

Phytochemical Aspects of Onions - *Allium cepa* L.

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Onion (*Allium cepa*) is known as “Queen of the Kitchen” as it is an irreplaceable ingredient in most of the Asian cuisines [1]. Global production of onions is more than 90 million tons per year; China and India contribute around 50% to the global production. Now-a-days more than 170 countries cultivate onions, including Egypt, USA, Iran, Pakistan, Afghanistan *etc.* [2,3]. Red onion, yellow onion, and white onion (not garlic) are the varieties of *A. cepa* that are abundant in the market.



Figure 1: Varieties of onion

<https://cdn.britannica.com/48/82548-050-A61BF320/Onion-bulbs-shapes-variety-colours-sizes.jpg>

Scientific Classification of onion

Kingdom	: Plantae
Division	: Magnoliophyta
Class	: Liliopsida
Order	: Asparagales
Family	: Alliaceae
Genus	: <i>Allium</i>
Species	: <i>Allium cepa</i>

Morphology

Around 850 species are known from the genus *Allium* and about 660 species are found in Asia [2]. *A. cepa* is a perennial herb with fibrous adventitious root system. The stem grows about 2.5 m tall [2]. The leaves gather

in a stem as a rosette type, while greenish white flowers occur as globular umbel inflorescence. Seeds of *A. cepa* are black in color as shown in figure 3.

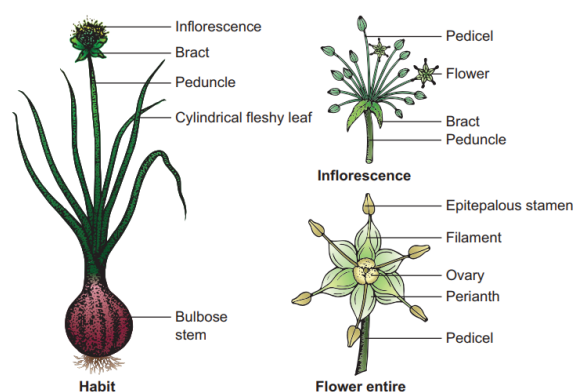


Figure 2: Parts of the onion plant

https://www.brainkart.com/article/Botanical-description-of-Allium-cepa_32996/



Figure 3: Onion flower with seeds

<https://sanctuarygardener.files.wordpress.com/2013/05/onion-seed-pods.jpg>

Bulb is an underground stem, which helps to survive in arid climate conditions. Bulb of *A. cepa* is a cylindrical fleshy structure, which covered with special leaves called skin [2]. Onion bulb is the most popular edible part of the plant, even though leaves, flowers and seeds are also used to prepare food such as soup, salads *etc.* Fried rings, flakes, powder and oil are some of the products of onion bulbs [1]. The color of the bulb depends on

the anthocyanin content present in the epidermal and outer skin of it (red onion has the highest content of cyanidin-3-glucoside (1) while the white onion has the least) [4].

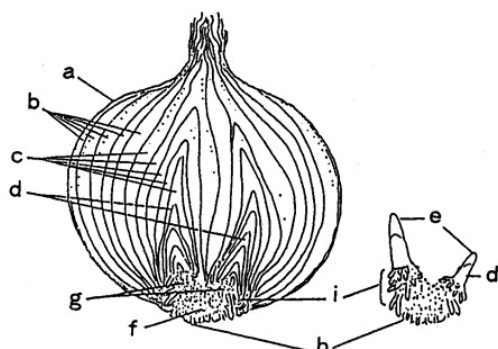
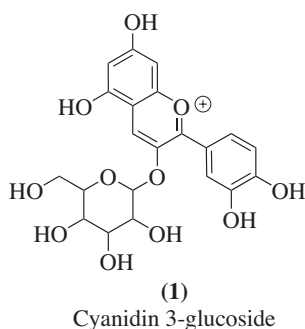


Figure 4: Parts of onion bulb

a: skin, b: scales with leaf blades, c: scales without leaf blade, d: young sprout leaves, e: sprouting leaves, f: old stem plate, g: new stem, h: outer roots, i: inner roots

https://www.researchgate.net/publication/266039333_evaluating_vidalia_onion_packinghouse_improvement_with_discrete_event_simulation_and_non-destructive_testing/figures?lo=1



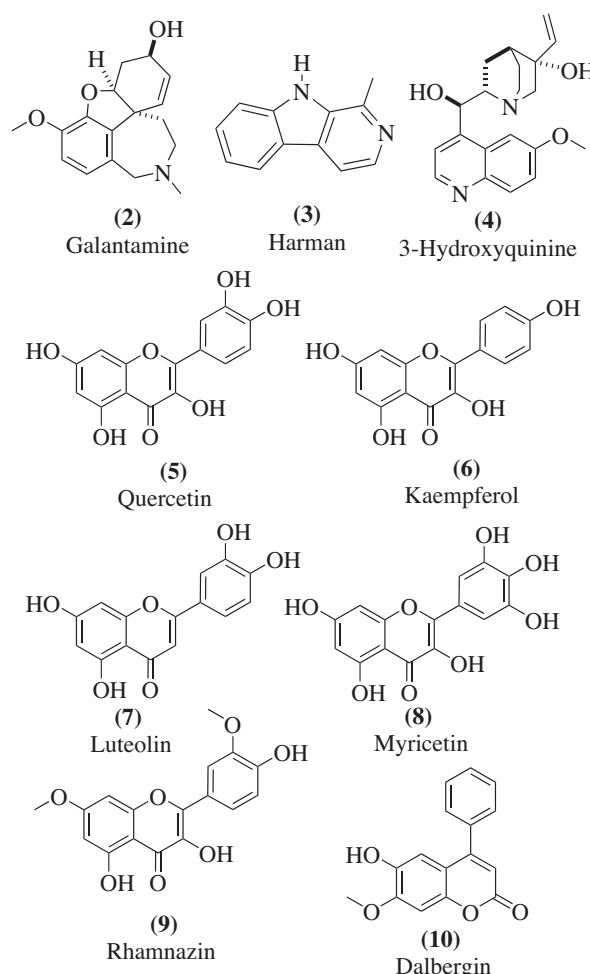
Phytochemicals of onion

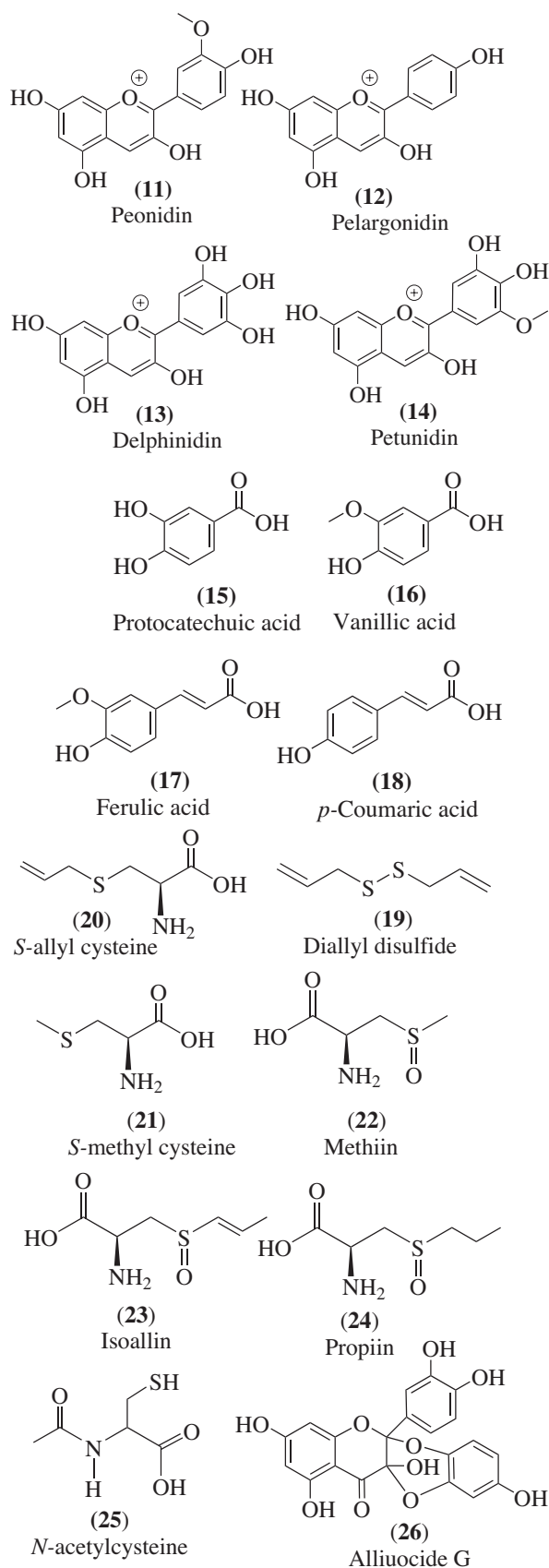
Chemicals produced in plants due to secondary metabolic pathways are known as phytochemicals [5]. Onion bulb and other parts including leaves contain various phytochemicals belong to alkaloids, flavonoids, tannins, saponins *etc.* [6]. Phytochemicals that are present in bulb are given in Table 1 [1-4, 7, 8].

Table 1: Phytochemicals found in the onion bulb

Type	Names of compounds
Alkaloids	Galantamine (2), Harman (3), 3-Hydroxyquinine (4), Morphine-6-Glucuronide

Flavonoids	Quercetin (5) and derivatives, Kaempferol (6) and derivatives, luteolin (7), Myricetin (8), Rhamnazin (9), Dalbergin (10), Xanthomicrol, Petunidin 3-galactoside, Isorhamnetin
Anthocyanin	Cyanidin, Peonidin (11), Pelargonidin (12), Delphinidin (13), Petunidin (14)
Phenolic acids	Protocatechuic acid (15), Vanillic acids (16), Ferulic acid (17), p-Coumaric acid (18)
Organosulfur compounds	Diallyl disulfide (DDS) (19), S-allylcysteine (SAC) (20), S-methylcysteine (SMC) (21), Alliin, Isoalliins (22), Propiin (23), Methiine (24), Alliuocide G (25), Nacetyl cysteine (26)





Organosulfur compounds (such as diallyl disulfide (DDS) (19), S-allyl cysteine (SAC) (20) and S-methyl cysteine (SMC) (21) are caused the pungent taste and lachrymation property [8]. When the cells are

disrupted in an onion, alliinase enzyme excretes to produce sulfenic acids; these acids are rearranged to thiosulfinates, cepaenes and lachrymatory (tearing) factor. Isoalliins (22), propiin (23) and methiin (24) are the non-volatile odorless alkyl and alkenyl cysteine sulfoxide intermediates that are formed. [8].

Onion is also rich in folic acid, vitamin B6, elements in minerals, *e.g.*, potassium, calcium, magnesium and phosphorous [2]. Fructans are polymeric form of the fructose which held by the beta linkages, which accumulated during the growth of the bulb and sprouting [2]. Tannins and saponins are also present in high contents.

Health benefits

Geographical location, storage method, genetic factors determine the quality of an onion. Generally high pungent varieties give more health benefits because of the quantity of organosulfur compounds in those varieties is high. Organosulfur compounds provide anti-inflammatory, antiallergic, antimicrobial and anti-thrombotic properties to the onion [8]. These compounds (especially paraffinic polysulfides - PPS) inhibit the colon and renal carcinogenesis. Anti-thrombotic property reduces the platelet mediate thrombosis which leads heart attacks and strokes. SMC and SAC promote insulin production without elevating the level of cholesterol. Thiosulfinates give anti-asthmatic effect to onions. N-acetylcysteine decreases the adverse effects caused by high sucrose diet; induced obesity and high amount of LDL cholesterol [8, 9, 10, 11].

Free radicals have an adverse effect on living cells. The *ortho*-dihydroxy benzene derivatives (*e.g.*, catechol) and compounds with conjugated double bond to a 4-oxo function in the fused ring show effective free radical scavenging property. Both flavonoids and organo-sulfur compounds lower the risk of forming nitrosamine, which causes damages to cellular proteins, tissues and DNA [6, 12].

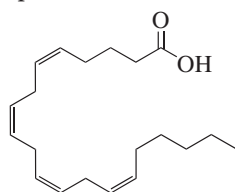
The flavonoid, Alliuocide G (26) is a newly discovered compound present in onion, which shows *in-vitro* α -amylase inhibitory activity and radical scavenging potency [7, 11].

Quercetin and its glucosides (3,4'-diglucoside and

4'-monoglucoside) play a leading role to enhance the health benefits of the onion [7]. It is found in dry skin of the onion in higher amount and decreases from outer to inner rings of the bulb [3]. Quercetin not only consists of anti-carcinogenic anti-obesity, anticancer, anti-oxidant, and neuroprotective properties, but also a good medicine for the cataract [4, 8]. Quercetin also reduces the LDL level, inflammation and inhibits platelet aggregation.

Fructans are important to improve the absorption of Ca and Mg in the human gut. Onions enhance the kidney function and immune function, and it is used to suppress HIV. Onions can inhibit functions of some medicines. For example, arachidonic acid (27) and its metabolites withdraw the effect of morphine which is used as a painkiller [8].

Onion is one of the well-known folk medicines; red onion is used for the treatment of runny nose and antitoxin for centipede bites.



(27)
Arachidonic acid

Onion has wound healing power due to the presence of ferulic acid, beta-sitosterol, kaempferol, myristic acid *etc.* These phytochemicals help to increase synthesis of collagen [14]. Juice of onion bulb is used as a remedy for acute earache [2]. Scientists have discovered the potential of onions to cure semen disorders, defects in seminal volume ejaculation, defects in sperm count, erectile dysfunction and hormonal imbalance [5].

Generally, onion skin contains high flavonoid content. Thus, peel extract of bulbs shows cardioprotective, anticancer, antimicrobial, anti-obesity, antidiabetic, neuroprotective properties [4].

Conclusion

Onion is a herb which contains various phytochemicals such as alkaloids, flavonoids, polyphenols, tannings, organo-sulphur compounds *etc.* Thus, this plant shows immense medicinal properties such as antioxidant, anti-

inflammatory, anti-cancer, antimicrobial, anti-obesity, anti-diabetic, cardio protective, hepato-protective properties *etc.*

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