Genus *Allium*: The Potential Nutritive and Therapeutic Source

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Abstract: The two *Allium* species, Onion (*Allium cepa* L.) and garlic (*Allium* sativum L.) are the most edible and oldest cultivated plants. These two species have not only beneficial effects against disease also they have nutritive potential. They are very rich sources of several phytonutrients, electrolytes, carbohydrates, minerals, and vitamins and documented to have a significant identical pharmacological characteristic including hypocholestremic, hypotensive, hypoglycecmic, antithrombotic and anti allergic as well as wide range of biological activities such as anti-inflammatory, antimicrobial, antifungal and antioxidants. This review article will scan the nature with understanding, thinking, realizing and utilization of these two herbs for their therapeutic source in adding together their nutritive potential. In this review we focused on the nutritional attributes along with their curative potential of species of *Allium* genus (onion and garlic) belonging to the family Alliaceae.

Keywords: Phytonutrients, food value, chemical and therapeutic significance.

1. INTRODUCTION

Naturopathy encourages us to acquire health by diet and lifestyle management. Under the heading of naturopathy, a good diet is whole food which must provide necessary nutrients and liquid to the body to maintain the biochemical requirements and such diet is becoming rapidly and widely accepted as much of the basis of good health. Whole food comprising on live foods or unrefined organic foods, which is fuel vitality and involve stimulating the vital force of our body. Despite all the fabulous advancements in modern medicine the position of vegetables in nutrition and health has long been documented. *Allium* Linn. is one of the highly regarded genus throughout the world for both its therapeutic and culinary value. *Allium* is a large genus represented by about 600 species. It is distributed throughout the most regions of temperate world including Europe, Asia, North America and Africa. The area of greatest diversity of this genus is the mountains of central Asia, including Afghanistan, India, Tajikistan, Pakistan, and parts of Siberia and China. In Pakistan it is represented by about 41 species. The most widespread and extensively used species of *Allium* genus are *Allium cepa* and *Allium sativum* (onion and garlic respectively) belongs to the cooling family Liliaceaec but recent taxonomic revisions have seen members of the genus *Allium* and placed them in the family Alliaceae. *Allium cepa* and *Allium sativum* have been used prehistorically time since 3,000 years as flavor-enhancing foods and folk medicines [1-3]. They are the twins herbs which are dominating members of kitchen cabinet, used as a wet condiments having ability to get rid of variety of disease conditions of the body and give miraculous relieve. They live together, keep together, cook together, look together, use together but both of them are differing in taste, appearance and color, but close up in biochemical, phytochemical and nutraceutical contents and got the control on our immune system to acquire the health. These two herbs can be used as ornamentals, vegetables, spices, or as medicine. Besides their remarkable medicinal powers their nutritive values have been appreciated only in recent times [4-5]. Therefore, in the current review we will briefly account the nutritive and therapeutic properties of these two species of genus *Allium*.

2. CHEMICAL CONSTITUENT

Both species of *Allium* have large number of primary and secondary types of nutritional and medicinal components.

2.1. Nutrients

Several health benefits have been attributed to the onion and garlic. The major nutrient is vitamin C. However; it is also clear that both contains other vitamins as well as wide range of minerals in small but useful amounts. Garlic has a relatively low water content (around 65%) than Onion (around 88%) with the bulk of the dry weight comprising fructooligosaccharides, followed by protein, fibre and free amino acids Table **1** [6]. Although garlic is a rich source of a number of nutrients, but it is consumed in a smaller amount than onions, its dietary involvement is less. In the light of current research it has been anticipated that in the United States the average daily

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intake of garlic is 3 g/day, in contrast to 23.5 g/day of onions [7]. This RDA (Recommended daily allowance) may vary according to geographical ethnic populations of the world. They may appear as a supplementary nutrient; in reality they actually construct smaller male and female daily dietary inputs which are shown in Figure **1** and **2** for garlic and onion respectively.

Table 1: Nutritional Value of Onion and Garlic (Athar et al. 2004)

Principle	Onion, flesh, Raw	Garlic cloves, Raw, peeled
Proximals		
Water g	87.9	**64.3**
Energy kcal/ kJ	40/166	**97/402**
Protein g	1.27	**7.9**
Total fat g	0.12	**0.6**
Total saturated fatty acids g	0.023	**0.122**
Total monounsaturated fatty acids g	0.02	**0.015**
Total polyunsaturated fatty acids g	0.054	**0.342**
Cholesterol mg	0	**0**
Dry matter g	12.1	**35.7**
Ash g	0.46	**1.5**
Dietary fibre (Englyst 1988) g	2.36	**8**
Total nitrogen g	0.2	**1.27**
Alcohol g	0	**0**
Electrolytes		
Sodium mg	2.21	**4**
Potassium mg	184	**620**
Phytonutrients		
Beta-carotene equivalents µg	10	**T**
Carbohydrates		
Carbohydrate, available g	8.53	**15**
Glucose g	3.6	**0.4**
Fructose g	2	**0.6**
Sucrose g	2.4	**0.57**
Lactose g	0	**0**
Maltose g	0	**0**
Total available sugars g	8	**1.6**
Starch g	0.53	**13.4**
Soluble non-starch polysaccharides g	1.31	**5.5**
Insoluble non-starch polysaccharides g	1.06	**2.5**
Minerals		
Calcium mg	21.2	**19**
Phosphorus mg	39.5	**170**
Iron mg	0.24	**1.9**
Magnesium mg	8.43	**25**
Manganese µg	161	**500**
Copper mg	0.059	**0.06**
Zinc mg	0.25	**1**
Selenium µg	0.16	**16**
Vitamins		
Potential niacin from tryptophan mg	0.304	**1.1**
Vitamin B6 mg	0.036	**0.38**
Folate, total µg	26.9	**5**
Vitamin B12 µg	0	**0**
Vitamin D µg	0	**0**
Vitamin E mg	0.3	**0.01**
Total vitamin A equivalents µg	1.7	**T**
Thiamin mg	0.043	**0.13**
Riboflavin mg	0.015	**0.04**
Niacin mg	0.734	**0.4**
Vitamin C mg	7.1	**17**
Total vitamin A equivalents µg	1.7	**T**
Retinol µg	0	**0**
Total niacin equivalents mg	**1.04**	**1.5**

2.2. Phytochemical

Biologically active plant constituents, other than traditional nutrients, that have a beneficial effect on human health have been termed 'phytochemicals' [8]. There are two major phytochemicals i.e. sulpher containing and non sulpher containing compounds found in onion and garlic that have health benefits when consumed by humans.

2.3. Sulpher Containing Compounds

The Organosulpher compounds which present in these twins are lipid and water soluble in nature Table -

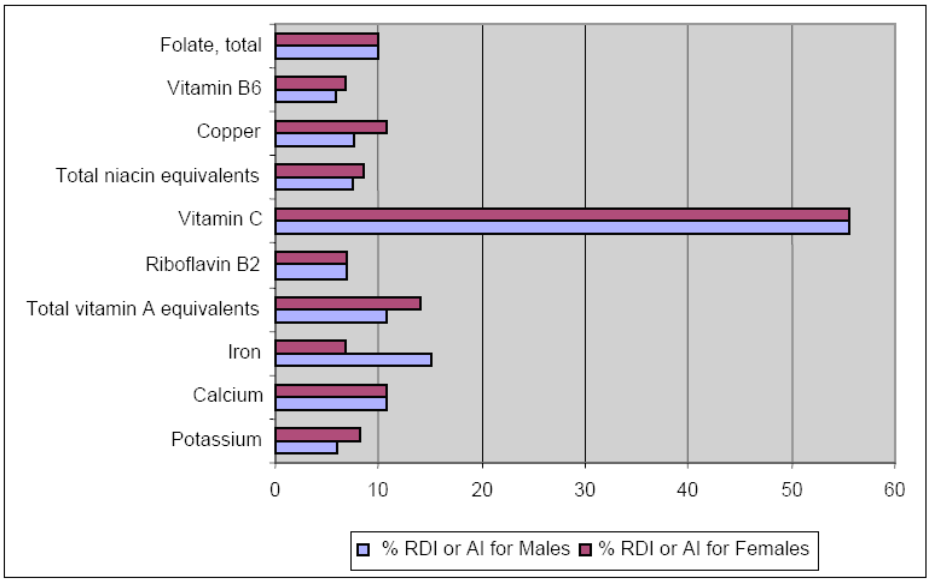

Figure 1: Contributions to Recommended Dietary Intake (RDI) or Adequate Intake (AI) by major micronutrients in raw spring onions (flesh of bulb), adapted from Athar et al. [50] and NHMRC [52].

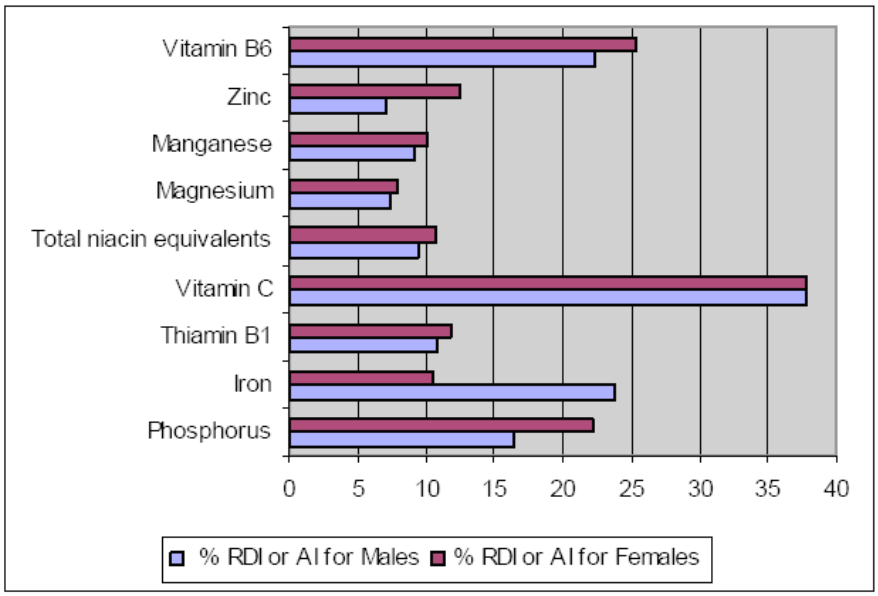

Figure 2: Contributions to Recommended Dietary Intake (RDI) or Adequate Intake (AI) by major micronutrients in raw garlic, adapted from Athar et al. [50] and NHMRC [52].

2. Garlic derivatives normally have a thioallyl moiety whereas onion has thiopropyl group. Onion has different chemical properties such as cepaenes and thiosulfinates [9-10] whereas, two kinds of organosulfur compounds present in garlic, gamma glutamylcysteines and cysteine sulfoxides [11-12]. These compounds are formed on cutting an onion bulb due to damaging and disrupting tissues **Figure 3**. While garlic tissue contains a sulphar compounds which react when crushed, cut or chopped to form a new compound named as “allicin”. It is most powerfull component which is responsible for characteristic smell of garlic. It is unstable compound which readily converted into other basic sulphur compound including mono, di and tri allylsulfide and other compounds such as ajoene or vinyl dithiins. Thus allicin is the key source of most of garlic healing and therapeutic powers, and even though it breaks down very quickly into other sulphur, bearning chemicals without reducing its power. Allicin is actually biosynthesized from sulphur containing amino acid called allin by the action of an enzyme Allinase, which change allin into allicin. Cutting or crushing the garlic clove brings the amino acid and the enzyme together and set up a chain reaction [13-15].

Table 2: Major Organosulpher Compounds Present in Garlic and Onion

Chemical structure	Compounds	Common names
Lipid soluble compounds		
CH_2=CH-CH_2-S(O)-CH_2-CH(NH_2)-COOH S-	Allylcysteine sulfoxide	Alliin
CH_3-CH=CH-S(O)-CH_2-CH(NH2)-COOH S-	Propenylcysteine sulfoxide (lacrimatory precursor)	Isoallin
CH_3-CH_2-CH_2-S(O)-CH_2-CH(NH_2)-COOH S-	Propylcysteine sulfoxide	Propiin
CH_3-S(O)-CH_2-CH(NH_2)-COOH S-	Methylcysteine sulfoxide	Methiin
CH_2=CH-CH_2-S(O)-S-CH_2-CH=CH_2	Allicin	
CH_2=CH-CH_2-S(O)-CH_2-CH=CH-S-S-CH_2-CH=CH_2	Ajoene	
CH_3-CH_2-CH=SO	Propanethial S-oxide (lacrimatory factor)	
CH_2=CH-CH_2-S-CH_2-CH=CH_2	Diallylsulfide	
CH_2=CH-CH_2-S-S-CH_2-CH=CH_2	Diallyldisulfide	
CH_2=CH-CH_2-S-S-S-CH_2-CH=CH_2	Diallyltrisulfide	
CH_2=CH-CH_2-S-CH_3	Allylmethylsulfide AMS	
CH_2=CH-CH_2-S-S-CH_3	Allylmethyldisulfide	
CH_2=CH-CH_2-S-S-S-CH_3	Allylmethyltrisulfide	
CH_2=CH-CH_2-S-S-CH_3	Allylmethyldisulfide	
CH_2=CH-CH_2-S-S-S-CH_3	Allylmethyltrisulfide	
CH_3-CH_2-CH_2-S-CH_2-CH_2-CH_3	Dipropylsulfide	
CH_3-CH_2-CH_2-S-S-CH_2-CH_2-CH_3	Dipropyldisulfide	
CH_3-CH_2-CH_2-S-S-S-CH_2-CH_2-CH_3	Dipropyltrisulfide	
CH_3-CH_2-CH_2-S-CH_3	Propylmethylsulfide	
CH_3-CH_2-CH_2-S-S-CH_3	Propylmethyldisulfide	
CH_3-CH_2-CH_2-S-S-S-CH_3	Propylmethyltrisulfide	
Water-soluble compounds		
CH_2=CH-CH_2-S-CH_2-CH(NH_2)-COOH S	Allylcysteine	
CH_2=CH-CH_2-S-S-CH_2-CH(NH_2)-COOH S	Allylmercaptocysteine	
CH_2=CH-CH_2-S-H	Allylmercaptan	

2.4. Non-Sulpher Containing Compounds

Besides the sulfur compounds, onion has three major groups of non sulpher compound that have health benefits when consumed by humans. These groups are flavonoids, fructans, and Saponins. Major onion's flavonoids are Flavonols and Anthocyanins which are mainly contain subgroup of Quercetin and kaempferol. Onions are composed of fructans (including oligofructans or fructooligosaccharides (FOS) of 2.8% FOS (wet weight) compared with 1.0% FOS in garlic [16]. Whereas garlic has high levels of saponins, some phenolics and moderate levels of provitamin A [6]. A number of sapogenins (the aglycone base) and saponins have been identified in garlic. The major flavonoids in garlic are the flavonols, myricetin and apigenin and in striking contrast to onions, only low levels of quercetin [17-20].

3. EFFECTS ON HUMAN HEALTH

The use of *Allium* species for medicinal purposes has at least 3500 years history, the ancient Egyptian papyrus Codex Ebers, documented their beneficial uses along with food and ornamental plants [21]. In addition, dietary elements that have antimicrobial or antioxidant like properties may also play an important role in the prevention of human pathologies. No of studies have been conducted to determine the dietary botanicals and their phytochemical constituent which can modulate several defensive pathways. Therefore to categorize the effects of onion and garlic on human

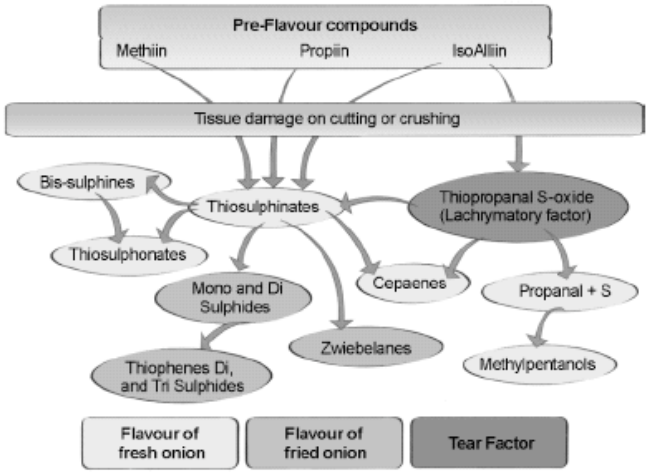

Figure 3: Generation of the major flavor groups in onions Griffiths et al. [51].

health it will be necessary to assemble the current available data to get the potential of twin herbs. We will provide brief nutritive description of twin herbs which already been focused in several review articles.

3.1. Anticarcinogenic Properties

Epidemiological literature by several researchers revealed that high dietary intake of fruits and vegetables can reduced the human cancer [22-23]. These twins have marvelous protective effects, mainly been observed in various clinical findings specially in oesophageal, stomach, lungs, female breast, colon, rectal, prostrate and developing brain carcinomas. Phytochemicals of onion and garlic are also potent inhibitors of chemically induced tumors in rodent models too [24].

3.2. Apoptosis

Programmed cell death means living organisms control abnormalities in cells which happen as a result of genetic or environmental nods. Both *Allium* sulphides have also been shown to be potent inducers of apoptosis in human colon SW480 and HT29cancer cell and [25] in cultured human neoplastic (A549) and non neoplastic (MRC-5) lung cancer cell [26] by interaction with extra cellular ligands with membrane bound receptor and with mitichondria through release of apoptosis signaling molecules respectively [27-28].

3.3. Anti-Inflammatory

Garlic and its constituent have been found to inhibit the activity of inflammatory enzymes as well as inhibiting the activity of other components involved in the process of inflammation [12]. In addition, garlic was also observed to inhibit cyclooxygenase and lipoxygenase enzymes which are observed in numerous human pathologies including inflammatory disease and similar findings were also reported for extracts of onion [29-30].

3.4. Antioxidants

Antioxidants inhibit the damaging effect of free radical agents, including reactive oxygen (ROS), nitrogen (RNS) and chlorine species (RCIS). In addition now a day's plant derived anti oxidants have received the major attention not only because of the connection between oxidative stress and pathologies such as atherosclerosis, cancer, and aging, in which free radicals and reactive oxygen species are implicated as having a major role [31-33] also in food products as a preservatives [34]. The authors establish that the addition of garlic or BHA, delayed lipid oxidation, and fresh garlic showed the uppermost antioxidant activity followed by garlic powder, BHA and garlic oil [35]. Information from a series of in vitro testing methods proposes that onions have moderate levels of antioxidant activity compared with other vegetables [36-38].

3.5. Antibacterial Activity

Over the previous century, garlic has been proven to be effective against both gram-positive, gram negative and acid-fast bacteria. These include *Pseudomonas, Proteus, Escherichia coli, Staphylococcus aureus, Klebsiella, Salmonella, Micrococcus, Bacillus subtilis, Mycobacterium*, and *Clostridium* [24]. Furthermore, garlic also inhibits the development of strains of *S. aureus, E. coli, Proteus*

mirabilis and *Pseudomonas aeruginosa* that are increase resistant to antibiotics including penicillin, streptomycin, doxycilline and cephalexin [39]. In the same way, the bactericidal effects of extracts of onion towards *Streptococcus mutans* and *S. sobrinus*, the main connecting bacteria for dental caries, and *Porphyromonas gingivalis* and *Prevotella intermedia*, considered to be the main causal bacteria of adult periodontitis, have been described [40]. From a fundamental point of view, Cavillato and Bailey discovered that the major antibacterial agent present in garlic was allicin. Nevertheless, onion is not as potent as garlic since the sulfur compounds in onion are only about one-quarter the level found in garlic. Among these numerous and abundant naturally occurring compounds, *Allium* extract has been considered as a natural preservative or food additive, and can be used as supplementary methods of scheming pathogens [41].

3.6. Antifungal and Antiparasitic Properties

The first investigation was reported by Raghunandana [42] . Very small piece of work has been done on antifungal effect of fungi on onion as compare to the garlic. Many fungi have proven susceptible to *Allium* extracts, particularly those of garlic. These included *Candida, Trichophyton, Torulopsis, Rhodotorula, Cryptococcus, Aspergillus,* and *Trichosporon* [24]. The antifungal properties observed for *Allium* extracts and sulfur compounds appear to be connected with their capability to decrease the growth of and inhibit lipid, protein and nucleic acid synthesis [43]. In addition, few reports have been published regarding the use of *Allium* species and their constituents as an antiprotozoals, sulphides can inhibit metabolism or growth of parasites, mainly *Trypanosoma brucei ssp. brucei, ssp. rhodesiense, ssp. gambiense, ssp. evansi, ssp. congolense and ssp. equiperdum,* as well as *Entamoeba histolytica* and *Giardia lamblia* a parasitic species responsible for causing waterborne diarrhea [44-45]. Aqueous onion extracts has also been reported for the antileishmanial activity towards *Leishmanial promastigotes*. Five strains of *Leishmania* including *L. major* (Pakistan), *L. tropica, L. mexicana ssp. mexicana* and *L. donovani* were found to be responsive to onion juice [46].

3.7. Cardiovascular Disease

From the beginning of 1960s various studies have been conducted on animal and humans, show that garlic has an effect on heart and circulatory system. By appropriate application, garlic may shield the blood vessels from the deleterious effect of free radicals, exert a positive influence on blood lipids, increase capillary flow and lower elevated blood pressure levels. According to recent studies, some of the antiatherosclerotic effects are based on the reduction of trombocyte adhesiveness and aggregation. The tendency of the platelets to aggregate and to form thrombi is significantly decreased by the effective constituents Allicin, ajoene and diallyl disulphide of garlic. Moreover, part of the antiaggregation activity of onion preparations seems to be mediated by the inhibition of thromboxane biosynthesis in platelets. In addition, onion extracts posses some lipid-lowering and in higher concentrations also hypoglycaemic effects [47-48]. In contrast a recent Chinese study originate that long term garlic supplementation had no outcome upon lipid profiles [49]. In this connection, a potential therapeutic role of garlic or indeed other *Allium* species towards cardiovascular disease requires more research to elucidate the exact mode of action.

4. CONCLUSION

The Alliaceae family comes into view as a useful tool to the human health same as it is in the kitchen. This review reveals by documented studies the benefits of *Allium* for its bioactive compounds which are being found to make available a wide range of protective properties across the major chronic current diseases of the 21st century. Both species of *Allium* have great ability to produce synergetic effects if they are taken in combination, in case of commonly existing disease conditions such as in cardiac ailments, hypertension, diabetes, hepatotoxicity, GIT upsets infectious diseases and even HIV and cancer. These diseases are not come to live forever in our body they must leave through natural means. It is greatly possible that stronger scientific evidence will emerge to justify their importance in traditional remedies throughout history and around the globe.

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