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Allelopathic Plants: 24. Genus *Allium* L.

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CONTENTS

ABSTRACT

Allium is medicinal genus, rich in carbohydrates and organic-sulphur compounds such as Allicin (a precursor for the production of alkaloids, saponins and glycosides). Many phytochemicals have been isolated from various species of this genus, but only few (Allinase and Ajoene) are active as pesticides. Leaf extracts of garlic (*A. sativum*) controls 98% growth of citrus nematode (*Tylenchulus semipenetrans*). *Allium cepa, A. sativum, A. fistulosum and A. ampeloparasum* are fungicidal against the *Alternaria alternata, A. brassicola* and *Myrothecium roridum.* The phenol and sulphur based allelopathic compounds of genus *Allium* can be used for weeds and insects management in agricultural systems.

Key words: Allelopathy, allelochemicals, *Allium spp.*, biofumigation, herbicidal, Insecticidal.

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1. INTRODUCTION

Allium L. is the largest genus of petaloid monocotyledons (except orchids), with 750 species world wide (40) and includes numerous perennial plants with underground storage organs [bulbs or rhizomes (46)]. Its species are of great economic importance (46) as vegetables [onion (*Allium cepa* L.), garlic (*A. sativum* L.), Japanese leek (*A. fistulosum)*, wild leek (*A. ampeloprasum),* chives (*A. schoenoprasum)*, Chinese chives (*A. tuberosum)*], ornamentals [(*A. aflatunense*, *A. giganteum*, *A. karataviense*)] and medicinal plants [*A. victorialis*, *A. tricoccum*] (31). The Romans disliked garlic due to strong scent and fed it to their labourers to strengthen them and to soldiers to excite the courage (20). Wild onions is popular food and as home medicines in many parts of the world. In addition, a large number of *Allium* species are ornamental plants (37).There are many *Allium* species with unknown value, which should be preserved for future studies (23).

Table 1. *Allium spp.* and their economic importance

Name of specie	English	Economical importance	Reference
A. cepa L	Onion	Vegetable	30,31
A. sativum L.	Garlic	Vegetable	30,31
A. fistulosum L.	Japanese Leek	Vegetable	30,31
A. ampeloprasum L.	Wild leek	Vegetable	30,31
A. schenoparsum L.	Chives	Vegetable	30,31
A. tuberosum Rottl. ex Spreng	Chinese chives	Vegetable	30,31
A. aflatunense B.Fedtsch.	Wild onion	Ornamental plant	16
A. giganteum Regel	Giant onion	Ornamental plant	16
A. karataviense Regel	Turkestan Onion	Ornamental plant	16
A. victorialis L.	Alpine leek	Medicinal plant	1,34
A. tricoccum Ation	Ramps	Medicinal plant	1,34

2. MORPHOLOGY AND GEOGRAPHICAL DISTRIBUTION

Allium is characterized by special feature of bulb (shape, number, length, width and nature of outer tunica), which help in identification of genus. Morphological markers play a major role in identification of various species of genus e.g. *A. fedtschenkoanum* Regel and *A. semonovii* Regel are quite confusing but can be separated on the basis of outer tunic nature, scape length and floral characters (46). *A. lilacinum A. jacquemontii* Kunth showed confusion with *A. przewalskianum* Regel, *A. griffithianum* Boiss., and *A. roylei* Stearn (40). Differentiation between *A. griffithianum* Boiss and *A. jacquemontii* Kunth can be made by using characters of scape and flowers. *A. griffithianum* has pink flower, glabrous leaf sheath and the umbel inflorescence. The genus *Allium* is characterized by superior ovary and scapose umbellate inflorescence with membranous bracts (32, 36). During growth, plants subdivide continuously and form a dense clump of shoots (43).

The main centre of genus *Allium* evolution stretches along the Irano-Turanian phyto-geographical zone. Whereas the secondary centers of diversity are found in the Mediterranean basin and western North America (16, 19). From these centers, *Allium* species have widely spread in northern hemisphere (30). Most *Allium species* are common from the dry subtropics to the boreal zone, and a few species grow wild even in the sub-arctic belt (19, 43).

3. ALLELOPATHY- COMPETITION: RESEARCH

3.1. Allelochemicals

The most abundant class of allelochemical compounds in *Allium* species are carbohydrates (Glucose, fructose, sucrose, oligosaccharides) and the fructans (10). *Allium* plants also contain proteins, pectin, minerals and polyamines (15, 33). A distinguishing trait of all *Allium* spp. is the metabolic chain of sulfur compounds (4, 38). Most of the sulphur-containing compounds are in the form of non-protein amino acids, some of which serve as precursors of the volatile flavour (38) and of allelochemicals in nature (1, 12, and 22). "Cepaenes", a class of structurally related R-sulfinyl disulfides, are potent inhibitors of platelet aggregation, cyclo oxygenase (CO) and lipoxygenase (LO) enzymes (3, 28 and 29). For instance, the Siberian species *A. obliquum and A. cepa* contains high levels of alliin. This allelochemical act as enzyme inhibitor for cyclo-oxygenase and lipoxygenase (3). However it gets converted into the anti-microbial active allicin, in the presence of enzyme allinase. The other forms of alliin are Isoalliin and methiin. High level of alliin and isoalliin are found in *A. ampeloprasum*, while methinin was found in species from Central Asia, including *A. stipitatum* and *A. jestianum*. Ajoene (secondary degradation product of alliin) contains sulfur compounds, it provides protection against diseases and has fibrinolytic activity. Ajoene inhibits thromboxane synthesis through the inhibition. Alliin is responsible for the anti-thrombotic activity (44). *Allium* species also contain volatile oils [which give characteristics pungent smell (45)], vitamins, minerals (18) and trace elements (selenium and germanium) (39).

3.2. Allelopathic effects of *Allium* spp. on recipient plants

Fan Sheng Zhi Shu, first century BC, is the earliest Chinese agricultural book on plant allelopathy (47). The author Fan Sheng Zhi claimed that cucurbit and leek (*Allium porrum*) could be interplanted to reduce the disease of cucurbit, because leek produces special substances to inhibit the pathogens of cucurbit. *Allium* plant is recognized not only as a spice but also to control the microbial pathogens. Garlic extract has a broad-spectrum antimicrobial activity against many genera of bacteria and fungi and the active component (allicin) has been isolated and characterized (7, 49).

3.2.1. Laboratory Bioassays

To investigate the leaching of phenolic compounds from *A. cepa* and *A. sativum*, soil in laboratory experiments was altered with dried and milled crop residues of onion (*Allium cepa* L. cv. Mission) or garlic (*A. sativum* L. cv. California Early). The amendments, along with the additional factors of amendment concentration (0, 1 or 3% (w/w)) and soil temperature (23 or 39 °C), were evaluated for their effects on seeds germination of weeds [*Echinochloa crus-galli* (L.) Beauv. (Barnyard grass), *Portulaca oleracea* L. (common purslane), *Sisymbrium irio* L. (London rocket) and *Solanum nigrum*

Table 2. Allelochemicals present in various parts of *Allium* species

Allelochemicals	Plant part			Reference No
	Whole plant	Bulb and Leaf	Bulb	
1,4-Butanedithial S,S′-dioxide	+			37
1-propenesulfenic acid			+	37
2-Propenesulfenic acid		+		37
Allinase	+		+	38
Carbohydrates	+			10
Cepaenes	+		+	45
Diallyl disulfide			+	40
Dipropyl disulfide	+			40,33
Dipropyl thiosulfonate	+			40
Dipropyl Ti	+			40
Dithiabicyclo[2.1.1]hexanes	+			24,
Ferulic		+		27
Glucose,fructose,sucrose,	+			10
Methyl propenyl disulfate	+			40
Methylpropyl trisulfate			+	44
Oligosaccharides, fructans	+			10
p-coumaric		+		68
p-hydroxybenzoic		+		30
Proteins, pectin, minerals and polyamines	+			33
S-(2-propenyl)2-propene-1-sulfinothioate	+			40
S-alk(en)yl-L-cysteine S-oxides			+	37
Sulfenic acids			+	37
Sulfine (Z)-propanethial			+	24,37
Syringic acid		+		37
thiosulfinate			+	37
Trace elements (selenium and germanium)			+	39
Vanillic acid		+		31
Vitamins and minerals	+			31
Volatile oils			+	44
α- Sulfinyl disulfides			+	16

L. (black nightshade)]. The effect of garlic versus onion amendment was significant only in *S. nigrum*, where garlic residues demonstrated more herbicidal activity. The results showed that the garlic and onion plant residues were capable of causing significant reductions in seed germination of weeds during their decomposition in soil. The activity of these residues could be exploited as a component of integrated weed management using appropriate crop sequence in crop production (41).

In another experiment, the effects of phenolic acids and total phenolics of *Allium* leaves, bulbs and soil were studied on lettuce, amaranth and wheat. The aqueous extract and volatile compounds of *Allium* bulbs drastically reduced the seed germination and seedling growth of lettuce, amaranth and wheat than its leaves. The phenolic-containing fraction of soil under wild garlic (*Allium ursinum)* also inhibited the seed germination and growth of test plant seedlings (Table 3) (25). *A. cepa* was more sensitive to the compounds assayed, at the concentrations tested. Nearly all esters had nificant effects, a feature that could make them promising for the development of new natural herbicides. (27,42).

Table 3. Effects of volatile compounds, water extracts and phenolic fractions (soil 0 - 10 cm) from *A. ursinum* leaves and bulbs on seed germination and seedling growth of lettuce, amaranth and wheat

Species names	Treatments	Germination (%) (SD)	Shoot length (SD)	Root length (SD)
		Volatile compounds		
Lactuca sativa L.	Control	78.7(±3.5)	100(±4.2)	100(±6.0)
	Leaves	36.0(±3.3)***	66(±5.4)***	50(±5.9)***
	Bulbs	27.3(±3.6)***	51(±6.5)***	47(±4.7)***
Amranthus caudatus L.	Control	74.1(±4.1)	100(±5.6)	100(±5.1)
	Leaves	16.8(±1.2)***	71(±4.1)***	78(±6.6)***
	Bulbs	7.5(±1.8)***	67(±6.7)***	59(±4.3)***
Triticum aestivum L.	Control	79.1(±4.0)	100(±4.9)	100(±6.8)
	Leaves	10.0(±2.7)***	69(±6.3)***	65(±4.5)***
	Bulbs	1.8(±0.3)***	60(±6.3)***	54(±5.3)***
		Water extracts		
Lactuca sativa L.	Control	79.5(±4.6)	100(±6.2)	100(±6.0)
	Leaves	15.8(±4.4)***	42(±7.1)***	48(±6.8)***
	Bulbs	2.1(±1.2)***	37(±5.0)***	29(±7.9)***
Amranthus caudatus L.	Control	76.8(±4.5)	100(±8.5)	100(±7.7)
	Leaves	19.9(±1.9)***	60(±6.9)***	58(±6.5)***
	Bulbs	1.0(0.9)***	30(±3.0)***	27(±5.1)***
Triticum aestivum L.	Control	80.0(±1.6)	100(±7.9)	100(±8.2)
	Leaves	10.0(±2.6)***	54(±4.3)***	61(±7.2)***
	Bulbs	4.3(±1.4)***	28(±5.5)***	42(±5.0)***
		Phenolic extracts		
Lactuca sativa L.	Control	76.9(±6.0)	100(±5.1)	100(±6.5)
	Phenolic fraction	0.7(±0.2)***	56(±4.4)***	49(4.7)***
Amranthus caudatus L.	Control	72.5(±4.2)	100(±6.3)	100(±5.6)
	Phenolic fraction	0.7(±0.3)***	60(±5.3)***	61(±4.9)***
Triticum aestivum L.	Control	80.2(±3.0)	100(±6.3)	100(±5.9)
	Phenolic fraction	0.7(±0.4)***	49(±4.1)	41(±3.8)***

The sulphur volatiles produced during the degradation of *Allium* tissues attributes to the biocidal properties of various *Allium* species (Garlic, onion and leek). Thiosulfinates and zwiebelanes are the form of sulfur compounds released into soil and converted into disulfides. The activities of these compounds were studied *in vitro* on soil pathogenic fungi and insects to measure their disinfection potential. From such studies it was concluded that disulfides: dimethyl disulfide (DMDS), dipropyl disulfide (DPDS) and diallyl disulfide (DADS) inhibited the growth of several fungal species [*Aphanomyces euteiches, Colletotrichum coccodes, Fusarium moniliforme, Fusarium oxysporum radicis cucumerinum, Phytophtora cinnamomi, Pythium aphanidermatum, Rhizoctonia solani, Sclerotium rolfsii* and *Sclerotinia slerotiorum*]. The insecticidal activity of two disulfides were also investigated for termites. It was found that the sensitivity of sulphide compounds varied with termite phenotypes. However DMDS was found most toxic disulfide. As the sulphide compound of *Allium* species are insecticidal, fungicidal and nematicidal, thus use of *Allium* species for soil bio fumigation has been suggested (13).

Allium spp. and various graminae taxa like grasses and cereals possess antibiotic/allelopathic properties (9, 11). *Allium ursinum* L. (wild garlic) forms dense populations in which the other species are either sparsely present or absent. Its allelopathic influences were studied using both the seeds and seedlings of test plants (lettuce, amaranth and wheat) and by analyzing phenolic acids and total phenolics in the leaves, bulbs and soil. Aqueous extract and volatile compounds of bulbs were most inhibitory seed germination and seedling growth than leaves. The soil and phenolic-containing fraction of soil under *Allium ursinum* also inhibited the seed germination and growth of test plant seedlings. The bulbs and leaves were found to contain 2.30 mg/g and 3.24 mg/g (dry weight) of total free phenolics, respectively. The same amount of bound phenol forms (1.0 mg/g) was also found in both Bulb and leaves. Among the allelocheicals in bulb and leaf extracts, *p*-coumaric, ferulic, *p*-hydroxybenzoic and vanillic acids were identified both in free and bound forms (25.43–87.93 µg/g). The soil contained 0.16 mg/g free and 1.61 mg/g total bound phenolics and *p*-coumaric, ferulic, *p*-hydroxybenzoic, vanillic and syringic acids as free (1.00–9.65 µg/g) and bound forms (26.45–44.76 µg/g) were recorded. These results suggest that *A. ursinum* influences other herbaceous plants in plant community via soil and volatile compounds, which inhibit seed germination and plant growth (25).

3.2.2. Field Experiments

The sulfur compounds in *Allium* can act as insecticides, acaricides, nematicides, herbicides, fungicides and bactericides, and also as repellents against arthropods. Field studies showed that germination of sclerotia of *Sclerotium cepivorum* was slow in the presence of cultivars of leek than in the presence of onion, garlic and *Allium fistulosum*. Spread of infection amongst closely spaced plants was also less in leeks than in the other three species. No evidence was found for any differences in the resistance of root tissues of four *Allium* species. It is considered that differential stimulation of *sclerotium* germination is likely to have been the principal reason for the low incidence of white rot infection in leeks (8,39). Mughal *et al*. (30) observed that aqueous leaf extracts of *Allium sativum*, *Datura alba* and *Withania somnifera* inhibited the growth of *Alternaria alternata, A. brassicola* and *Myrothecium roridum. A*queous extract of *Allium cepa* showed antifungal activity against *Helminthosporium turcicum* and *Ascochyta rabiei* (30) (Table 4).

3.2.2.1. Weeds

The effect of *Allium fistulosum* L. and *A. cepa* L. genotypes on plant growth and seed germination of spiny amaranth (*Amaranthus spinosus* L.) and kochia (*Kochia scoparia* L. Schrad.) was investigated (26). Biomass of amaranth and kochia plants were significantly reduced when grown with *A. fistulosum* var. Heshiko and an inter specific F_1 hybrid 81215, Heshiko X *A. cepa* cv. New Mexico Yellow Grano (Table 6). Weeds grown with Heshiko and 81215 were significantly shorter at harvest, but height usually did not differ from controls when grown with *A. fistulosum* var. Ishikura or other *Allium*

Table 4. Effects of species of *Allium*, *Datura* and *Withania* species on fungal species (54)

Fungal species	Plant species	Effects
Sclerotium cepivorum Berk	*Allium ampeloparasum var porrum* L.	Strongly effect germination
	Allium cepa L.	Effects germination
	Allium sativum L.	Effects germination
	Allium fistulosum L.	Effects germination
Alternaria alternate (Fr.:) Keissl	*Allium sativum* L.	Drastic growth inhibition
	Datura alba Nees.	Growth inhibited
	Withania somnifera (L.) Dunal.	Growth inhibited
Alternaria brassicola (Schwein.) Wiltshire	*Allium satvium L.*	Drastic growth inhibition
	Datura alba Nees	Growth inhibited
	Withania somnifera (L.) Dunal.	Growth inhibited
Myrothecium roridum Tode	*Allium stavium* L.	Drastic growth inhibition
	Datura alba Nees	Growth inhibited
	Withania somnifera (L.) Dunal.	Growth inhibited
Helminthosporium turcicum Pass	*Allium cepa* L.	Drastic growth inhibition
Ascochyta rabiei Kovatsch	*Allium cepa L.*	Drastic growth inhibition

genotypes. Germination of kochia seeds was not affected by root exudates from any *Allium*. Germination of amaranth seeds moistened with root exudates from Heshiko was 44-53% less than controls or when moistened with exudates from other genotypes, providing evidence of allelopathy against *Amaranthus spinosus* (Table 5).

Table 5. Effects of *Allium fistulosum* root extracts on germination (%) of *Amaranthus spinosus* seeds (26)

Allium fistulosum variety	Germination (%)	
	Experiment 1	Experiment 2
Heshiko	15.5*	27.0
Ishikura	77.5	78.0
NMYG	76.5	67.0
81215	85.5**	86.0**
8273	64.0	66.0
Control	68.5	71.0.
L.S.D.	4.3	3.3

Mean separation by Fisher's 1.s.d. = 5%; *inhibition of germination in relation to control; **stimulation of germination in relation to control

Table 6. Influence of *Allium fistulosum* on dry weight (g per plant) of *Aamaranthus spinosus* and *Kochia scoparia* (26)

A. fistulosum	*Amaranthus spinosus*			*Kochia scoparia*	
genotype	Spring	Summer	Autumn	Summer	Autumn
			Days after planting		
Allium	52	32	93	69	93
Control	26.9b	114.7bc	108.8d	109.0d	91.9d
Heshiko	10.2a	79.4a	60.la	67.5a	46.3a
Ishikura	23.3b	104.4abc	81.6bc	86.5c	63.2b
NMYG	25.9b	135.8c	102.2d	93.oc	87.8cd

3.2.2.2. Insects

The insecticidal activity of *Allium* plants, plant extracts and *Allium* sulphur volatiles has been studied (16,17,32) and many studies assessed the repellent effects of plant sulphur compounds (15).

3.2.2.3. Nematodes

The citrus nematode (*Tylenchulus semipenetrans)* is major nematode in citrus gardens worldwide and causes decline and growth reduction of citrus plants. Chemical control is the only way to prevent this nematode that is dangerous to environment (24). The leaf extracts of *Allium sativum, Brassica campestris*, *Capsicum frutescense, Glycyrrhiza glabra, Datura innoxia, Chenopodium botrys* and *Foeniculum vulgar*e effects were evaluated on plant growth and citrus nematode control in Fars province, Iran. In laboratory conditions different plant extracts, concentration of each extract and duration time of exposure extracts was examined in Petri dishes (Table 7).

Results showed that increase in concentration and duration of exposure to extracts increased the mortality of nematode. In laboratory experiments extracts of *Allium sativum* and *Capsicum frutescense, Datura innoxia, Foeniculum vulgar*e were more effective respectively. In pot experiments, nematode populations decreased and increased the plant growth that were treated with *Allium sativum, Capsicum frutescense* and *Foeniculum vulgar*e compared with control. Thus it is possible to use local plant extracts to control citrus nematode instead of using chemical nematicides (24). The nematicidal activity of *Allium* has been reported against the root knot *Meloidogyne incognita* and the most active compounds isolated from *Allium grayi* and *Allium fistulosum* were methylpropyl trisulfide, dipropyl disulfide (DPDS), diallyl disulfide (DADS), dipropyl Ti, methylpropenyl Ti and dipropyl thiosulfonate (41).

Table 7. Nematode (*Tylenchulus semipenetrans*) mortality in interaction exposure times x plant spp. treatments (24)

Plant species	Mortality (%) at different times (h)			
	12h	24h	48h	72h
Control	0	0	0	0
Foeniculum Miller	40i	70h	98a	97a
Chenopodium L.	40i	60i	81e	82de
Datura L.	42i	70gh	91b	93ab
Glycyrrhiza L.	38m	58i	78f	78f
Capsicum L.	48k	70g	96a	98a
Brassica L.	28n	52j	82cd	83c
Allium L.	44k	70gh	98	98

3.2.2.4. Termites: To find the natural and cheaper methods to control termites (*Isoptera termitidae*), some traditionally useful Ghanaian plant materials were evaluated. Thirteen plants traditionally used by farmers for termite control in Ghana were recorded after a survey. After field and laboratory assessments, *Ocimum canun*, *Ocimum gratissimum*, *Zanthoxylum xanthoxyloides*, *Sporobolus pyramidalis* and *Allium sativum* were found biologically active (Table 8). On the whole, *Ocimum canum* and *O. gratissimum* were found to have repellent effects with 77.78 and 69.24 % repulsion rates, respectively.

Additionally *Allium sativum*, *Ocimum canum*, *O. gratissimum*, *Sporobolum pyramidalis* and *Zanthoxylum xanthoxyloides* roots were also observed to possess anti feedant effects on termites recording 100 % mortality after 5 to 9 days of exposure. The tolerance, walking trail, choice and non-choice tests using *Ocimum canum*, *O. gratissimum*, *Sporobolus pyramidalis* and *Zanthoxylum xanthoxyloides* showed significant differences between the control (corn stalk) and the candidate plant materials (p< 0.001), with strong indication that these plant materials could be used for effective and safe management of termites in agricultural crop systems. (33)

Table 8. Effects of different plants and their parts extracts on growth of termite *Isoptera termitidae* (after 3 months) (33)

Plant species	Part used	Effectiveness on termites		
		Complete control	Moderate effect	No effect
Azadirachta indica Adr. Juss	Stem		√	
Jatropha curcas L. / *J. gossypiifolia* L.	Stem			√
Chromolaena odorata Linnaeus) King & Robinson	Stem and leaves		√	
Carica papaya L.	Stem		√	
Senna siamea Lamk.,	Stem	√		
Manihot exculentus Crantz.	Stem and leaves			√
Sporobolus pyramidalis P. Beauv	Whole plant	√		
Ocimum gratissimum L.	Stem and leaves	√		
Zanthoxylum xanthoxyloides Fasa Kwari	Leaves			√
Z. xanthoxyloides	Stem	√		
Z. xanthoxyloides	Root	√		
Allium sativum L.	Whole plant	√		
Ocimum canum Sims	Stem and leaves	√		

The acaricidal activity of *Allium* has received little attention. However garlic extracts have repellent effects on *Tetranychus urticae* mites (5) and on human ticks *Ixodes ricinus* (6). The toxic effects of *Allium* and any derived sulphur compounds for microbial agents in humans are known since long time (7).

3.2.2.5 Microorganisms

Fan Sheng Zhi Shu, first century BC, the earliest Chinese agricultural book describes the plant allelopathy (148) and shows that cucurbit and leek (*Allium porrum*) should be interplanted to reduce the diseases in cucurbit, because leek produces special substances to inhibit the pathogens of cucurbit. At that time the *Allium* plant was used not only as a spice but also to control the microbial pathogens. The garlic extract has broad-spectrum antimicrobial activity against many genera of bacteria and fungi. The active component (allicin) has been isolated and characterized (7).

Allium sativum is also effective against several species of *Pseudomonas* and *Xanthomonas*. The fungicidal activity of *Allium* has focused mainly on mushrooms that are poisonous to humans (2). Grainge *et al.* (17) mentioned a number of phyto pathogenic mushrooms that are sensitive to *Allium* and their extracts. *Alternaria tenuis, Aspergillus* *niger*, various *Fusarium* including *F. oxysporum* and *F. Poae* and *Verticillium albo-atrum* are particularly sensitive to onion and garlic.

4. FUTURE LINES OF RESEARCH

Future research on the genus *Allium* may be conducted on the following aspects:

(I). *Allium cepa* and *A. sativum* are two important crops of subcontinents, should be put under trial for intercropping/ cover crop with major cash crops. In this way we can not only achieve the aim of biological control of weeds but also the productivity of these crops can be increased.

(II). Genetic makeup of *Allium cepa*, *A. sativum* and their wild relatives should be explored.

(III). Recently secondary plant metabolites (phytochemicals), have been extensively Investigated as a source of medicinal agents. Thus, it is anticipated that phytochemicals with adequate antibacterial efficacy will be used to control bacterial infections. Phytochemicals produced by this genus should be investigated as antibacterial agents.

5. CONCLUSIONS

Allium species are present in different modes [Vegetable, medicinal plants, inhibitors of insects and non-cultivated species), chemically enhance the productivity of cultivated crops. These are seasonally grown in cultivated and non-cultivated lands, bunds and channels. Phytochemicals produced by the species of this genus are mainly phenolic and organo-Sulpher compounds, however, these allelopathic chemicals can be used for weed and insects management in agricultural systems.

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