PHARMACOLOGICAL EFFECTS OF ALLIUM SPECIES GROWN IN IRAQ. 
AN OVERVIEW
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Abstract
Four species of the genus Allium belong to the Alliaceae family were grown in Iraq, these included Allium sativum, Allium cepa, Allium porrum and Allium schoenoprasum. They were considered as edible vegetables with low toxicity. They possessed many pharmacological effects including antimicrobial effects (antibacterial, antifungal, antiviral, antiprotozoal and anthelmentics), anticancer effects, hypolipidemic, hypotensive, antioxidant, detoxification, anti-inflammatory and analgesic, endocrine and many other pharmacological effects. The chemical analysis of Allium species showed that they contained volatile and essential oils, monosulphides, disulphides, oxygen compounds, thiophene derivatives, trisulphides, thiols, tetrasulphide, flavonoids, carbohydrates, amino acids, vitamins and minerals.

Keywords: Allium sativum, Allium cepa, Allium porrum, Allium schoenoprasum.

Introduction
Plants are a valuable source of a wide range of secondary metabolites, which are used as pharmaceuticals, agrochemicals, flavours, fragrances, colours, biopesticides and food additives. Medicinal plants are the Nature’s gift to human beings to help them pursue a disease-free healthy life. Plants have been used as drugs by humans since thousands of years ago. As a result of accumulated experience from the past generations, today, all the world’s cultures have an extensive knowledge of herbal medicine. Two thirds of the new chemicals identified yearly were extracted from higher plants. 75% of the world’s population used plants for therapy and prevention. In the US, where chemical synthesis dominates the pharmaceutical industry, 25% of the pharmaceuticals are based on plant-derived chemicals (1). Four species of the genus Allium of the Alliaceae family were grown in Iraq, these included Allium sativum, Allium cepa, Allium porrum and Allium schoenoprasum. They showed a wide range of pharmacological effects included antimicrobial, antithrombotic, antitumor, hypolipidaemic, antiarthritic and hypoglycemic agents and other effects. The objective of the present review is to highlight the chemical constituents and the pharmacological and therapeutic effects of Allium species grown in Iraq.

I-Allium sativum
Distribution:
Allium sativum is supposed to originate from Central Asia, from where its cultivation has spread to Southwest Asia and the Mediterranean region.
Today garlic is cultivated in regions with moderate or subtropical climate all over the world\(^{(2)}\).

**Traditional use:**
Garlic used traditionally as expectorant, for the treatment of asthma, antipyretic, sedative, aphrodisiac, diuretic, emmenagogue, carminative, to promote hair growth, for the treatment of dyspepsia, urinary and respiratory tract infections and cardiac complaints\(^{(3,6)}\).

**Physicochemical properties\(^{(4,9)}\):**
Total ash: not more than 5.0%, acid-insoluble ash: not more than 1.0%, water-soluble extractive: not less than 5.0%, alcohol-soluble extractive: not less than 4.0%, and moisture: not more than 7%.

**Chemical constituents:**
Bulbus *Allium sativum* contained sulfur compounds including cysteine sulfoxides and the non-volatile γ-glutamylcysteine peptides reached about 82% of the total sulfur content of garlic. These sulfur compounds included thiosulfonates (alliin), ajoenes (E-ajoene, Z-ajoene), vinylthiinins (2-vinyl-[4H]-1,3-dithian, 3-vinyl-[4H]-1,2-dithian, sulfides (diallyl disulfide, diallyl trisulfide) and others\(^{(5,10-12)}\). However, when garlic is cut and the parenchyma is destroyed, alliin is the major cysteine sulfoxide liberated. Alliin is converted by the enzyme allinase (alliin lyase) to allicin. Allicin [S-(2-propenyl) 2-propene-1-sulfinothioate or diallylthiosulfinate] is an odoriferous compound and the main component of freshly crushed garlic homogenates. Garlic also contains S-propylcysteine-sulfoxide (PCSO) and S-methylcysteine-sulfoxide (MCSO). PCSO can generate over 50 compounds depending on temperature and water content. The activation of allinase on the mixture of alliin, PCSO, and MCSO can produce many other molecules, including allyl methane thiosulfinate, methyl methanethiosulfinate, and other mixed or symmetrical thiosulfonates (R-S-S-R’), where R and R’ are methyl, propyl, and allyl groups\(^{(13)}\). The hydro distillation of *Allium sativum* (bulbs) gave essential oils of about 0.073 % (v/w). *Allium sativum* (bulbs) essential oil contained the following compounds: 3,3’-thiobis-1-propene 3.03%, disulfide 4.60%, methyl-trans-propenyl-disulfide 0.20%, cis-propenyl methyl disulfide 0.47%, propanedioic acid 3.23%, dimethyl trisulfide 2.63%, limonene 0.14%, di-2-propenyl disulfide 25.18%, methyl-2-propenyl trisulfide 23.80%, 3-vinyl-[4H]-1,2-dithiin 1.30%, 2,4,5,6-tetramethylpyrimidine 1.12%, 2-vinyl-[4H]-1,3-dithiin 1.85%, di-2-propenyl trisulfide 21.05%, isobutyl isothiocyanate 0.18%, 3,3’-thiobis-1-propene 0.24%, 2,3-dicarboxylylphene 1.45%, diallyl tetrasulphide 3.56%, diallyl pentasulfide 2.45%, diallyl hexasulfide 1.15%, methyl allyl pentasulfide 0.22%, methyl allyl hexasulfide 0.15%\(^{(13)}\). Peptides (17 amino acids), steroids, terpenoids, flavonoids, phenols, and minerals such as selenium have been isolated from garlic\(^{(15-16)}\).

Aliin is well absorbed orally in rats. It gave the maximum serum concentrations within 10 minutes. It is completely excreted within 6 hours. Allicin and vinylidithiones are absorbed slowly. They gave the peak levels between 30 and 120 minutes and persisting in the body for up to four days. S-allylcysteine is well absorbed orally (98-100%) in rats, mice and dogs with a significant first pass effect. Allicin is metabolized to allyl mercaptan, ajoene and vinylidithiones. Excretion occurs via the renal system, hepatic breakdown, fecal excretion and exhalation\(^{(17-19)}\).

**Antimicrobial effects:**

**Antibacterial**
Numerous reports indicate that garlic extract has broad spectrum antimicrobial activity against Gram positive and Gram negative microorganisms. The juice, aqueous and alcoholic extracts, and an essential oil of garlic inhibited the *in vitro* growth of *Staphylococcus aureus, Streptococcus faecalis, Bacillus sp., Clostridium, Escherichia coli, Shigella sonnei, Proteus sp., Pseudomonas aeruginosa, Erwinia carotovora, Pasteurella multocida, Mycobacterium tuberculosis, Candida sp., Cryptococcus sp., Torulopsis sp., Trichosporon pullulans, Rhodotorula rubra,* and *Aspergillus niger*\(^{(20-31)}\).

In 1982 Bolton et al mentioned that, around the turn of the century, Minchin, the head of the tuberculosis ward at a Dublin hospital, wrote that garlic had a remarkable cure rate for tuberculosis. It was used as an inhalant and taken internally. At the same time, McDuffie, in New York City, compared garlic with 55 other treatments for tuberculosis and concluded that it was the most effective\(^{(32)}\). 2 mg/ml of garlic extract was required to inhibit one *Mycobacterium tuberculosis* strain\(^{(33)}\).
Thirty strains of mycobacterium, consisting of 17 species, were inhibited by various concentrations of garlic extract. The inhibitory concentration was ranged from 1.34 mg/ml to 3.35 mg/ml. M. bovis was the species most easily inhibited by the extract, requiring only a concentration of 1.34 mg/ml. The six strains of M. tuberculosis required only slightly more concentration, with a mean value of 1.67 mg/ml of media. Garlic extracts can also prevent the formation of Staphylococcus enterotoxins A, B, and C1 and thermonuclease. Garlic extracts are also effective against Helicobacter pylori. Pure allicin produced significant antibacterial effects against various bacterial isolates.

In general, the antimicrobial effects have been attributed to the action of thiolsulfonates. Inhibition of certain thiol-containing enzymes in the microorganisms by the rapid reaction of thiolsulfonates with thiol groups was assumed to be the main mechanism. Allicin also inhibited other bacterial enzymes such as acetate kinase and phosphotransacetyl-CoA synthetase. Allicin also inhibited the DNA and protein synthesis, the effect on RNA is suggesting that RNA could be a primary target of allicin.

**Antifungal effects:**
The effect of aqueous garlic extract on the macromolecular synthesis of Candida albicans was studied. Protein and nucleic acid syntheses were inhibited to the same extent as growth, but lipid synthesis was completely arrested. Blockage of lipid synthesis is likely an important component of the anticanidal activity of garlic. A successful treatment of Cryptococcal meningitis was achieved by oral, muscular, and intravenous administration of garlic.

The antifungal activity in human serum against seven species of Candida and two species of Cryptococcus was detected after ingestion of garlic. Garlic extract showed potent antifungal activity against three different isolates of Cryptococcus neoformans. The minimum inhibitory concentration was 6 to 12 g/mL. It also showed synergistic fungistatic activity with amphotericin B. Pure allicin was also effective against Candida, Cryptococcus, Trichophyton, Epidermophyton, and Microsporum with MIC between 1.57 and 6.25 g/mL. It inhibited germination of spores and growth of hyphae.

**Antiviral effects:**
The antiviral activity of hydro-distilled essential oils of Allium sativum (bulbs) against (HSV1) was tested by using cytopathicity (CPE) assay. African green monkey kidney (Vero) cell line (virus infected cells) was incubated with different levels of essential oils. The antiviral activities were increased with increasing essential oils concentrations. The additions of 200, 500 and 1000 g/ml of garlic essential oils increased antiviral activity percentages to 37.66, 72.94 and 93.81%, respectively. Nagai reported that garlic extract has preventive effect against infection with influenza virus. Garlic extracts have been shown to have in vitro and in vivo antiviral activity against the human cytomagalovirus, influenza B, herpes simplex virus type 1, herpes simplex virus type 2, parainfluenza virus type 3, vaccinia virus, vesicular stomatitis virus, and human rhinovirus type 2. Ajoene was found to block the integrin-dependent processes in a human immunodeficiency virus-infected cell system.

**Anthelmentic and antiprotozoal effects:**
Some experimental studies have been performed to explain the mechanism of anthelmentic action of A. sativum extract in 12 different human and non-human parasites. It was used in the treatment of roundworm (Ascaris) and hookworm (Ancylostoma caninum and Necator americanus). Sulfur compounds of the plant, such as Allicin, diallyl trisulphide (DAT) and ajoene can reduce the formation of certain thiol- dependent processes in a mammalian system. Allicin inhibited to the same extent as growth, but lipid synthesis was completely arrested. Blockage of lipid synthesis is likely an important component of the anticanidal activity of garlic.

Allium sativum and its constituents were also active against amoeba. 30 g/mL of allicin was totally inhibited the growth of amoeba cultures. However, 5 g/mL allicin inhibited 90% the virulence of trophozoites of E. histolytica as determined by their inability to destroy monolayers of tissue-cultured mammalian cells in vitro. 30 g/mL was very efficiently inhibited the growth of other protozoan parasites such as Giardia lamblia, Leishmania major and Leptomonas colosoma. The methanolic extract of A. sativum bulbs was screened for in vitro and in vivo antileishmanial activity against Leishmania major strain (NLB 145) and L. donovani strain (NLB 065). BALB/c mice and golden hamsters (Mesocricetus auratus) were used in in vivo studies.
of *L. major* and *L. donovani*. The extract showed IC50 values of 34.22 g/ml and 37.41 g/ml against *L. major* and *L. donovani* promastigotes respectively, compared to 1.74 g/ml against *L. major* and 1.18 g/ml against *L. donovani* for Amphotericin B. The multiplication indices for *L. major* and *L. donovani* amastigotes in macrophages treated with 100 g/ml of the extract were significantly decreased (55). Cytotoxic potential of *A. sativum* on *L. major* (MRHO/IR/75/ER) promastigotes was determined using the MTT assay in order to find 50% inhibitory concentration (IC50) of this herbal extract. *A. sativum* showed a dose-dependent cytotoxic effect in *L. major* with almost 100% death at a concentration of 93 g/ml (48).

**Anticancer effects:**

Diallyl disulfide from garlic (*Allium sativum*) has been shown to have an antiproliferative effect on human tumor cells including those of colon, lung, skin, breast and liver origins (56-61). The consumption of garlic and related sulfur compounds has been reported to inhibits N-methyl-N-nitrosourea induced mammary cancer, dimethylhydrazine induced colon cancer, 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanone induced lung cancer, 1,2-dimethylhydrazine induced hepatic cancer, 7,12-dimethyl benz[a]anthracene and benzo[a]pyrene-induced skin cancer and carcinoogen- induced stomach cancers in experimental animals (62-67).

Many studies showed a low incidence of stomach, colorectal, prostate, esophagus cancers and female breast carcinoma in societies with high Allium vegetables consumption (65, 68-74). Garlic oil increased glutathione (GSH) peroxidase activity in isolated epidermal cells incubated in the presence or absence of the potent tumor promoter 12-O-tetradecanoylphorbol-13-acetate (TPA), and inhibited the sharp decline in the intracellular ratio of reduced (GSH)/oxidized (GSSG) glutathione caused by TPA. According to these findings, it was postulated that the inhibitory effects of garlic oil on skin tumor promotion may result from their enhancement of the natural GSH-dependent antioxidant protective system of the epidermal cells (75).

On the other hand, garlic and some of its constituents inhibited the nuclear factor kappa B (NF-κB) activation induced by various receptor agonists, including lipopolysaccharide and tumor necrosis factor a (TNFa) (76-77). In addition, garlic extract can directly inhibit the Toll-like receptors (TLRs)-mediated signaling pathway at the receptor level. Garlic extract and its sulfur-containing compounds inhibited nuclear factor kappa B (NF-κB) activation induced by various receptor agonists including lipopolysaccharide (LPS) (78).

**Cardiovascular effects:**

Garlic (1-4% in diet) and garlic protein administration in hypercholesterolemic rats induced by a high-cholesterol diet, significantly reduced serum cholesterol, triglyceride and LDL cholesterol (79-85). Long term feeding of garlic and garlic preparations on experimental atherosclerosis induced by a high-cholesterol diet in rabbits cause statistically significant reduction in serum lipids and atheromatous lesions (86-91). Water soluble extract of garlic inhibited the biosynthesis of cholesterol in hepatocytes. Garlic derived components are capable of combining with the sulphhydryl (-SH) group. Reduced conversion of acetate into cholesterol has been observed both in vivo and in vitro (82, 92-93). Eating of 10 g fresh garlic per day for 2 months significantly decreases (15%-28.5%) serum cholesterol levels among hypercholesterolemic patients (94). Garlic oil caused a steady decrease in LDL and VLDL levels with concomitant increase in HDL levels (80, 95). Intake of enteric-coated garlic powder (equal to 400 mg garlic, 1mg allicin) twice daily in hyperlipidemic patients has significantly reduced total cholesterol, LDL-cholesterol and triglyceride and increased HDL-cholesterol (96).

The level of cholesterol, triglyceride, phospholipids and β- lipoproteins were significantly declined in the individuals consuming 10-50 g of garlic /week. These results indicate that routine consumption of garlic in the diet has a beneficial effect in maintaining the serum lipids at low or normal levels (97). In a placebo-controlled trial of patients with stage II peripheral arterial occlusive disease, garlic powder supplements, 800 mg daily were associated with a significant increase in walking distance by 46 meters; the improvement started after the fifth week of treatment (98). Patients treated with 900 mg daily of standardized garlic powder showed 9-18% reduction in plaque volume, a 4% decrease in LDL levels, an 8% increase in HDL concentrations, and a 7% decrease in blood pressure (99).
Garlic inhibited platelet aggregation in both in vitro and in vivo studies. A water, chloroform, or methanol extract of the drug inhibited collagen-, ADP-, arachidonic acid-, epinephrine-, and thrombin-induced platelet aggregation in vitro. As appeared in experimental animals and clinical studies, garlic, ether extract and garlic juice and its constituents decreased cholesterol and fibrinogen, increased tissue plasminogen activator activity, increased fibrinolytic activity and blood coagulation time, and decrease in thrombocyte aggregation in blood. Experimental and clinical studies showed that garlic produced hypotensive effects. Garlic induced significant reduction in systolic and diastolic blood pressure. The authors postulated that the hypotensive action of garlic is due to a direct relaxant effect on smooth muscles.

Antioxidant effects:
Garlic compounds were reported to have tremendous antioxidant property which exerts actions by scavenging ROS, enhancing cellular antioxidant enzymes and increasing glutathione in the cells. The radical scavenging activity (% inhibition, DPPH radical scavenging assay) of the essential oil Allium sativum was 87.0% By using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging methods, raw garlic extract shows a good antioxidant activity.

Aqueous extract of Allium sativum has been studied in hyperlipidemic Charles foster rats fed on high fat diet to find out possible mechanism responsible for its lipid lowering and antioxidant behavior. Plasma and hepatic lipid levels were found to be lowered by A. sativum (200mg/kg bw). A. sativum activates lecithin: cholesterol acyltransferase, which converts cholesterol into HDL. In addition, enhancement of the activity of plasma and hepatic lipoprotein lipases cause reduction in levels of LDL & VLDL. A. sativum treatment also increased synthesis of bile acids from cholesterol, resulted in enhanced excretion. A. sativum significantly reduces oxidative stress and normalizes the activities of superoxide dismutase, catalase, and glutathione peroxidase and glutathione reductase in liver. Lipid peroxidation in plasma has also been found significantly decreased in treated animals. Moreover, the body weight of treated animals was found to be significantly lesser (47%) than untreated animals. These findings suggest that activation of LCAT as well as enhanced synthesis and excretion of bile acids were also responsible for reduction of cholesterol level and elevation of high density lipoprotein level.

Antidiabetic effects:
Garlic has been found to be effective in lowering serum glucose levels in streptozotocin and alloxan-induced diabetes in rabbits, rats and mice. S-allyl cysteine sulphoxide, (allicin) in a dose of 200 mg/kg body weight was significant antidiabetic in rats. However, both garlic oil and diallyl trisulphide produced hypoglycemic effects and improved glycemic state in streptozotocin-induced diabetes in rats. Orally administered garlic juice resulted in better utilization of glucose in glucose tolerance tests in rabbits. Allicin produced 60% of the activity of tolbutamide in alloxan-induced diabetic rabbits at a dose of 250 mg/kg. Oral administration of garlic powder (800mg/day) to 120 patients for 4 weeks in a double-blind, placebo-controlled study decreased the average blood glucose by 11.6%.

Detoxification effects:
Garlic administration (Allium sativum) has some beneficial effect in preventing heavy metal (nickel and chromium VI) induced alteration in lipid profile. Metwally investigated the effect of treatment with garlic oil (Allium sativum) on some heavy metal (copper and zinc) toxicity in Oreochromis niloticus, the concentration of CuSO4 was 300 mg/kg diet and ZnSO4 400 mg/kg diet. Garlic oil was added with concentration of 250 mg/kg diet, the experiment was extended for three months. Bioaccumulation of copper and zinc were recorded in treated fish as monitored by the significant (P<0.01) increase in serum and liver tissues concentrations, but they were decreased significantly after treatment with Allium sativum. Lipid profile, triglyceride (TG), cholesterol, very low density lipoprotein (VLDL), low density lipoprotein (LDL) showed significant increase. The antihepatic toxicity of garlic was investigated experimentally in rats, CrCl3 alone increased serum levels of AST and ALT. However, garlic inhibited the hepatotoxicity of CrCl3, and the concomitant use of garlic and CrCl3 decreased the levels of AST and ALT when garlic used in a dose of 60 and 120 mg /kg and CrCl3 is 8 mg /kg. Garlic decreased lead contents in tissues of lead exposed r chicken and rats. The prophylactic efficacy of garlic (Allium sativum) to reduce tissue lead (Pb)
concentration was evaluated experimentally in goats. The concomitant use of lead acetate and garlic dry powder reduced lead concentration considerably, which was indicating the potential activity of garlic against lead toxicity in goats\(^{(136)}\).

**Contraindications and adverse effects:**
Allergic reactions and contact dermatitis to garlic, and occupational asthma among garlic harvesters have been reported\(^{(137-140)}\). Garlic is generally recognized as safe (GRAS list), in humans, daily doses of up to 60 grams of fresh garlic and 120 mg of essential oil of garlic over a period of three months did not result in any serious disorders. However, in high doses, it caused gastric irritation, heartburn, nausea, vomiting, diarrhea, flatulence, bloating, mild orthostatic hypotension, flushing, tachycardia, headache, insomnia, sweating, dizziness and offensive body odor\(^{(141-143)}\). It was recommended to be avoided during pregnancy and lactation\(^{(144-145)}\).

**Dosage:**
Raw garlic cloves: 0.5-2 raw cloves (2-6 grams), up to three times daily (one clove is approximately equivalent to 3 grams of fresh garlic). Garlic powder: 0.4–1.2 grams daily divided into three doses. Juice: 2-4 mL three times daily, **Syrup:** 2-8 mL three times daily\(^{(146)}\). The European scientific cooperative on phytotherapy recommended the daily equivalent of 6-10 mg of alliin (or 3-5 mg of allicin), which can be found in one clove of fresh garlic or in 500-1000 mg of garlic powder\(^{(141,147)}\).

**II- Allium cepa**

**Synonyms:** *Allium esculentum Salisb, Allium porrum cepa Rehb\(^{(148)}\).*

**Distribution:** Central Asia is considered the region of origin. Onion was introduced to the Mediterranean and is cultivated worldwide\(^{(149)}\).

**Traditional uses:**
*Allium cepa* was used traditionally as carminative, emmenagogue, contraceptive, expectorant, anthelmintic, aphrodisiac, and tonic. It was also used in the treatment of cholera, bronchitis, bruises, earache, colic, insect bites, tuberculosis, diabetes, dropsy, catarrh, scurry, epileptic fits, hysterical fits, fevers, hypertension, jaundice, pimples, and sores\(^{(4,150)}\).

**Physicochemical properties**\(^{(4,104)}\):
- Total ash: not more than 6%, acid-insoluble ash: not more than 1.0%, water-soluble extractive: not more than 5.0%, and alcohol-soluble extractive: not more than 4.0%.

**Chemical constituents:**
- Food value of onion per 100 g of the edible portion: moisture 86.6% , protein 1.2% , fat 0.1%, minerals 0.6% (calcium 47 mg , phosphorus 50 mg , iron 0.7 mg), fiber 0.4%, carbohydrates 11.1% and Vitamin C 11 mg\(^{(151)}\). The bulbs on steam distillation yield an essential oil (0.005%) with an acrid taste and an unpleasant odour. The characteristic odor of the oil is attributed to the presence of several unsaturated sulphur and other organic compounds. The alkyl di- and tri-sulphides are primarily responsible for the cooked onion flavour. The compounds identified in the oil of onion included\(^{(148,152-153)}\):

- **Monosulphides:** dimethyl sulphide, allyl methyl sulphide, methyl propenyl sulphide (2 isomers), allyl propyl sulphide, propenyl propyl sulphide (2 isomers) and dipropenyl sulphides (3 isomers).

- **Oxygen compounds:** propanal, dimethylfuran, 2-methylpentanal, 2-methyl-pent-2-enal, tridecan-2-one and 5-methyl-2-n-hexyl-2,3-dihydrofuran-3-one.

- **Disulphides:** dimethyl disulphide, methyl propyl disulphide, allyl methyl disulphide, methyl cis-propenyl disulphide , methyl trans-propenyl disulphide, isopropyl propyl disulphide, dipropyl disulphide, allyl propyl disulphide, cis-propenyl propyl disulphide, trans-propenyl propyl disulphide, diallyl disulphide, allyl propenyl disulphide (2 isomers) and dipropenyl disulphide (3 isomers).

- **Thiophene derivatives:** 2,5-dimethylthiophene , 2,4-dimethylthiophene ,3,4-dimethylthiophene and 3,4-dimethyl-2,5-dihydrothiophen-2-one.

- **Trisulphides:** dimethyl trisulphide, methyl propyl trisulphide, allyl methyl trisulphide methyl cis-propenyl trisulphide, methyl trans-propenyl trisulphide, diisopropyl propyl trisulphide, isopropyl propyl trisulphide, dipropyl trisulphide, allyl propyl trisulphide, diallyl trisulphide, cis-propenyl propyl trisulphide and trans-propenyl propyl trisulphide.

- **Thiols:** Hydrogen sulphide, mehanethiol, propanethiol, allylthiol.

- **Tetrasulphide:** dimethyl tetrasulphide.

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Pharmacological effects:

Effects on enzymes:
Fresh bulb and water extract administered intragastrically to rats inhibited acid phosphatase (154). Lyophilized extract of the fresh bulb, in the chicken at a concentration of 2.0% of the diet inhibited alanine racemase and Cu-Zn superoxide dismutase activity. Water extract of the fresh bulb, in the rats and rabbits inhibited alkaline phosphatase. Water extract of the fresh bulb also inhibited alpha amylase. Water extract of the fresh bulb, in the rabbits at a concentration of 20.0% of the diet stimulated lactate dehydrogenase. Ethanol (75%) extract of the fixed oil inhibited lipooxygenase in the polymorphonuclear leukocytes of guinea pigs. Methanol extract of the fresh bulb, at a concentration of 100.0 mcg/ml, inhibited lipooxygenase in the platelets (150).

Antiplatelet and fibrinolytic activities:
Both raw onions and the essential oil increased fibrinolysis in rabbits and humans. An increase in coagulation time was also observed in rabbits. Allium cepa inhibited platelet aggregation in vitro and in vivo. An aqueous extract of Allium cepa inhibited diphosphate, epinephrine, arachidonic acid, adenosine, and collagen induced platelet aggregation in vitro. Essential oil, a butanol and chloroform extract inhibited platelet aggregation in rabbits. Chloroform, ethanol, butanol extract and the essential oil 10–60 g/ml inhibited aggregation of human platelets in vitro by decreasing thromboxane synthesis (105,148,155,159). Sulfur compounds of onion oil also inhibited the formation of thromboxanes and the action of platelet activating factor (PAF) (16-17).

The bulb juice exerted fibrinolytic effects in rabbits. The essential oil administered by gastric intubation to the rabbits at a dose of 2.0 gm/kg for 3 months, decreased fibrinolytic activity (150). Butanol extract and ethanol soluble fractions of the bulb (20.0 microliters) inhibited ADP-induced aggregation of platelets in human and rabbit via inhibition of thromboxane synthesis. The essential oil, at concentrations of 10 to 30 mcg/ml, produced strong antiplatelet in human adults vs ADP-induced aggregation (150).

Hypolipidemic effects:
The hypolipidemic effects were observed with the using of onion extract, scales of bulb, and fixed oil of onion in experimental animals. Onion extract in rabbits lowered the level of total lipids, cholesterol and phospholipids in the eyes compared to those fed only cholesterol. The bulb juice, administered orally to rabbits was also significantly decrease serum lipids. The outer skin fiber at a dose of 263.0 mg/day, and the scales of bulb, at a dose of 5.0 mg/kg for 45 days in rats, was active hypolipidemic treatments. The fixed oil at a dose of 100.0 mg/kg was also significantly decreased plasma lipids in male rats (150,162-167).

Antimicrobial effects:
The petroleum ether extract of Bulbus Allium cepa inhibited the growth of Clostridium paraputrificum and Staphylococcus aureus. The aqueous extract or the juice of Allium cepa inhibited the growth of Escherichia coli, Serratia marcescens, Pseudomonas aeruginosa, Salmonella typhi, Streptococcus species and Lactobacillus odontolyticus (168-171).

The extracts of dried scale leaves of Allium cepa exerted antibacterial activities against Gram positive bacteria like Staphylococcus aureus and Bacillus subtilius and Gram negative bacteria like Escherichia coli and Klebselilia pneumonia (172).

Antimicrobial activity of different concentrations (50, 100, 200, 300 and 500 ml/l) of essential oil extracts of three type of onions (green, yellow and red) against two bacteria, Staphylococcus aureus, Salmonella enteritidis, and three fungi, Aspergillus niger, Penicillium cyclopium and Fusarium oxysporum, was investigated. The essential oil extracts of onions exhibited marked antibacterial activity, comparatively, 50 and 100 ml/l concentrations of onions extracts were less inhibitory than 200, 300 and 500 ml/l concentrations. However S. enteritidis was strongly inhibited by the red onion essential oil extract. The fungus F. oxysporum showed the lowest sensitivity towards extracts, whereas A. niger and P. cyclopium were significantly inhibited particularly at low concentrations (173).

The effect of the ethanolic extracts of onion against V. cholera was investigated. All tested strains of V. cholerae were sensitive to onion (Allium cepa) extracts of two types (purple and yellow). Purple type of extract had MIC range of 19.2–21.6 mg/ml while, the extract of yellow type onion had an MIC range of 66– 68.4 mg/ml (174).
The essential oil exerted antifungal activity against Aspergillus niger, Cladosporium herneckii, Candida albicans, Fusarium oxysporum, Saccharomyces cerevisiae, Geotrichum candidum, Brettanomyces anomalus, and Candida lipolytica. Bulb essential oil, at a concentration of 1.0%/disc, was active against Brettanomyces anomalus, Hansenula anomala, Kloeckera apiculata and Lodderomyces elongisporus. A concentration of 10.0%/disc was active against Kluyveromyces fragilis, Metschnikowia pulcherrima, Pichia membranaefaciens, Rhodotorula rubra, and Saccharomyces cervisiae.

The antimicrobial effects have been attributed to the action of allicin (diallyldisulphide oxide) on the growth and respiration of microorganisms such as Staphylococcus aureus, Escherichia coli and Candida albicans. Candida was the most sensitive of these organisms to allicin, whilst E. coli seemed to be less sensitive than Staphylococcus aureus. The -SO-S- group is essential for the antibacterial action of allicin as it inhibited the -SH enzymes. It has been observed that the permeability of bacterial cells to allicin is greatly influenced by the lipid content of the microorganisms. Allium cepa also exerted anti-parasitic activity for many helminthes and protozoa such as, Trichinella spiralis, and leishmania. It also minimized the pathological and biochemical effects of many parasites such as cryptosporidia and toxoplasma.

Anticancer effects: In vivo and in vitro studies showed that the constituents of Allium cepa such as Allylsulfides (ajoene, allicin, diallylsulfide, diallyldisulfide, diallyltrisulfide, S-allyl cysteine, and sallymercaptocysteine) exerted anticarcinogenic and antitumor activities. The aqueous extracts of Allium cepa exerted antiproliferative effects. The protein fraction of onion extract also exhibited antimitotic activity. The beneficial effects of red, yellow and white onion extracts, particularly their antioxidant and antimitogenic activities were related to their phenols and flavonoids. Many mechanisms proposed for anticancer activity of Allium cepa included, inhibition of cell proliferation, inhibition of protein tyrosine kinase, inhibition of carcinogens activation, and modulation of phase II enzyme activity.

Smooth muscle relaxant effect and antiasthmatic activity: Ether and ethanolic extract of the fresh bulb inhibited allergen and platelet activating factor-induced asthmatic reactions when administered intragastrically to guinea pigs. Oral administration of an ethanol extract to guinea-pigs inhibited tracheal smooth muscle contractions induced by carbachol, and inhibited histamine-, barium chloride-, serotonin-, and acetylcholine-induced contractions in the ileum. Five alk(en)ylsulfinothioic acid alk(en)y1-esters isolated from onions and four synthetic thiosulfonates inhibited 5-lipoxygenase of porcine leucocytes, histamine release and leukotriene B4 and C4 biosynthesis of human polymorphonuclear leucocytes, thromboxane B2 biosynthesis by human platelets and allergen- and PAF-induced bronchial obstruction of guinea-pigs. According to the results the authors postulated that the anti-asthmatic and anti-inflammatory effects of onions depend in part on the thiosulfonate moiety. On the other hand, the effect of onion extracts on bronchial obstruction (BO) induced by inhalation of ovalbumin in guinea-pigs was investigated. Bronchial obstruction was measured by whole body plethysmography. Benzylisothiocyanate (BITC) inhibited BO in a dose-dependent fashion: 150 mg/kg: 89%; 75 mg/kg: 76%; 30 mg/kg: 66%; 15 mg/kg: 49%. Ethyl-isothiocyanate and allyl-isothiocyanate showed similar effects, while, p-hydroxy-benzyl-isothiocyanate, was ineffective. Additional experiments showed no antagonistic effects for the crude onion extract on histamine- or acetylcholine-induced BO. The authors mentioned that the antiasthmatic effects of onions mediated at least in part by isothiocyanates.

Effects on reproductive systems: Allium cepa showed significant antifertility activity, female rats treated with ethanolic extract showed significant inhibition of number of implant sites at a dose of 300 mg/kg. There was no change in ovulation, hence the antifertility activity observed for Allium cepa was attributed largely to its antiimplantation activity. Fresh bulb juice was enhanced uterine contraction in rats. The treatment was equivalent to 0.003 IU of oxytocin. Water extract of the bulb was also produced strong activity on pregnant mice and rats. Allium cepa was investigated in renal failure in...
male rats which experimentally infected by *Toxoplasma gondii*. The study showed that *T. gondii* exerted significant effect on serum creatinine, albumin, blood urea nitrogen (BUN), malondialdehyde (MDA) and total antioxidant capacity (TAC), and fresh onion juice returned and treated these harmful effects⁴⁰².

**Hypoglycemic and antioxidant effects:**

The ethanol, chloroform and petroleum ether extracts of *Allium cepa* exerted hypoglycemic effects in alloxan, glucose and epinephrine induced diabetes in experimental animals ⁴²³⁻⁴²⁰. The aqueous extract of onion, as well as its hypoglycemic effects, it improved the reduction in the antioxidant parameters (superoxide dismutase, catalase, glutathione peroxidase, and reduced glutathione) in alloxan induced diabetic rabbits ⁴²¹.

In assessment of hypoglycemic activity of *Allium cepa* in type 1 and type 2 diabetic patients, ingestion of crude *Allium cepa* (100 g) caused a considerable reduction in fasting blood glucose levels by about 89 mg/dl in relation to insulin (145 mg/dl) in type 1 diabetic patients and it reduced fasting blood glucose levels by 40 mg/dl, compared to glibenclamide (81 mg/dl) in type 2 diabetic patients, 4 hours later. The same dose of crude *Allium cepa* produced a significant reduction in the induced hyperglycemia (GTT) by about 120 mg/dl compared to water (77 mg/dl) and insulin (153 mg/dl) in type 1 diabetic patients and considerably reduced GTT by 159 mg/dl in relation to water (55 mg/dl) and glibenclamide (114 mg/dl) in type 2 diabetic patients, after 4 hours ⁴²¹².

The mechanisms that mediate the hypoglycemic effects of *Allium cepa* were included: Aliph propyl disulfide compounds competed with insulin for metabolism resulting in an increase of free insulin. *Allium cepa* also facilitated glycogen storage and increased glutathione peroxidase. Sulfur containing compounds such as dialkyl disulfides and their oxidized thiols can trap electrons from other systems and act as antioxidants. In addition, phenolic acids such as caffeic, chlorogenic, ferulic, sinapic, p-coumaric, vanillic, syringic and p-hydroxy produced antioxidant activity ⁴²¹⁻⁴²¹².

**Antiinflammatory and analgesic effects:**

Hot plate and formalin tests were used to study the analgesic effect of fresh onion juice (7.5 ml/kg) in mice during acute and chronic pain stages modeling. A significant analgesic property for fresh onion juice in both pain phases was recorded, the effect was similar to that of morphine (5 mg/kg). Fresh onion juice also decreased the hind paw thickness significantly. In the mean time, it also demonstrated better results than the standard treatment, diclofenac ⁴²¹³. Ethanol (75%) extract of the fixed oil inhibited lipoxigenase in the polymorphonuclear leukocytes of guinea pigs ⁴²¹⁰.

The anti-inflammatory effect of an aqueous extract of Welsh onion green leaves (WOE) was investigated in mice. Administration of WOE, in the range of 0.25–1 g/kg, showed a concentration dependent inhibition on paw edema development after carrageenan treatment. The anti-inflammatory effects of WOE were closely attributed to decreased levels of tissue NO and tumor necrosis factor-α (TNF-α). Further evidence for WOE’s protection is shown in the reduction of lipid oxidation and the increase of antioxidant enzyme activities, including catalase (CAT), superoxide dismutase (SOD), and glutathione peroxidase (GPX) *in vivo*. WOE also decreased the number of acetic acid-induced writhing responses and formalin-induced pain in the late phase in mice. Overall, the results showed that WOE might serve as a natural source of anti-inflammatory compounds ⁴²¹⁴.

Seven different synthetic thiosulfonates, and cepaene- and/or thiosulfinate-rich onion extracts were found to inhibit *in vitro* the chemotaxis of human granulocytes induced by formyl-methionine-leucinephenylalanine in a dose-dependent manner at a concentration range of 0.1–100 M. Diphenylthiosulfinate showed the highest activity and was found to be more active than prednisolone. The anti-inflammatory properties of onion extracts are related, at least in part, to the inhibition of inflammatory cell influx by thiosulfonates and ceapaenes ⁴²¹⁵. In addition, ajoene inhibited the pain receptors at dorsal root of spinal cord, thus resulting in an inhibition of pain signal transduction ⁴²¹⁶.

**Contraindication and adverse effects:**

No health hazards or side effects are known with the proper administration of the designated therapeutic dosages. The intake of large quantities
can lead to stomach complaint. Frequent contact with the onion leads on rare occasions to allergic reactions (hand eczema)\(^ {140} \).

**Dosage:** 50 g of fresh onion or 20 g of the dried onion and 10-20 ml of the juice of bulb\(^ {104,217} \).

**III-Allium porrum**

**Synonym:** Allium ampeloprasum var. porrum

**Distribution:** Allium porrum (look) is native in temperate regions, cultivated in Africa, Asia-temperate, Asia-tropical, Australia, Europe and Southern America\(^ {218} \).

**Traditional use:** Leek may be eaten raw or cooked, in salads. The whole plant was used as expectorant. The juice of the plant was used as a moth and insects repellent\(^ {217,219} \).

**Chemical constituents:**

All parts of Allium porrum have an offensive, pungent odor and an acrid taste, dependent on an essential oil, of which allyl sulphide, is the main ingredient\(^ {220} \). Allium porrum, as other members of Allium species, produce nonprotein sulfur amino acids derived from cystein, i.e., alk (en) ylcysteine sulfoxides. These amino acids are considered precursors of sulfur volatiles because their contact with the enzyme alliinase produced after the rupture of plant tissue cells leads to the formation of sulfur volatiles mainly in the form of thiosulfinates that subsequently breakdown and rearrange into disulfides and trisulfides. This complex involving alk (en) ylcystein sulfoxides –alliinase-thiosulfinates and di- or trisulfides\(^ {221-224} \). An increase in the production of sulfur compounds in both the precursor and volatile form, occurring only in association with intensive attacks by leek moths\(^ {219} \).

Micro and macronutrients in Allium porrum (raw bulb) showed that it contained: water 86g, energy kcal 35, protein 1.9 g, total fat 0.4 g, carbohydrate, available 5.9 g, dietary fiber 3.3 g, ash 1 g, sodium 9 mg, phosphorus 43mg, potassium 310 mg, calcium 63 mg, iron 1.1 mg, beta-carotene equivalents 49 g, total vitamin A equivalents 8 g, thiamin 0.1 mg, riboflavin 0.05 mg, niacin 0.6 mg, vitamin C 18 mg, cholesterol 0 mg, total saturated fatty acids 0.061 g, total monounsaturated fatty acids 0.006 g, total polyunsaturated fatty acids 0.253 g, dry matter 14 g, total nitrogen 0.31 g, glucose 2.4 g, fructose 2.4 g, sucrose 1.1 g, lactose 0 g, maltose 0 g, total available sugars 5.9 g, starch 0 g, alcohol 0 g, total niacin equivalents 0.9 mg, soluble non-starch polysaccharides 1.6 g, insoluble non-starch polysaccharides 1.6 g\(^ {225} \). The total phenol compounds in Allium porrum ranged from 41.6 to 88.2 mg/100 g fresh weight\(^ {226-227} \). The green leaves of Allium porrum mainly contain kaempferol glycoside and traces of quercetin-3-glucoside (0.10 mg/100 g)\(^ {228-229} \). However, five flavonoid glycosides were also isolated from Allium porrum L. including kaempferol 3-O-[2-O-(trans-3-methoxy-4-hydroxy-cinnamoyl)-beta-D-galactopyranosyl]-(1->4)-O-beta-D-glucopyranoside, and kaempferol 3-O-[2-O-(trans-3-methoxy-4-hydroxy cinnamoyl)-beta-D-glucopyranosyl]-(1->6)-O-beta-D-lucopyranoside\(^ {230} \).

Eight saponins were isolated from Allium porrum\(^ {231} \), two of them are new compounds and have been identified as: (25R)-5 alpha-spirostan-3-beta, 6 beta-diol 3-O-[O-beta-D-glucopyranosyl-(1->2)-O-[beta-D-xlyopyranosyl-(1->3)]-O-beta-D-glucopyranosyl-(1->4)-beta-D-galactopyranoside] and (25R)-5 alpha-spirostan-3-beta, 6 beta-diol 3-O-[O-beta-D-glucopyranosyl-(1->3)-O-beta-D-glucopyranosyl-(1->2)-O-[beta-D-xlyopyranosyl-(1->3)]-O-beta-D-glucopyranosyl-(1->4)-beta-D-galactopyranoside]\(^ {232} \).

Five polypeptides were isolated from Allium porrum, appear to be specifically associated with the priming period. Two additional polypeptides were found in leek embryos that were synthesized at higher levels at the end of priming than during germination alone. These continued to be synthesized, at lower levels in leek embryo tissue upon germination after priming\(^ {233} \).

**Pharmacological effects:**

**Hypolipidemic effects:**

The antihypercholesterolemic effect of a hydroalcoholic extract of A. porrum L. bulbs was evaluated in rabbits on hypercholesterolemic diet. The extract was given in three doses, 250, 500, and 1,000 mg/kg of body weight. Plasma total cholesterol decreased in all groups treated with A. porrum extract in a dose-dependent fashion\(^ {234} \). The antioxidative activity of Allium porrum ranged from 490 to 3323 mol TE/100 g fresh weight\(^ {235} \).
Antioxidant activity: 
Tsai et al reported that aqueous extracts of Allium porrum appeared to contain more phenolic compounds than those of garlic and green onion and thus the antioxidant activities of Allium porrum is bigger than green onion and garlic (236). The effect of alcoholic extract of Allium porrum (250 and 500mg/kg) was investigated on osteoporosis, which was induced experimentally in male rats. Alcoholic extract of Allium porrum (250 and 500mg/kg) was given by oral route daily for 11 successive weeks, 8 weeks before the induction of osteoporosis and 3 weeks during induction, the extract induced significant antioxidant activity resulted in a significant elevation in the decreased bone mineral density in osteoporotic rats as compared with control group (237).

Cytotoxic activity: 
All the eight saponins isolated from leek were tested for their cytotoxic activity against two different cell lines in vitro. Three of them showed cytotoxic activity (231).

Antimicrobial effects: 
All the Allium species possessed thiosulfinate contents. It reached 0.15 mol/g in leek (A. porrum). Thiosulfinates are the best studied compounds arising from Allium species. The antibacterial and antifungal activities against a variety of Gram-negative and Gram-positive bacteria were frequently recorded (238-240).

Other pharmacological effects: 
Allium porrum flavonoids exerted platelet anti-aggregation activity (230). Spirostanol saponins isolated from Allium porrum showed antifungal activity (232). Saponins give the Allium porrum an expectorant properties (217, 241). It was useful for the treatment of the disturbances in the gastrointestinal tract (e.g. colic pain, flatulent colic and dyspepsia) (237). If the production of propyl-cysteine sulfoxide (PCSO) precursor in Allium porrum, is induced in response to moth attack and mechanical wounding, the results showed an increase in the production of sulfur compounds in both the precursor and volatile form. The increase in sulfur precursors also led to an increase in the release of sulfur volatiles. This induced response may provide an effective defense strategy against the plant’s main natural enemy (219). The chemopreventive effects of Allium vegetables (onions, garlic, shallots, leeks, chives, and so forth) have been studied extensively, consumption of large amounts of Allium vegetables (in a comparison of the highest and lowest consumption groups) reduced the risk for gastric cancer (odds ratio, 0.54; 95% confidence interval, 0.43-0.65). Specific analyses for onion, garlic, leek, Chinese chive, scallion, garlic stalk, and Welsh onion yielded similar results, except for onion leaf. The estimated summary odds ratio for an increment of 20 g/day of Allium vegetables consumed (approximately the average weight of 1 garlic bulb) was 0.91 (95% confidence interval, 0.88-0.94), based on case-control studies from the dose-response meta-analysis (242).

Contraindication and adverse effects: 
Hypersensitivity to leek as a cause of asthma and dermatitis, and occupational rhinitis due to inhalation of leek juice has been described (243-244). Allium species contain a wide variety of organosulfides, particularly alk (en) ylcysteine sulfoxides. Trauma to the plants, such as chewing, converts the organosulfides to a complex mixture of sulfur-containing organic compounds. Many of these compounds or their metabolites are responsible for the odors, flavors, and pharmacologic effects of these plants. Many Allium species’ organosulfur compounds appear to be readily absorbed through the gastrointestinal tract and are metabolized to highly reactive oxidants. Cooking or spoilage of Allium species does not reduce their potential toxicity (245-246).

In dogs and cats, clinical signs of Allium species toxicosis may appear within one day of consumption if large amounts of material have been ingested; however, it is more common for clinical signs to develop after a lag of several days. Clinical signs often include depression, hemoglobinuria, hemoglobin and possibly hemosiderin urinary casts, icterus, tachypnea, tachycardia, weakness, exercise intolerance, and cold sensitivity. Inappetence, abdominal pain, and diarrhea may also be present. In cases of recent ingestion, the affected dog’s or cat’s breath may smell of sulfur compounds (247).

IV-Allium schoenoprasum 
Distribution: Allium schoenoprasum (chive) is derived from a wild ancestor that is native to Europe and Asia. At present chives are cultivated as vegetables or seasoning herbs all around the world, especially in the Northern Hemisphere (248-249).
Traditional uses: In traditional folk medicine, chives were eaten to treat and purge intestinal parasites, enhance the immune system, stimulate digestion, and treat anemia (249-250).

Chemical constituents: Allium schoenoprasum contained alliins (alkyl cysteine sulfoxides): in particular, methyl alliin (S-methyl-L-(+)-cysteine sulfoxide) and pentyl alliin (S-pentyl-L-(+)-cysteine sulfoxide), as well as their gamma-glutamyl conjugates; in the course of cutting up the fresh foliage, the allins undergo a transformation (triggered by fermentation) into the so-called alliaceous oils, e.g., dimethyl-disulfide-mono-S-oxide (259).

All the Allium species possessed thiosulfinate contents, which reached 0.19 mol/g in A. schoenoprasum (238,240,251-252). Chives also contain flavonoid glycosides, mainly quercetin glucoside, isorhamnetin glucoside, and kaempferol glucoside. The green leaves of chive mainly contain kaempferol glucosides (di- and tri-glycosides). The 3-beta-D-glucosides of kaempferol, quercetin and isorhamnetin were also isolated. The total flavonoids contents of the chives were 16.7 mg/10 g fresh weight. The ratio of the kaempferol glucoside, quercetin glucoside and isorhamnetin glucoside was found to be 4:1:2. Eight anthocyanins have been determined in acidified methanolic extract of the pale-purple flowers of chives. Four of them have been identified as the anthocyanin-flavonol complexes (253-256).

Micro and macronutrients in the raw and freeze dried (100g) Allium schoenoprasum were respectively: water 90.65 and 2.0 g, energy 30 and 311 kcal, protein 3.27 and 21.2 g, total lipids (fat) 0.73 and 3.5 g, carbohydrates 4.35 and 64.29 g, fiber, total dietary 2.5 and 26.2 g, total sugars 1.8 and 0 g, minerals, potassium 296 and 2960 mg, calcium 92 and 813 mg, magnesium 42 and 640 mg, phosphorus 58 and 518 mg, sodium 3 and 70 mg, iron 1.6 and 20 mg, zinc 0.56 and 5.12 mg, vitamins, vitamin A 4353 and 68300 IU, vitamin C (total ascorbic acid) 58.1 and 660 mg, folate 105 and 108 mcg DFE, niacin 0.647 and 5.9 mg, vitamin B6, 0.138 and 1.996 mg, riboflavin 0.115 and 1.5 mg, thiamin 0.078 and 0.9 mg, vitamin B12, and vitamin E (alpha tocopherol) 0.21 and 0 mcg, vitamin D (D2 and D3) 0 and 0 µg, vitamin D 0 and 0 IU, lipids, total polyunsaturated fatty acids 0.267 and 1.369 g, total saturated fatty acids 0.146 and 0.591 g, total monounsaturated fatty acids 0.095 and 0.49 g, and cholesterol 0 and 0 g (257).

Pharmacological effects: Antioxidant activity: The antioxidative properties of the bulb, leaf and stalk of Allium schoenoprasum L. was examined. Activities of antioxidant enzymes (superoxide dismutase, catalase, peroxidase, glutathione peroxidase), quantities of malonyldialdehyde, superoxide and hydroxyl radicals and reduced glutathione were determined along with total flavonoids, chlorophylls a and b, carotenoids, vitamin C and soluble proteins of the plant. The extracts from all plant organs exhibited antioxidant activity. The highest antioxidant activity was observed in the leaves (258).

A comparison between antioxidant activities of Allium schoenoprasum cultivated plant and Allium schoenoprasum tissue culture organs, showed that the crude extract of Allium schoenoprasum tissue culture exhibited antioxidant and scavenging abilities in all investigated plant parts, especially in the roots. However, the cultivated plants showed highest activities in the leaves (259).

Cytotoxic effects: The antiproliferative and tumour arresting effects of phenolic compounds (PhC) in flowers of Allium schoenoprasum were investigated. The effects on proliferation of HaCaT cells were evaluated in vitro using phenolic compounds in cultivation medium (100, 75, 50 and 25 µg/mL). It appeared that even low concentrations of these flowers’ phenolic compounds inhibited cell proliferation significantly (260). DNA polymerase inhibitory activity and antiproliferative activity of chive glycolipids toward human cancer cells was investigated, chive had an inhibitory effect on pol alpha activity and human cancer cell proliferation (261).

The chemopreventive effects of Allium vegetables (onions, garlic, shallots, leeks, chives, and so forth) have been studied extensively, consumption of large amounts of Allium vegetables reduced the risk for gastric cancer (odds ratio, 0.54; 95% confidence interval, 0.43-0.65). Specific analyses for onion, garlic, leek, Chinese chive, scallion, garlic stalk, and Welsh onion yielded similar results, except for

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onion leaf. The estimated summary odds ratio for an increment of 20 g/day of Allium vegetables consumed (approximately the average weight of 1 garlic bulb) was 0.91 (95% confidence interval, 0.88-0.94), based on case-control studies from the dose-response meta-analysis (242).

**Antimicrobial activity:**
Diallyl sulfides (diallyl monosulfide, diallyl disulfide, diallyl trisulfide, and diallyl tetrasulfide) are believed to be responsible for the antimicrobial activity in Allium species. Chive oil was examined for its diallyl sulfide content and its antimicrobial activity against some strains of food-borne pathogenic bacteria. Chive oil had a low concentration of diallyl monosulfide in comparison with the other diallyl sulfides. They inhibited all the tested pathogenic bacteria with a different degree of inhibition. Chive oil was also shown to be able to inhibit Escherichia coli O157:H7 in a food model (262).

**Contraindications and adverse effects:**
No health hazards or side effects are known in conjunction with the proper administration of designated therapeutic dosages. The intake of large quantities can lead to stomach irritation (4). In dogs and cats, clinical signs of Allium species toxicosis may appear within one day of consumption if large amounts of material have been ingested; however, it is more common for clinical signs to develop after a lag of several days. Clinical signs often include depression, hemoglobinuria, hemoglobin and possibly hemosiderin urinary casts, icterus, tachypnea, tachycardia, weakness, exercise intolerance, and cold sensitivity. Inappetence, abdominal pain, and diarrhea may also be present. In cases of recent ingestion, the affected dog’s or cat’s breath may smell of onions or garlic sulfur compounds (247).

**Dosage:** Chives are used fresh or dried, as a cut drug (149).

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