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A REVIEW ON ONION *(ALLIUM CEPA L.)*

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ABSTRACT
One of the most popular and widely farmed vegetable crops worldwide is the onion (Allium cepa L.). The onion bulb, which has a distinctive flavour and is the third-most important horticultural spice, has a high commercial value. A. cepa is traditionally used for its therapeutic benefits in a wide range of indigenous cultures in addition to its culinary benefits. Numerous publications have been created in an effort to support these conventional views. However, there is still a severe lack of current, a thorough compiling and evaluation of A. cepa's traditional and ethno pharmacological tendencies. Therefore, the objective of the current review is to thoroughly examine the published literature on the traditional uses, pharmacological characteristics, and phytochemical makeup of A. cepa. Numerous pharmacological qualities, including as antibacterial, antioxidant, analgesic, anti-inflammatory, anti-diabetic, hypolipidemic, anti-hypertensive, and immunoprotective activities, were discovered in A. cepa. Although several in vitro and in vivo investigations have been carried out, there are still a number of restrictions and knowledge gaps that must be filled in future research.

Keywords: *Allium cepa L., Onion, Pharmacological Characteristics, Ethnopharmacological tendency.*

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INTRODUCTION

The circular economy (CE) is now a well-liked structure that is supported by numerous industries worldwide [1]. The "take, make, and dispose" premise underpins the linear economy [2]; in contrast, the CE aims to use resources efficiently by reducing waste and retaining long-term value [3]. As a result, the CE is a potential remedy that encourages the effective use of resources in order to maximise economic gains and lessen environmental strain [4]. According to the European Commission, the manufacturing sector alone might gain from the CE transition to the tune of 600 billion euros annually [1]. The agro-industry generates a lot of organic waste, much of which is either dumped in landfills or used to make items with little additional value. The CE concept, however, intends to turn this waste into goods with significant commercial value, like pharmaceuticals, nutraceuticals, and cosmetics [5,6]. In the food, cosmetics, and pharmaceutical industries, secondary products of the food industry frequently contain useful compounds that can be employed as functional additives [7]. After tomatoes, onions (Allium cepa L.) are the second most widely grown crop in the world, with a harvest estimated to be around 89 million tonnes [5,6]. The variety of the onion contributes to its enormous popularity. It can be consumed raw or cooked in a variety of ways, including as baking, boiling, braising, grilling, frying, etc. [8]. The usage of onions as a source of bioactive phytonutrients as well as their use as a flavouring or spicy element have both contributed to a recent increase in global onion production of at least 25% [7,9]. Numerous epidemiological studies have proven that regular onion consumption lowers the incidence of different types of cancer, cardiovascular and neurodegenerative diseases, as well as other diseases associated with oxidative stress. Onions are known to be rich in antioxidant compounds and to contribute to the prevention of certain diseases associated with oxidative stress [8,10]. When onions are processed, which involves peeling, slicing, and dicing them, more than 550,000 tonnes of bio-waste are produced [5,6]. These activities also produce a lot of trash [11]. The surge in relevant scientific studies over the last two years is a hint that interest in onion trash has expanded dramatically in recent years. This is because this garbage is inexpensive and readily available. However, onion skin represents the predominant waste component in onion processing (up to 60%) [7,11], with roots, tops of the bulbs, and degraded bulbs making up the remainder of the waste biomass [6,12]. Because onion waste has a bad flavour and smell, it cannot be used as organic fertiliser or as animal food and is typically disposed of in landfills, which harms the environment [5-7]. On the other hand, onion peel is abundant in polyphenolic antioxidants, particularly quercetin and its derivatives, glucosides, a class of flavonoids, ferulic acid, gallic acid, and kaempferol, all of which have significant positive effects on a variety of biological processes, such as antidiabetic, antioxidant, anti-inflammatory, antitumor, antimicrobial, and enzyme-inhibitory effects [5,13]. When it comes to onion types, quercetin and its derivatives, along with glucosides, are the most common flavonols in all types of onions, whether they are white, yellow, or red. In contrast, anthocyanins are primarily found in red onions, where they account for about 10% of the total flavonoid content in fresh weight [7,9]. The largest concentrations of notable flavonoids, including quercetin and its glucosides, are found in pearls, followed by red, yellow, and white onion husks [11,13], with extraction conditions having a significant impact [14]. In Russia, a large percentage of all vegetables are produced as onions. Onions of all colors—yellow, white, and red—are eaten, with yellow being the most common. This study's objective was to evaluate these three forms of husk waste's antioxidant capability.

Figure.1; Onion (*Alium cepa* L)

CHEMICAL CHARACTERISTICS OF ALLIUM CEPA

Onion has a lot of dietary fibre and sugar, which is mostly water. In terms of vitamins and minerals, the onion is low in sodium and high in folic acid, vitamin B6, magnesium, calcium, potassium, and phosphorus. Only glutamic acid and arginine are the two remarkable amino acids in onion, which has a low lipid content [1]. Numerous phytochemical analyses of A. cepa have been conducted, and several chemicals that are in charge of both its distinctive aroma and its therapeutic effects have been identified. The diverse classes of phytochemicals have become quite interested in phenolic compounds since they support the biological functions of medicinal plants. A research on four A. cepa variants (violet, red, green, and white) for their compliance with the high-performance liquid chromatography (HPLC) was performed [14]. Kaempferol, ferulic acid, quercetin, gallic acid, and protocatechuic acid were also identified. The number of phenolic compounds found in each variety varied significantly, e.g., gallic acid (9.3–354 lg/g), ferulic acid (13.5–116 lg/g), quercetin (14.5–5110 lg/g), protocatechuic acid (3.1–138 lg/g), and kaempferol (3.2–481 lg/g). In addition, a variety of flavonoids were discovered in various onion varieties: quercetin40-monoglucoside [15], isorhamnetin 3,40-diglucoside, quercetin-3,40-diglucoside, quercetin aglycon, quercetin-3- monoglucoside, delphinidin 3,5-diglycosides, quercetin 3- glycosides [16], quercetin 7,40-diglucoside, quercetin 3,7,40- triglucoside, quercetin 3,40-diglucoside [17], and many others. When compared to apples (50 mg/kg), broccoli (100 mg/kg), and blueberries (40 mg/kg), A. cepa has 5 to 10 times higher quercetin content (300 mg/kg) [18]. Moreover, various experiments have found various onion anthocyanins: cyanidin 7-O-(300-O-β-glucopyranosyl-600-Omalonyl-β-glucopyranoside)-40-O-β-glucopyranoside, cyanidin 3-O-(300-O-β-glucopyranosyl-600-O-malonylβ-glucopyranoside)-40-O-β-glucopyranoside, cyanidin 40- O-β-glucoside, cyanidin 3,40-di-O-β-glucopyranoside, peonidin 3-O-(600-O-malonyl-β-glucopyranoside), and peonidin 3-O-(600-O-malonyl-β-glucopyranoside)-5-Oβ-glucopyranoside were present in minute amounts from parts which are pigmented of red onion [17]. Additionally, four anthocyanins with the same unique structure were produced by methanolic extracts of red onions. Two of their structures were identified as 4-substituted aglycone, carboxypyranocyanidin, 5-carboxypyranocyanidin 3-O-glucopyranoside, and 5-carboxypyranocyanidin 3-O-(6′′-O-malonyl-glucopyranoside) [19]. Additionally, Malvidin 3′-glucoside and Peonidin 3′-Glucoside Acetate were effectively established by Fredotovic et al. [20]. According to a study by VazquezArmenta et al., the two primary components of onion oil are dipropyl trisulfide and dipropyl disulfide [21]. A class of biologically active organo-sulfuric chemicals is known as S-alk(en)yl-Lcysteine sulfoxides, and includes substances like c-glutamylcysteine and alliin. Fresh onion flavour and scent are produced as methiine, allicin, iso-alliin, propin, and lipid-soluble sulphur compounds are released during the crushing of plant components (for example, diallyl-disulfide and diallyl sulfide). The irritating lachrymatic component that is released when an onion is chopped is thought to form spontaneously as a result of the action of the enzyme alliinase [22]. Another thiopropal S-oxide chemical, the sulphide volatile, is a lachrymal component found only in onions that eventually converts thiopropal S-oxide to methylpentanols [23]. Thin-layer chromatography with dichloromethane extraction also revealed many disulfide radicals (methyl, allyl, and propyl) in the red onion varieties [24]. Quantitative analyses have revealed that the abundance of tri- and disulfides, such as trans- and cis-methyl-1propenyl disulfides, dipropyl disulfides, methyl-2-propenyl disulfides, trans- and cis-propenyl propyl disulfides, and methyl propyl trisulfides, is over 60%. The bulb extracts also included certain organic acids, according to Dhumal et al.They were succinic, ascorbic, tartaric, malic, oxalic, and citric acids. Moreover, Liguori et al. (Italy) discovered many aldehydes and ketones in the onion land races of Bianca di Pompei cv., grown in the region Campania [25]. The most prevalent and potent test of all was furfuraldehyde in Aprilatica. Propionaldehyde and 2-methyl-2-pentenal material samples varied between landraces. Pentanedione's 1,2-cyclo concentration was higher than that produced during the months when Maggiaiola, Aprilatica, and Giugnese onions were not harvested throughout the winter (Marzatica and Febbrare). The butyrolactone recipe only used spring-harvested onions (Maggiaiola, Aprilatica, and Giugnese). Aqueous extraction on DEAE cellulose, ion exchange chromatography, affinity chromatography on FPLC-gel filtration, and affi-gel blue gel on Superdex were used to isolate the antifungal peptide allicepin. Another chemical discovered from bulbs called Zwiebelane A (cis-2, 3- dimethyl-5, 6-dithiabicyclohexane 5-oxide) was found to increase the potential fungicidal activity of the conventional antibiotic polymyxin B [27]. The flavouring created during frying is called zwiebelane A. From the bulbs, Tverskoy et al. discovered two more phytoalexins. They are 5-octyl- and 5-hexyl-cyclopenta-1,3-dione [2] respectively.

BIOACTIVE COMPOUNDS

The abundance of sulphur compounds in onions, which cause the throat and back of the mouth to burn, are what give them their pungent flavour. An efficient method for determining onion pungency is to analyse the pyruvic acid that thiosulfins create in stoichiometric proportions. Pyruvic acid and flavour perception have been found to be correlated. The mix of pungency and sugar in an onion determines its sweetness. To prevent the onion from being thought of as sweet, a strong pungentness will mask a high sugar content. Onions with little flavour and little sweetness may likewise be thought of being tasteless. A sweet onion should have high sugar content and low pungency [28]. Particularly in the presence of heat, isulfinates are unstable and split into a variety of compounds, the most common of which are mono-, di-, tri-, and tetrasulfides. Dipropyl trisulfide, dipropyl disulfide, and propenyl disulfides are the major components of onion volatiles. Several additional substances, such as dipropenyl sulphide and dipropyl sulphide, have also been identified [31]. Yamazaki et al. have identified 11 sulfur-containing taste precursors in onions, including methiin, S-alkyl-L-cysteine derivatives, isoalliin, alliin, deoxyalliin, cycloalliin, and N-(gamma-glutamyl)-S- (2-propenyl) N-nitroso L-cysteine (gamma-glutamyl) The compound S-methyl-L-cysteine, N-(gamma-glutamyl)-S- (2-propenyl) N-nitro-L-cysteine sulfoxide (gammaglatamyl) -S-(E-1-propenyl) S-(2-carboxypropyl) glutathione, N-(gamma-glutamyl)-S, and L-cysteine (Glu-PEC) (E-1- propenyl) Glu-PECSO (L-cysteine sulfoxide) [32]. Numerous intriguing new chemicals have been isolated from onions, according to recent literature. With their potential health benefits, peptides and saponin have been extracted and studied. In Allium species, several saponins have been identified, and processing has led to the reoccurrence of numerous saponins [33,34].In vitro inducers of glutathione S-transferase and quinone reductase were discovered, including 5-Hydroxy-3-methyl-4-propylsulfanyl5H-furan-2-one and four additional substances [35]. The saponins extracted from onions and garlic have been shown in several studies to have anticancer, antifungal, blood coagulability, cytotoxicity, cholesterol-lowering, and antispasmodic properties [33]. Four furostanol saponins, including two new compounds termed ceposide A and ceposide B, were identified from the seeds of A. cepa [36]. Additionally, Corea et al. found novel saponins that showed antispasmodic activity in the isolated ileum of the guinea pig, an effect that would support the conventional use of ointment in the treatment of digestive disorders [34]. In vitro osteoclast development and activity have also been shown to be inhibited by gamma-glutamyl onion peptide [37,38]. As they directly contribute to the energy needed for drying, which is crucial in the onion dehydration sector, the contents of dry matter bulbs represent a significant onion quality criterion [39,40]. The dry bulb is composed of nonstructural carbohydrates to a degree of 65 to 80%. Although low molecular fructans are lacking, the three main nonstructural carbohydrates found in onions are glucose, fructose, and sucrose. Onions have a significant carbohydrogen reserve known as FOS, which is a polyfructose with various molecular sizes. The name for fructans is fructooligosaccharides (FOS). When the bulbs are developing and sprouting, fructans build up during bulbing and catabolism [39].Only fructose oligomers with fructosyl units (F) attached to sucrose position (GF + fructose) by ßlinkage and principally made of nystose (GF3), ketose (GF2), and fructofuranosylnystose (GF4) are referred to be FOS in popular usage. Every onion tissue contains ketoses (GF2) in abundant amounts, but there are no substantially polymerized fructans. The fleshy layers are the most productive tissues, making the outer two fleshy layers the most abundant by product of the onion and a possible source of fructan [41,42]. Onion typically has a fructan degree of polymerization (DP) level between 3 and 15. Theoretically, short chain fructans with polymerization rates under five can be employed as natural sweeteners. For lipid substitution, onion bulbs with high DP fructans may be employed, with possible consequences. Compared to other vegetables, onions have a higher ratio of soluble to insoluble nutritional fibre (SDF: IDF), which has been associated to a variety of physiologic and metabolic consequences. IDF reduces intestinal transit and increases meal mass for the majority of people, but SDF increases stomach viscosity, leading nutrients to be decreased and absorbed [43]. The health benefits of allium vegetables have been supported by numerous in vitro, in vivo, and ex vivo studies. Onions have been specifically recognised as having anticarcinogenic, antioxidant, hypoglycemic, hypolipidemic, and antiaggregatory properties. From a nutritional and medical perspective, it is clear that onions, which are frequently used as a vegetable or food element in recipes, are frequently extremely beneficial in their treatments. A diet high in vegetables, especially onions, has been linked to a range of health benefits, including the prevention of CVD and cancer resurgences, two of today's most significant and common diseases [1].

THERAPEUTIC POTENTIAL OF ALLIUM CEPA

Aliumcepa has been recognised as an efficient antibacterial agent for the treatment of infectious illnesses. Numerous A. cepa solvent extracts have been reported to be effective against numerous fungi, bacteria, and viruses [2]. In a study by Liguori et al. [25], the impact of compound organosulfur on the proliferation of microorganisms has been reevaluated. While it wasn't as effective as kaempferol in stopping the growth of L. monocytogenes, B. cereus, and P. aeruginosa, quercetin was just as effective at stopping the development of M. luteus and S. aureus [44]. Another study found that the essential oils of red, green, and yellow onions were highly effective at inhibiting the growth of a number of pathogens, including Salmonella enteritidis, Fusarium oxysporum, Penicillium cyclopium, Staphylococcus aureus, and Aspergillus Niger [39]. It has been demonstrated that the red A. cepa extract has more antibacterial capabilities than the yellow and white types [45].

CONCLUSION

The purpose of the current study is to update and modify the compilation of A. cepa-related studies. Teshika et al; relatively little attention placed on the ethnopharmacological uses of this plant, this compilation sought to highlight the medicinal features of A. cepa crop. However, this approach might be seen as an effort to include slivers of scientific data based on the A. cepa's ethnopharmacology. Attempts were also made designed to deepen and broaden understanding of the herb that has been utilised traditionally for its unnecessary medicinal characteristics, bioactive makeup, and pharmacological aspects. A. cepa might be thought of as a source of essential phytopharmaceuticals with potential uses in developing disciplines of study.

REFERENCES

1. Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: the concept and its limitations. Ecological economics, 143, 37-46.
2. Jørgensen, S., & Pedersen, L. J. T. (2018). The circular rather than the linear economy. In RESTART sustainable business model innovation (pp. 103-120). Palgrave Macmillan, Cham.
3. Morseletto, P. (2020). Targets for a circular economy. Resources, Conservation and Recycling, 153, 104553.
4. Velenturf, A. P., & Purnell, P. (2021). Principles for a sustainable circular economy. Sustainable Production and Consumption, 27, 1437-1457.
5. Milea, Ș. A., Aprodu, I., Enachi, E., Barbu, V., Râpeanu, G., Bahrim, G. E., & Stănciuc, N. (2021). Whey protein isolate-xylose Maillard-based conjugates with tailored microencapsulation capacity of flavonoids from yellow onions skins. Antioxidants, 10(11), 1708.
6. Benito-Román, Ó., Blanco, B., Sanz, M. T., & Beltrán, S. (2020). Subcritical water extraction of phenolic compounds from onion skin wastes (Allium cepa cv. Horcal): Effect of temperature and solvent properties. Antioxidants, 9(12), 1233.
7. Celano, R., Docimo, T., Piccinelli, A. L., Gazzerro, P., Tucci, M., Di Sanzo, R., ... & Rastrelli, L. (2021). Onion peel: Turning a food waste into a resource. Antioxidants, 10(2), 304.
8. González-de-Peredo, A. V., Vázquez-Espinosa, M., Espada-Bellido, E., Ferreiro-González, M., Carrera, C., Barbero, G. F., & Palma, M. (2021). Development of Optimized Ultrasound-Assisted Extraction Methods for the Recovery of Total Phenolic Compounds and Anthocyanins from Onion Bulbs. Antioxidants, 10(11), 1755.
9. González-de-Peredo, A. V., Vázquez-Espinosa, M., Espada-Bellido, E., Carrera, C., Ferreiro-González, M., Barbero, G. F., & Palma, M. (2021). Flavonol composition and antioxidant activity of onions (Allium cepa L.) based on the development of new analytical ultrasound-assisted extraction methods. Antioxidants, 10(2), 273.
10. Marrelli, M., Amodeo, V., Statti, G., & Conforti, F. (2018). Biological properties and bioactive components of Allium cepa L.: Focus on potential benefits in the treatment of obesity and related comorbidities. Molecules, 24(1), 119.
11. Sagar, N. A., Pareek, S., Benkeblia, N., & Xiao, J. (2022). Onion (Allium cepa L.) bioactives: Chemistry, pharmacotherapeutic functions, and industrial applications. Food Frontiers.
12. Vojvodić Cebin, A., Šeremet, D., Mandura, A., Martinić, A., & Komes, D. (2020). Onion solid waste as a potential source of functional food ingredients. Engineering Power: Bulletin of the Croatian Academy of Engineering, 15(3), 7-13.
13. Bedrníček, J., Kadlec, J., Laknerová, I., Mráz, J., Samková, E., Petrášková, E., ... & Smetana, P. (2020). Onion peel powder as an antioxidant-rich material for sausages prepared from mechanically separated fish meat. Antioxidants, 9(10), 974.

14. Prakash, D., Singh, B. N., & Upadhyay, G. (2007). Antioxidant and free radical scavenging activities of phenols from onion (Allium cepa). Food chemistry, 102(4), 1389-1393.
15. Vian, M. A., Fabiano-Tixier, A. S., Elmaataoui, M., Dangles, O., & Chemat, F. (2011). A remarkable influence of microwave extraction: Enhancement of antioxidant activity of extracted onion varieties. Food Chemistry, 127(4), 1472-1480.
16. ZHANG, S. L., Peng, D. E. N. G., XU, Y. C., Lü, S. W., & WANG, J. J. (2016). Quantification and analysis of anthocyanin and flavonoids compositions, and antioxidant activities in onions with three different colors. Journal of Integrative Agriculture, 15(9), 2175-2181.
17. R. M. P´erez-Gregorio, M. S. Garc´ıa-Falc´on, J. SimalGandara, A. S. Rodrigues, and D. P. F. Almeida(2010). "Identifi- ´ cation and quantification of flavonoids in traditional cultivars of red and white onions at harvest," Journal of Food Composition and Analysis, vol. 23, no. 6, pp. 592–598.
18. Hollman, P. C. H., & Arts, I. C. W. (2000). Flavonols, flavones and flavanols–nature, occurrence and dietary burden. Journal of the Science of Food and Agriculture, 80(7), 1081-1093.
19. Fossen, T., & Andersen, Ø. M. (2003). Anthocyanins from red onion, Allium cepa, with novel aglycone. Phytochemistry, 62(8), 1217-1220.
20. Fredotović, Ž., Šprung, M., Soldo, B., Ljubenkov, I., Budić-Leto, I., Bilušić, T., ... & Puizina, J. (2017). Chemical composition and biological activity of Allium cepa L. and Allium× cornutum (Clementi ex Visiani 1842) methanolic extracts. Molecules, 22(3), 448.
21. Vazquez-Armenta, F. J., Ayala-Zavala, J. F., Olivas, G. I., Molina-Corral, F. J., & Silva-Espinoza, B. A. (2014). Antibrowning and antimicrobial effects of onion essential oil to preserve the quality of cut potatoes. Acta alimentaria, 43(4), 640-649.
22. Imai, S., Tsuge, N., Tomotake, M., Nagatome, Y., Sawada, H., Nagata, T., & Kumagai, H. (2002). An onion enzyme that makes the eyes water. Nature, 419(6908), 685-685.
23. Thomas, D. J., & Parkin, K. L. (1994). Quantification of alk (en) yl-L-cysteine sulfoxides and related amino acids in Alliums by high-performance liquid chromatography. Journal of Agricultural and Food Chemistry, 42(8), 1632-1638.
24. Griffiths, G., Trueman, L., Crowther, T., Thomas, B., & Smith, B. (2002). Onions—a global benefit to health. Phytotherapy research, 16(7), 603-615.
25. Liguori, L., Califano, R., Albanese, D., Raimo, F., Crescitelli, A., & Di Matteo, M. (2017). Chemical composition and antioxidant properties of five white onion (Allium cepa L.) landraces. Journal of Food Quality, 2017.
26. Wang, H. X., & Ng, T. B. (2004). Isolation of allicepin, a novel antifungal peptide from onion (Allium cepa) bulbs. Journal of Peptide Science: An Official Publication of the European Peptide Society, 10(3), 173-177.
27. Borjihan, B., Ogita, A., Fujita, K. I., Doe, M., & Tanaka, T. (2010). The cyclic organosulfur compound zwiebelane A from onion (Allium cepa) functions as an enhancer of polymyxin B in fungal vacuole disruption. Planta medica, 76(16), 1864-1866.
28. Vågen, I. M., & Slimestad, R. (2008). Amount of characteristic compounds in 15 cultivars of onion (Allium cepa L.) in controlled field trials. Journal of the Science of Food and Agriculture, 88(3), 404-411.
29. Rose, P., Whiteman, M., Moore, P. K., & Zhu, Y. Z. (2005). Bioactive S-alk (en) yl cysteine sulfoxide metabolites in the genus Allium: the chemistry of potential therapeutic agents. Natural product reports, 22(3), 351-368.
30. Munday, R., & Munday, C. M. (2004). Induction of phase II enzymes by aliphatic sulfides derived from garlic and onions: an overview. Methods in Enzymology, 382, 449-456.
31. Munday, R., & Munday, C. M. (2001). Relative activities of organosulfur compounds derived from onions and garlic in increasing tissue activities of quinone reductase and glutathione transferase in rat tissues. Nutrition and cancer, 40(2), 205-210.
32. Yamazaki, Y., Iwasaki, K., Mikami, M., & Yagihashi, A. (2010). Distribution of eleven flavor precursors, S-alk (en) yl-L-cysteine derivatives, in seven Allium vegetables. Food science and technology research, 17(1), 55-62.
33. Lanzotti, V. (2006). The analysis of onion and garlic. Journal of chromatography A, 1112(1-2), 3-22.
34. Corea, G., Fattorusso, E., Lanzotti, V., Capasso, R., & Izzo, A. A. (2005). Antispasmodic saponins from bulbs of red onion, Allium cepa L. var. Tropea. Journal of agricultural and food chemistry, 53(4), 935-940.
35. Xiao, H., & Parkin, K. L. (2007). Isolation and identification of potential cancer chemopreventive agents from methanolic extracts of green onion (Allium cepa). Phytochemistry, 68(7), 1059-1067.
36. L. Yuan, T. F. Ji, A. G. Wang, J. B. Yang, and Y. L. Su(2008). "Two new furostanol saponins from the seeds of Allium cepa L," Chinese Chemical Letters, vol. 19, no. 4, pp. 461–464.
37. H. A. Wetli, R. Brenneisen, and I. Tschudi(2004). "Gamma-glutamyl-peptide isolated from onion by bioassay guided fractionation inhibits resorption activity of osteoclasts," Journal of Bone and Mineral Research, vol. 19, p. S314, 2004.
38. Langos, M., Hofstetter, W., Dolder, S., Felix, R., Mühlbauer, R. C., & Brenneisen, R. (2007). A gamma-glutamyl peptide from onion inhibits the development and activity of osteoclasts in vitro. Planta Medica, 73(09), P_458.
39. Benkeblia, N. (2004). Antimicrobial activity of essential oil extracts of various onions (Allium cepa) and garlic (Allium sativum). LWT-food science and technology, 37(2), 263-268.

40. R. Kahane, E. Vialle-Gu´erin, I. Boukema et al.(2001). "Changes in non-structural carbohydrate composition during bulbing in sweet and high-solid onions in field experiments," Environmental and Experimental Botany, vol. 45, no. 1, pp. 73–83.
41. Jaime, L., Martínez, F., Martín‐Cabrejas, M. A., Mollá, E., López‐Andréu, F. J., Waldron, K. W., & Esteban, R. M. (2001). Study of total fructan and fructooligosaccharide content in different onion tissues. Journal of the Science of Food and Agriculture, 81(2), 177-182.
42. Jaime, L., Martín-Cabrejas, M. A., Mollá, E., López-Andréu, F. J., & Esteban, R. M. (2001). Effect of storage on fructan and fructooligosaccharide of onion (Allium cepa L.). Journal of Agricultural and Food Chemistry, 49(2), 982-988.
43. Jaime, L., Mollá, E., Fernández, A., Martín-Cabrejas, M. A., López-Andréu, F. J., & Esteban, R. M. (2002). Structural carbohydrate differences and potential source of dietary fiber of onion (Allium cepa L.) tissues. Journal of Agricultural and Food Chemistry, 50(1), 122-128.
44. Santas, J., Almajano, M. P., & Carbó, R. (2010). Antimicrobial and antioxidant activity of crude onion (Allium cepa, L.) extracts. International journal of food science & technology, 45(2), 403-409.
45. K. Sharma, N. Mahato, and Y. R. Lee(2018). "Systematic study on active compounds as antibacterial and antibiofilm agent in aging onions," Journal of Food and Drug Analysis, vol. 26, no. 2, pp. 518–528.