP-HPLC) analysis suggested higher concentrations of quercetin aglycone in fermented onions then fresh ones. Free radical quenching assay was used to examine the effect of quercetin aglycone, *in vitro*. Treatment resulted in elevated levels of GSH (glutathione), GSSG-R (glutathione reductase), and CAT (catalase). Whereas, GOT (glutamate oxaloacetate transaminase), GPT (glutamate pyruvate transaminase), TBA (thiobarbituric acid) were decreased [20].

7.3. Anti-depressant activity

Researcher found that elevated amounts of oxidative species cause depression and anxiety, which can be attenuated using *Allium cepa*. Polyphenols found in *Allium cepa* prevent CNS from anxiety and depression [21]. An experiment was performed to evaluate the anti-depressant activity of onion powder, using forced swimming test (FST) model, in rats. Fourteen days daily administration of *Allium cepa* powder at doses of 0.05g/kg (w.r.t. body wt.) showed moderate antidepressant activity. Quercetin was found to be responsible for antidepressant potential of *Allium cepa* [22].

7.4. Anti-pathogenic activity

Antifungal potential of *Allium cepa* and *Allium sativum* extracts (aqueous) was tested against 25 strains of *Malassezia furfur*, 18 strains of *Candida albicans*, 12 strains of other *Candida* species, and dermatophyte species (35 strains), using agar dilution model. Ketoconazole (KTZ) was used as standard drug. Both extracts and Ketoconazole strongly inhibited the tested fungal strains, in a dose dependent behavior [23]. Aqueous extract of *Allium cepa* was investigated for its antifungal effect against two dermophytes (*Trichophyton mentagrophytes*, *Trichophyton rubrum*), with special reference to their morphology. Dose dependent (>3.12%) inhibitory effect was shown against both fungi. *Allium cepa* extract affected the morphology of both dermophytes by disrupting their plasma membranes and other cellular structures. *Trichophyton mentagrophytes* was found to more affected then *Trichophyton rubrum* [24]. Antimicrobial effects of garlic and onion (red, yellow, and green) essential oil extracts at doses of (50, 100, 200, 300 and 500 ml/l) were evaluated against two bacterial strains (*Staphylococcus aureus* and *Salmomella Enteritidis*) and three fungal strains (*Fusarium oxysporum*, *Aspergillus niger*, and *Penicillium cyclopium*). Significant inhibitory effect was shown by the extracts (garlic and red onion) against *Salmomella Enteritidis*, whereas, *Staphylococcus aureus* showed less sensitivity towards extracts. In case of fungal strains, maximum inhibitory effect was shown against *Aspergillus niger* and *Penicillium cyclopium*. However, *Fusarium oxysporum* was less sensitive towards extracts. Antimicrobial potential of garlic was higher than onion [25]. In another study, it was demonstrated that sulfur containing compounds of onion prevent the microbial growth and pro-inflammatory messengers.

7.5. Anticancer activity

Cancerous related health problems including gall-bladder, esophageal, cervical, ovarian, and breast cancers, are spreading worldwide. Disease is associated with nutrient deficient food, fatness, less intake of fiber, concentrated sugars etc., which can be prohibited using *Allium* speices [26]. Researchers concluded that cancer preventing properties of *Allium* speices are due to the presence of organo-sulphur compounds [27]. In a study, it was shown that consumption of onion and garlic may have inhibitory effects against tumor. In another study, it was demonstrated that onion has higher anticancer potential then garlic [28]. Recently, a new sulphur compound, “Onionin A” (3, 4-dimethyl-5-(1E-propenyl) tetrahydro-thiophe -2-sulfoxide-S-oxide), showing potential anti-tumor properties has been isolated from onion [29]. Hot air, vacuum, and freeze dried onion powder has been reported to prevent the growth of leukemia cells by scavenging free radicals [30]. Above data suggested the use of *Allium cepa* as a potential anticancer agent.

7.6. Hypo-lipidemic activity

Hyper-cholesterol has been positively associated with cardiovascular disorders and obesity [31]. In a study, dehydrated onion extracts significantly decreased the levels LDL (low density lipoprotein), in rat’s serum. While, concentrations of α-tocopherol, vitamin C, and glutathione in blood of model animals were increased [19]. In another study, the onion extracts reduced TC (total cholesterol), TAG (tri-acylglycerols), and LDL (low density lipoproteins) cholesterol, but enhanced the level of HDL (high density lipoprotein) cholesterol, in rat’s serum [32]. Above mentioned reports suggested that incorporation of onions in daily foods may lead to reduction in serum cholesterol level.

7.7. Cardio-protective activity

Onions (raw or moderately cooked) are used to prevent cardiovascular disorders. Bitterness is positively linked to cardioprotective activity. Overheating leads to instability of sulfur containing compounds and in turn reduces both bitterness as well as anti-aggregatory property [33]. In a study, Methanol extract of onion showed

cardioprotective effect against Ischemic heart damage and hypoxia-induced apoptosis, in rats (in vivo, in vitro). Onion extract prevented ROS formation, depolarization of mitochondrial membrane and cytochrome c liberation, at dose level of 500mg/ml, in vitro. While, extract at dose level of 10g/kg, significantly decreased the myocardial infarct size, apoptosis, and plasma MDA (malonaldehyde) level, *in vivo* [34].

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