Guest Articles

Guest Articles

Phytochemical Aspects of Onions - Allium cepa L.

K. Sarath D. Perera and A. D. Theeshya Dulmini Department of Chemistry, The Open University of Sri Lanka

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 counties 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 : Allium

Species : Allium cepa

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.

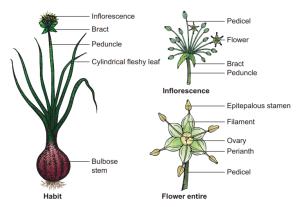


Figure 2: Parts of the onion plant https://www.brainkart.com/article/Botanical-description-of-Allium-cepa_32996/



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-glycoside (1) while the white onion has the least) [4].

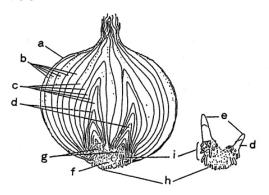


Figure 4: Parts of onion bulb

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	Diallyl disulfide (DDS) (19),
compounds	S-allylcysteine (SAC) (20),
	S-methylcysteine (SMC) (21),
	Alliin,
	Isoalliins (22), Propiin (23),
	Methiine (24), Alliuocide G (25),
	Nacetylcysteine (26)

Vol. 40 No. 2, June 2023

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 methiine (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. Antithrombotic 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 antiasthmatic 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.

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

48

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, hepeto-protective properties *etc*.

References

- 1. Pareek, S.; Sagar, N. A.; Sharma, S.; Kumar, V. Onion (*Allium cepa* L.). Fruit and vegetable phytochemicals: chemistry and human health. **2018**, 2, 1145-1161.
- Chakraborty, A. J.; Uddin, T. M.; Zidan, B.M.R.M.; Mitra, S.; Das, R.; Nainu, F.; Dhama, K.; Roy, A.; Jamal Hossain, M. J.; Khusro, A.; Emran, T.B. Allium cepa: A treasure of bioactive phytochemicals with prospective health benefits. Evidencebased complementary and alternative medicine, 2022, Article ID 4586318, 27 pages. https://doi. org/10.1155/2022/4586318
- 3. Kumar, M.; Barbhai, M. D.; Hasan, M.; Punia, S.; Dhumal, S.; Radha; Rais, N.; Chandran, D.; Pandiselvam, R.; Kothakota, A.; Tomar, M.; Satankar, V.; Senapathy,M.; Anitha, T.; Dey, A.; Sayed, A.A.S.; Gadallah, F.M.; Amarowicz, R.; Mekhemar, M. Onion (*Allium cepa* L.) peels: A review on bioactive compounds and biomedical activities. Biomedicine & pharmacotherapy, February 2022, 146, 112498
- Shabir, I.; Pandey, V.K.; Dar, A.H.; Pandiselvam, R.; Manzoor, S.; Mir, S.A.; Shams, R.; Dash, K.K.; Fayaz, U.; Khan, S.A.; et al. Nutritional profile, phytochemical compounds, biological activities, and utilisation of onion peel for food applications: A review. Sustainability, 2022, 14, 11958. https:// doi.org/10.3390/ su141911958
- Al-Tawalbeh, D.; Bdeir, R.; Al-Momani, J. The use of medicinal herbs to treat male infertility in Jordan: Evidence based review. International Journal of pharmaceutical research & allied sciences, 2023, 12(1), 66-74. https://doi.org/10.51847/42rWHfIT62
- Ramesh, C. K.; Rashmi, T. S.; Kavya B. K.; Manjula K.; Meghana M. Spring onion (leaves Of *Allium cepa*): As green antioxidants. IJCRT, February 2018, 6(1). ISSN: 2320-2882
- 7. Marrelli, M.; Amodeo, V.; Statti, G.; Conforti, F.

Vol. 40 No. 2, June 2023

- Biological properties and bioactive components of *Allium cepa* L.: Focus on potential benefits in the treatment of obesity and related comorbidities. Molecules. **2019**, 24, 119. doi:10.3390/molecules24010119
- 8. Onions Phytochemical and health properties, National onion Association, USA. https://www. onions-usa.org/wp-content/uploads/2019/10/ phytochemical_brochure.pdf (Accessed date: 07.03.2023)
- Al-zaedi, Y. M.; Hadoud, F. S. Anti-diabetic and hypoglycemic activities of onion: A review. Journal of educational, 2023, ISSN: 2011-421X.
- Kim, S.; Jo, S.; Kwon, Y.; Hwang, J. Effects of onion (*Allium cepa* L.) extract administration on intestinal α-glucosidases activities and spikes in postprandial blood glucose levels in SD rat's model. Int. J. Mol. Sci. 2011, 12, 3757-3769.
 - doi:10.3390/ijms12063757
- 11. Mohamed. G. A. Alliuocide G. A new flavonoid with potent α -amylase inhibitory activity from

- Allium cepa L. ARKIVOC, 2008, xi, 202-209
- Arora, E. K.; Sharma, V.; Khurana, A.; Manchanda, A.; Sahani, D. K.; Abraham, S.; Kundu, D.; Gupta, H.; Chiru, L. B.; Sharma, N.; Garg, N.; Jomy, S. Phytochemical analysis and evaluation of antioxidant potential of ethanol extract of *Allium cepa* and ultrahigh homoeopathic dilutions available in the market: A comparative study. Indian Journal of research in homoeopathy. 2017, 11(2), 88-96.
- Liguori, L.; Califano, R.; Albanese, D.; Raimo, E.; Crescitelli, A.; Di Matteo, M. Chemical composition and antioxidant properties of five white onion (*Allium cepa* L.) Landraces. Journal of food quality, 2017, Article ID 6873651, 9 pages https://doi.org/10.1155/2017/6873651
- Mahmood, N.; Muazzam, M. A.; Ahmad, M.; Hussain, S.; Javed, W. Phytochemistry of *Allium cepa* L. (Onion): An overview of its nutritional and pharmacological importance. Sci Inquiry Rev. 2021, 5(3), 41–59.

Professor K Sarath D Perera obtained his BSc from University of Sri Jayewardenepura and completed his PhD in Queen's University Belfast, UK. He is currently serving as a Senior Professor at the Department of Chemistry, Open University of Sri Lanka.

Ms. A. D. Theeshya Dulmini graduated from the Open University of Sri Lanka and obtained her MSc. in Analytical Chemistry from the University of Colombo.

CHEMISTRY IN SRI LANKA

Chemistry in Sri Lanka is a tri-annual publication of the Institute of Chemistry Ceylon and is published in January, May and September of each year. It is circulated among the members of the Institute of Chemistry and students of the Graduateship/DLTC course and libraries. The publication has a wide circulation and more than 500 copies are published. Award winning lectures, abstracts of communications to be presented at the annual sessions, review papers, activities of the institute, membership news are some of the items included in the magazine.

The editor invites from the membership the following items for publication in the next issue of the Chemistry in Sri Lanka which is due to be released in September 2023.

- Personal news of the members
- Brief articles of topical interests
- Forthcoming conferences, seminars and workshops
- Latest text books and monographs of interest to chemists

All publications will be subjected to approval of the 'Editorial and Publicity Committee' and the Council of the Institute of Chemistry Ceylon.

Further, prospective career opportunities for chemists, could be advertised in Chemistry in Sri Lanka at a nominal payment. The editor in chagge welcomes suggestions from the members for improvement of the publication.

Vol. 40 No. 2, June 2023