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Chinese onion (*Allium chinense*), an evergreen vegetable: A brief review

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Abstract. The history of using medicinal herbs and plant dates back to the ancient times. Chinese onion (*Allium chinense*) is famous as a plant for both food and medicinal purposes. It is widely cultivated as a vegetable and native to China. Its bulbs are commonly processed into pickles and spices. The bulb is anthelmintic, anti-inflammatory, antiseptic, antispasmodic, carminative, diuretic, expectorant, febrifuge, hypoglycaemic, hyptensive, lithontripic, stomachic and tonic. It can be also used to prevent oral infection and tooth decay. The most important chemical constituents of the essential oil derived from *Allium chinense* are: dimethyl disulfide, diallyl sulfide, allyl isothiocyanate, methyl allyl disulfide, methyl propyl disulfide, α-pinene, dimethyl trisulfide, β-pinene, 1,3-dithiane, limonene, diallyl disulfide, linalool, methyl allyl trisulfide, methyl propyl trisulfide, dimethyl tetrasulfide, diallyl trisulfide, diallyl thiosulfinate, and allyl methyl tetrasulfide.

Keywords: Chinese onion, Rakkyo, traditional medicine, saponin, volatile oils.

INTRODUCTION

There are plenty of plants in different parts of the world which have been reported to have important roles for the treatments and prevention of various diseases (Ogbaji et al., 2013; Soleymani and Shahrajabian, 2018; Shahrajabian et al., 2019a,b,c; Sun et al., 2019a,b). Traditionally, many plants have been used in Asia as medicine which they have bioactive phytochemical constituents (Ogbaji et al., 2018; Shahrajabian et al., 2019d,e,f,g). The traditional healer plants provide health care services based on religious background, knowledge, culture, attitudes and beliefs (Soleymani and Shahrajabian, 2012; Sun et al., 2020, Shahrajabian et al., 2020a,b,c,d). *Allium chinense* is an edible species of *Allium*, native to China and cultivated in many other Asian countries, characterized by its white, crisp bulbs, long green stalks, and tiny, purple flowers. Its close relatives are the onion, shallot, leek, chive and garlic. *Allium chinense* is used as a folk medicine in tonics to help intestines and as a stomachic. The strong, pungent odor of Chinese onion is thought to act as a repellent for moles and other garden vermins. This vegetable can also be pickled and served as a side dish or as an appetizer in Asian cuisine. The aim of this review is survey on the most important chemical constituent, health benefits and medicinal usage of Chinese onion.

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MATERIALS AND METHODS

All relevant papers in English language of various researchers and scholars from different countries were collected. The keywords of Chinese onion, Rakkyo, Traditional Medicine, Saponin, and Volatile oil were searched in Google Scholar, Scopus, Science Direct and PubMed.

CHINESE ONION OCCURRENCE AND CULTIVATION

Traditional medicinal science in Asia, that makes use of *Allium* plants, is one of the therapeutic systems of high repute in terms of its age and the number of species it employs (Poonthananiwatkul et al., 2015; Asemani et al., 2019). *Allium* species are supposed to be ones of the world's oldest cultivated vegetables. Most of the edible *Allium* species are native to the mountains of central Asia. The economically most important *Allium* crop species (common onion and garlic) are used worldwide as vegetables, spices and medicinal plants; and traditionally, they play an important role in the daily diet in Asia (Keusgen et al., 2006; Zhu et al., 2017; Teshika et al., 2018). *Allium chinense* bulbs have been reported to be used for making pickles (Gohil and Koul, 1981). Chinese onion (*A. chinense* G. Don), also

Figure 1. Chinese onion (*Allium chinense*).

known as oriental onion, is an ancient vegetable native to China (Yan et al., 2009; Wang et al., 2019). It is cultivated in most parts of China, especially in Anhui, Fujian, Guangdong, Guangxi, Guizhou, Hainan, Henan, Hubei, Jiangxi and Zhejiang provinces. Owing to its very mild and fresh taste, *A. chinense* is often pickled and served as a side dish in Japan and Vietnam to balance stronger flavor of some other components in a meal. Chinese onion is an important cash crop in Japan. It is a perennial and tillers vigorously and each shoot forms a small-ovoid bulb at the base (Tanaka et al., 2019). Bulbs are purplish or grayish white and covered by a semi-transparent, dry membranous skin (Fig. 1). They have a crisp texture and a strong onion-like but distinctive odour, and the leaves of Chinese onion grow up to 50 cm long and resemble those of chives but are angular rather than round and less erect. In the Japanese cuisine, it is eaten with Japanese curry as a garnish. It is widely cultivated in Asian countries such as China (its common name is Jiaotou), Japan (known as Rakkyo), Korea, Vietnam, and Indonesia for its edible bulbs and leaves, which may be eaten raw or cooked. Its flowers are also edible and may be used as a garnish on salads (Rabinowitch and Currah, 2002). Chinese onion bulbs that are commonly served as sweet or sour pickles after having been steeped in sugar and brine, cooked with other ingredients feature highly in varied Chinese cuisine (He et al., 2018).

CHINESE ONION NUTRITIONAL COMPOSITION, CHEMICAL CONSTITUENTS AND ITS MEDICINAL USES AND POTENTIAL HEALTH BENEFITS IN TRADITIONAL MEDICINE AND MODERN INDUSTRY

Phytochemical investigates on Chinese onion have led to the isolation of sulfur-containing compounds which are responsible for its onion-like flavor (Augusti, 1996; Pino et al., 2001), nitrogen-containing constituents (Okuyama et al., 1989), and steroidal saponins (Wang et al., 2016). The plant-derived polyphenols from genus *Allium* serve beneficial roles in human nutrition. The plant-derived phytochemical flavonols include quercetins and quercetin glycosides (Xiao et al., 2015; Kothari et al., 2019; Pan et al., 2018).Quercetins have been reported to exhibit anti-cancer and anti-inflammatory activities (Zielinska et al., 2003; Rohn et al., 2007). Baba et al. (2000) stated that *Allium chinense* G. Don has been cultivated since ancient times, and the bulbs, named Rakkyo in Japan, are widely used as pickles and spices. They have also reported that the bulbs of this plant are main source of a Chinese traditional medicine "Xiebai", in which they are used for the treatment of chest pain, stenocardia, and heart asthma. Chinese onion polysaccharides have attracted a great deal of interest in their therapeutic properties, especially anti-cancerous, anti-oxidant, anti-diabetic, anti-microbial properties and of course in their immunomodulatory role (Zhu et al., 2018). Baba et al. (2000) reported the isolation of 2 saponins, xiebaisaponin I, and laxogenin 3-*O*-α-arabinopyranosyl, and the aglycone, laxogenin, together with 2 chalcones, isoliquiritigenin and isoliquiritigenin-4-*O*-glucoside, and *β*-sitosterol glucoside. In their experiment, laxogenin was proven to have an antitumor activity in a two-stage lung carcinogenesis experiment. Flavonoids and organosulfur compounds are the two major classes of secondary metabolites found in *Allium* believed to promote beneficial health effects (El-Hadidy et al., 2014). Naibaho et al. (2015) revealed that *Allium chinense* contains biologically active compounds as antimicrobial, particularly anti-Candida, agent. Asemani et al. (2019) reported that 16 members of the genus *Allium* showed potential anticancer properties due to the accumulation of various sulfur and organic compounds like S-allyl mercaptocysterin, quercetin, flavonoids, and ajoene. In traditional Chinese medicine, the bulbs of *A. chinense* served as one of the botanical sources of the crude drug Xiebai, which is included in some classic prescription for treating chest pain, stenocardia, as well as heart asthma (Chinese Pharmacopeia Commission, 2015). Sulfur components of Chinese chive (*Allium tuberosum* Rottl. Ex Sprengel) and Rakkyo (*Allium chinense* G. Don) were isolated, and the sulfur compounds accounted for 88 and 94% of the total volatiles in the isolated extract of Chinese chive and rakkyo, respectively; besides, the most important among them were sulfides, disulfides, trisulfides, and tetrasulfides with ethyl, butyl, and pentyl groups (Pino et al., 2001). Nutritionally important compounds and the content thereof in Chinese onion are shown in Table 1.

The most important chemical composition of the essential oils of Chinese onion are isoamyl alcohol, methyl 1-propenyl sulfide, dimethyl disulfide, (Z)-3-hexenal, 2-methylpentenal, hexanal, propanal diethyl acetal, 2-ethylpyridine, (E)-hexenol, 1,3-propanedithiol, diallyl sulfide, *n*-hexanol, allyl propyl sulfide, bis-(1-propenyl)-sulfide, dimethyl thiophene, nonane, dimethyl thiophene, allyl methyl disul-

Table 1. Content of nutritionally important compounds in Chinese onion (Li et al., 1989).

Nutrient component	Content [%]
Water content	73.52
Protein	1.71
Sugar	11.51
Water soluble sugar	4.20
Vitamin B1	8.66
Vitamin C	0.16
Lysine	0.160
Asparginase	0.191
Aspartyl acid thtreonine	0.132
Arginine	0.127
B acid serine	0.130
Glutamate	0.071
Alanine	0.094
Methionine	0.027
γ-aminobutyric acid	0.124
Leucine isoleucine	0.104

fide, methyl propyl disulfide, methyl 1-propenyl disulfide, dimethyl trisulfide, 2-pentylfuran, diallyl disulfide, allyl propyl, linalool, dipropyl disulfide, ethyl-3-(methylthio) propionate, 1-propenyl propyl disulfide, 2,4,5-tTrithiahexane, 3,5-dimethyl-1,2,4-trithiolane, allyl methyl trisulfide, menthone, methyl propyl trisulfide, methyl 1-propyl trisulfide, borneol, α-terpineol, methyl salicylate, methyl chavicol, butyl thiocyante, tridecane, dipropyl trisulfide, eugenol, α-copaene, β-caryophyllene, β-selinen, β-ionone, benzyl salicylate, methyl palmitate, palmitic acid, methyl linoleate, methyl linolenate, phytol, ethyl linoleate, ethyl oleate, ethyl linolenate, and ethyl α-linolenate. The dried bulbs of Chinese onion (*A. chinense*) are well known as one of the traditional Chinese medicine "Xie Bai", which is used for treatment of thoracic pain, stenocardia, heart asthma and diarrhea (Liu et al., 2014). They have been reported to contain various furostanol saponins, steroidal saponins, and spirostane saponins in their extract (Kubota et al., 2003; Ren et al., 2010). A variety of biologically active chemicals have been isolated from Xiebai, such as saponins, volatile oils (mainly sulfur-containing compounds), nitrogen-containing compounds, and organic acids (Zhang and Gao, 2003). From the standpoint of the traditional Chinese medicine, Chinese onions are especially valued for their warm and hot tastes, together with their medicinal properties such as warming the lungs to reduce phlegm, warming the stomach during digestion, detoxifying and destroying intestinal worms, decreasing swelling and soreness, and decreasing blood pressure and blood lipids (Yang et al., 2018). Several studies have shown that preparations from Xiebai show a number of biological activities, including anti-atherogenic, hypolipidemic, anti-platelet aggregation, antihypertension, antioxidant and analgesic effects (He et al., 2018). Xiebai as a food is often pickled as a pleasing seasoning or cooked with other ingredients to make various delicious Chinese dishes that are both nutritive and healthy, Traditionally, it is used in combination with other herbs, in the treatment of multiple diseases of cardiovascular, respiratory and gastrointestinal systems (He et al., 2018). Several studies have shown that it possess a wide range of biological activities such as anti-hyperlipidemic activity (Lin et al., 2016), anti-tumor activity (Peng et al., 1996; Baba et al., 2000), and anti-Alzheimer's disease (Kuroda et al., 1995; Prasanna Kumar et al., 2015). Asemani et al. (2019) concluded that chemical constituents of *Allium* genus are involved in various mechanisms such as hindering cell cycle, inhibiting signaling pathways, inducing apoptosis, and antioxidant activity that interferes with diverse stages of formation, growth, differentiation, and metastasis of cancer cells. Zhou et al. (2011) reported that high consumption of *Allium* plants reduced the risk of various cancers. Mnayer et al. (2014) concluded that *Allium* oils had the highest antibacterial activity of the strongest antioxidants. Chinese onion bulbs extract can be used to inhibit the growth of methicillin-resistant *Staphylococcus aureus* (MRSA) (Aretha and Jusuf, 2019). Yu et al. (2015) provides evidence for the cytotoxicity of *A. chinense* saponins (ACSs) and a strong foundation for further research to establish the theoretical basis for cell death and help in the design and development of new anti-cancer drugs. They have declared that ACSs induced morphological changes, accelerated cell death and exhibited concentration dependence, inhibited cell proliferation and exhibited dose dependence, inhibited the migration rates of B16 and 4T1 cells, inhibited cell colony formation and exhibited dose dependence, inhibition of tyrosinase activity of B16 cells treated with ACSs. ACSs inhibited tumor growth and protected the liver and spleen against injury. Zeng et al. (2017) indicated that *Allium* genus is rich in organosulfur compounds, quercetin, flavonoids, saponins, and others, which have anticancer properties, prevent cardiovascular and heart diseases, and show anti-inflammation, antiobesity, antidiabetic, antioxidants, antimicrobial activity, neuroprotective and immunological effects. They have reported that *Allium* genus may be the source of promising dietotherapeutic vegetables and of organopolysulfides as well as quercetin mechanism in the treatment of chronic diseases. Lin et al. (2016) showed that ethanol extract from *A. chinense* showed notable antioxidant activity, and its high-content essential oil extract both meaningfully reduced serum and hepatic total cholesterol, triglyceride, and low-density lipoprotein levels and increased serum and hepatic total cholesterol, triglyceride, and low-density lipoprotein levels and increased serum high-density lipoprotein levels in high fat-diet wistar rats. Zeng et al. (2017) reported that functional components in alliums have long been known to play a key role in modifying the major risk factors for chronic disease. Yang et al. (2018) implied that onion oil has anti-obesity properties that can counteract

the effects of a high-fat diet (HFD) on body weight, adipose tissue weight and serum lipid profiles. It is also an immunity-boosting food rich in fructans (Prasanna Kumar et al., 2015). Liu et al. (2014) found that the essential oil of *A. chinense* and the major constituents demonstrated strong contact and fumigant toxicity against the booklice; they have suggested that the essential oil of *A. chinense* maybe recommended as effective in pest control programs. Brewster (2008) also confirmed its use to combat insects and moles due to its repelling characteristics. Chinese onion may be beneficial in treatment of inflammation related diseases because some steroidal saponins showed potential anti-inflammatory and anti-proliferative activities (Wang et al., 2016; Wang et al., 2019). A steroidal saponin isolated from *Allium* chinense simultaneously induced apoptosis and autophagy by modulating the PI3K/Akt/mTOR signaling pathway in human gastric adenocarcinoma (Xiao et al., 2015; Xu et al., 2020). Lin et al. (2016) suggested that *A. chinense* is a valuable plant that merits further investigation as a potential dietary supplement or botanical drug since ethanol extracts from *A. chinense* show notable antioxidant activity. The most important health benefits of Chinese onion are shown in Figure 2.

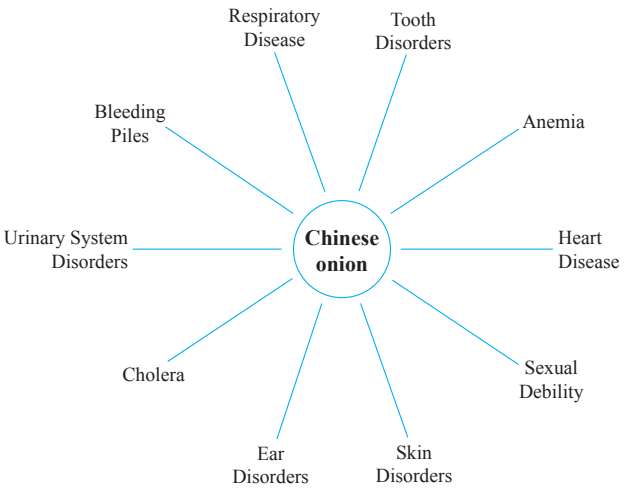

Figure 2. Major health problems preventable for treatable by Chinese onion.

SUMMARY

The significant rise in interest in medicinal properties of herbs and spices is reported because of low toxicity, high-efficacy and low price. Chinese onion belongs to the onion family, and it closely resembles chives. Chinese onion has very complex nutritional composition and its superior qualities give it a good potential to be used as a food ingredient, source of antioxidants, and also a major source of dietary flavonoids in different countries. It is also one of the most important medicinal plant in Eastern Asia. Chinese onion, that is also known as oriental onion, have bulbs that are purplish or grayish white and are covered by a semi-transparent, dry membranous skin. They have a crisp texture and a strong onion-like but distinctive odour. Chinese onion was found to possess a panoply of bioactive compounds and numerous pharmacological properties, including antimicrobial, antioxidant, analgesic, anti-inflammatory, anti-diabetic, hypolipidemic, anti-hypertensive and immunoprotective effects. The most important chemical constituents of the essential oil derived from *Allium chinense* are: dimethyl disulfide, diallyl sulfide, allyl isothiocyanate, methyl allyl disulfide, methyl propyl disulfide, α-pinene, dimethyl trisulfide, β-pinene, 1,3-dithiane, limonene, diallyl disulfide, linalool, methyl allyl trisulfide, methyl propyl trisulfide, dimethyl tetrasulfide, diallyl trisulfide, diallyl thiosulfinate, and allyl methyl tetrasulfide. The results of this article suggested that more research is needed on this valuable plant both as a medicinal herb and a potential dietary supplement.

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