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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.

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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 complains[(3-8)] .

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 thiosulfinates (allicin) , ajoenes (E-ajoene, Z-ajoene), vinyldithiins (2-vinyl-(4*H*)-1,3-dithiin , 3-vinyl-(4*H*)-1,2-dithiin , 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 action 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 thiosulfinates (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-dicarboxythiophene 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 vinyldithiines are absorbed slowly. They gave the peak levels between 30 and 120 minutes and persisting in the body for up to four days ., S-allyl-cysteine 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 vinyldithiines. 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 the 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, *Toruloposis* 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 [(28)]. Garlic extracts can also prevent the formation of *Staphylococcus* enterotoxins A, B, and C1 and thermonuclease [(34)]. Garlic extracts are also effective against *Helicobacter pylori*.[(35)] Pure allicin produced significant antibacterial effects against various bacterial isolates [(36)].

In general, the antimicrobial effects have been attributed to the action of thiosulfinates. Inhibition of certain thiol-containing enzymes in the microorganisms by the rapid reaction of thiosulfinates with thiol groups was assumed to be the main mechanism [(25, 37-38)]. 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 [(39)].

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 anticandidal activity of garlic [(40)]. A successful treatment of *Cryptococcal meningitis* was achieved by oral, muscular, and intravenous administration of garlic [(41)].

The antifungal activity in human serum against seven species of Candida and two species of Cryptococcus was detected after ingestion of garlic [(26)]. Garlic extract showed potent antifungal activity against three different isolates of *Cryptococcus neoformans*. The minimum inhibitory concentration was 6 to 12 µg/mL. It also showed synergistic fungistatic activity with amphotericin B [(42)]. Pure allicin was also effective against *Candida*, *Cryptococcus*, *Trichophyton*, *Epidermophyton*, and *Microsporum* with MIC between 1.57 and 6.25 µg/mL. It inhibited germination of spores and growth of hyphae [(43)].

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 µg/ml of garlic essential oils increased antiviral activity percentages to 37.66, 72.94 and 93.81%, respectively [(13)]. Nagai reported that garlic extract has preventive effect against infection with influenza virus [(44)]. Garlic extracts have been shown to have *in vitro* and *in vivo* antiviral activity against the human cytomegalovirus, 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[(45)]**.** Ajoene was found to block the integrin-dependent processes in a human immunodeficiency virus-infected cell system [(46)].

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 developing different protozoan parasites such as *Giardia lamblia*, *Leishmania major* and *Leptomonas colosoma* [(47-52)]**.**

Allium sativum and its constituents were also active against amoeba. 30 µg/mL of allicin was totally inhibited the growth of amoeba cultures**.** However**,** 5 µg/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 [(53-54)]. 30 µg/mL was very efficiently inhibited the growth of other protozoan parasites such as *Giardia lamblia, Leishmania major*, *Leptomonas colosoma*, and *Crithidia fasciculate* [(54)]. 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 µg/ml and 37.41 µg/ml against *L. major* and *L. donovani* promastigotes respectively, compared to 1.74 µg/ml against *L. major* and 1.18 µg/ml against *L. donovani* for Amphotericin B. The multiplication indices for *L. major* and *L. donovani* amastigotes in macrophages treated with 100 µg/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 µg/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 carcinogen- 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-$_k$B) 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-$_k$B) 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 sulphydryl (-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 ß- 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* [100-105]**.** 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 , increase fibrinolytic activity and blood coagulation time , and decrease in thrombocyte aggregation in blood[105 -114]. 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 [115-123].

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 [126]. The radical scavenging activity (% inhibition, DPPH radical scavenging assay) of the essential oil *Allium sativum* was 87.0 % [14]. By using the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) scavenging methods, raw garlic extract shows a good antioxidant activity [124].

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 1ecithin: 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 [125].

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 [126]. S-allyl cysteine sulphoxide, (allicin) in a dose of 200 mg/kg body weight was significant antidiabetic in rats [127-128]. However**,** both garlic oil and diallyl trisulphide produced hypoglycemic effects and improved glycaemic state in streptozotocin -induced diabetes in rats [129]. 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 [130]. 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 %[106]**.**

Detoxification effects:

Garlic administration (*Allium sativum*) has some beneficial effect in preventing heavy metal (nickel and chromium VI) induced alteration in lipid profile [131]. 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 [132]. The antihepatic toxicity of garlic was investigated experimentally in rats, $CrCl_3$ alone increased serum levels of AST and ALT. However , garlic inhibited the hepatotoxicity of $CrCl_3$, and the concomitant use of garlic and $CrCl_3$ decreased the levels of AST and ALT when garlic used in a dose of 60 and 120 mg /kg and $CrCl_3$ is 8 mg /kg[133]. Garlic decreased lead contents in tissues of lead exposed r chicken and rats [134-135]. 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, anthelminthic, aphrodisiac, and tonic . It was also used in the treatment of cholera, bronchitis, bruises, earache ,colic, insect bites , tuberculosis , diabetes, dropsy, catarrh, scurvy, 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 odour 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.

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 lipoxygenase in the polymorphonuclear leukocytes of guinea pigs. Methanol extract of the fresh bulb, at a concentration of 100.0 mcg/ml, inhibited lipoxygenase in the rat 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 10–60µg/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 fibrinoloytic 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 fribrinolytic 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 to30 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 hypolipedemic 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 *Klebseilia 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 werneckii, Candida albicans, Fusarium oxysporium, Saccharomyces cerevisiae, Geotrichum candidum, Brettanomyces anomalus,* and *Candida lipolytica*. Bulb essential oil, at a concentration of 1.0%/disc, was active against *Brittanomyces 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* [150,175].

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 [36,176-177]. *Allium cepa* also exerted anti-parasitic activity for many helminthes and protozoa such as, *Trichinella spiralis,* and *leishmania* [178-181]. It also minimized the pathological and biochemical effects of many parasites such as cryptosporidia and toxoplasma [182-183].

Anticancer effects:

In vivo and *in vitro* studies showed that the constituents of *Allium cepa* such as Allylsulfides (ajoene, allicin, diallylsulfide , dialyldisulfide , diallyltrisulfide , S-allyl cysteine , and sallylmercaptocysteine) exerted anticarcinogenic and antitumor activities[61,76,184-192]. The aqueous extracts of *Allium cepa* exerted antiproliferative effects. The protein fraction of onion extract also exhibited antimitotic activity [193-194]. The beneficial effects of red, yellow and white onion extracts, particularly their antioxidant and antimutagenic activities were related to their phenols and flavonoids **[195].** 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[196] .

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 [197]. 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 [198]. Five alk(en)ylsulfinothioic acid alk(en)yl-esters isolated from onions and four synthetic thiosulfinates inhibited 5-lipoxygenase of porcine leucocytes, histamine release and leukotriene B_4 and C_4 biosynthesis of human polymorphonuclear leucocytes, thromboxane B_2 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 thiosulfinate moiety [199]. 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. Benzyl-isothiocyanate (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-hydoxy-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 [200].

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 [201].

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 **[4].** *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 effects [202].

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 [203-210]. The aqueous extract of onion , as well as its hypoglycemic effects , it improved the reduction in the antioxidant parameters (superoxide dismutase, catalase , glutathion peroxidase , and reduced glutathione) in alloxan induced diabetic rabbits[211].

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 [212].

The mechanisms that mediate the hypoglycemic effects of Allium cepa were included : Alyl 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 antiuoxidants. In addition , phenolic acids such as caffeic, chlorogenic ,ferulic, sinapic , p-coumaric, vanillic, syringic and p-hydroxy produced antioxidant activity[211-212].

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 [213]. Ethanol (75%) extract of the fixed oil inhibited lipoxygenase in the polymorphonuclear leukocytes of guinea pigs [150].

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 [214].

Seven different synthetic thiosulfinates, 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 μ*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 thiosulfinates and cepaenes [215]. In addition, ajoene inhibited the pain receptors at dorsal root of spinal cord, thus resulting in an inhibition of pain signal transduction [216].

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 complain. Frequent contact with the onion leads on rare occasions to allergic reactions (hand eczema) [149].

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) yl-cystein 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 µg , total vitamin A equivalents 8 µg , 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-hydroxycinnamoyl)-beta-D-galacto pyranosyl]-(1-->4)-O-beta-D-glucopyrano side, 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-xylopyranosyl-(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-xylopyranosyl-(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 antioxidant activity of *Allium porrum* ranged from 490 to 3323 µmol 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 for11 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 µmol/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 organosulfoxides, particularly alk (en) ylcysteine sulfoxides. Trauma to the plants, such as chewing, converts the organosulfoxides 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[149,249] .

All the Allium species possessed thiosulfinate contents , which reched 0.19 µmol/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 isorthamnetin were also isolated. The total flavonoids contents of the chives were 16.7 mg/10 g^{-1} 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 B 12 , and vitamin E (alpha tocopherol) 0.21 and 0 mg , 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

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, dially 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)].

References

1. Orhan IE . Biotechnological production of plant secondary metabolites. Bentham ebook, 2012 p 107.
2. Koch HP, Lawson LD. Garlic, Williams & Wilkins, Baltimore, London, Paris, Tokyo Madaus G (1938) Lehrbuch der biologischen Heilmittel, Band I, Thieme, Leipzig 1996.
3. African pharmacopoeia, Vol. 1, 1st ed. Lagos, Organization of African Unity, Scientific, Technical and Research Commission,1985.
4. Materia medika Indonesia, Jilid VI. Jakarta, Departemen Kesehatan, Republik Indonesia, 1995.
5. Bradley PR (ed.) British herbal compendium, Vol. 1. Bournemouth, British Herbal Medicine Association, 1992.
6. Farnsworth NR, Bunyapraphatsara N, (eds). Thai medicinal plants. Bangkok, Prachachon, 1992 :210–287.
7. The Indian pharmaceutical codex, Vol. 1. Indigenous drugs. New Delhi, Council of Scientific and Industrial Research, 1953 pp 8–10.
8. Hsu HY. Oriental materia medica, a concise guide. Long Beach, CA, Oriental Healing Arts Institute, 1986 pp735–736.
9. European pharmacopoeia, 3rd ed. Strasbourg, Council of Europe, 1997.
10. Reuter HD, Sendl A. *Allium sativum* and *Allium ursinum*: Chemistry, pharmacology, and medicinal applications. In: Wagner H, Farnsworth NR (eds.). Economic and medicinal plants research, Vol. 6. London, Academic Press, 1994 pp 55–113.
11. Sendl A. *Allium sativum* and *Allium ursinum*, Part 1. Chemistry, analysis, history, botany. Phytomedicine 1995, 4:323–339.
12. Block E. The chemistry of garlic and onions. Scientific American 1985; 252:94–99.
13. Ebadi , M . Pharmacodynamic basis of herbal medicine , 2nd Ed. CRC Press, Taylor & Francis Group 2007 pp 477-478.
14. Romeilah RM , Fayed SA and Mahmoud GI. Chemical compositions, antiviral and antioxidant activities of seven essential oils . Journal of Applied Sciences Research 2010; 6(1): 50-62.
15. Pendbhaje NS, Narang AP , Pathan SM, Raotole SA and Pattewar SV. Ethnopharmacology, pharmacognosy and phytochemical profile of Allium sativum L. A review. Pharmacologyonline 2011; 2: 845-853.
16. Londhe VP, Gavasane AT, Nipate SS, Bandawane DD, and Chaudhari PD. Role of garlic (*Allium sativum*) in various diseases : an overview. Journal of Pharmaceutical Research and Opinion 2011; 1(4):129-134.

17. Lachmann G, Lorenz D, Radeck W, and Steiper M. The pharmacokinetics of the S35 labeled labeled garlic constituents alliin, allicin and vinyldithiine. Arzneimittelforschung 1994; 44:734-743.
18. Nagae S, Ushijima M, Hatono S, *et al*. Pharmacokinetics of the garlic compound S-allylcysteine. Planta Med 1994; 60:214-217.
19. Egen-Schwind C, Eckard R, Kemper FH. Metabolism of garlic constituents in the isolated perfused rat liver. Planta Med 1992; 58:301-305.
20. Adetumbi MA, and Lau BHS. *Allium sativum* (garlic) -a natural antibiotic. Med Hypotheses 1983; 12:227-237.
21. Abbruzzese MR, Delaha EC, Garagusi VF. Absence of antimycobacterial synergism between garlic extract and antituberculosis drugs. Diagnosis and microbiology of Infectious Diseases 1987; 8:79–85.
22. Fitzpatrick FK. Plant substances active against *Mycobacterium tuberculosis*. Antibiotics and Chemotherapy 1954; 4:528–529.
23. Sharma VD. Antibacterial property of *Allium sativum. In vivo* and *in vitro* studies. Indian Journal of experimental Biology 1980; 15:466–469.
24. Arunachalam K. Antimicrobial activity of garlic, onion and honey. Geobios 1980; 71:46–47.
25. Cavallito CJ, and Bailey JH. Allicin, the antibacterial principle of *Allium sativum*. 1. Isolation, physical properties and antibacterial action. J Am Chem Soc 1944;66:1950-1951.
26. Moore GS and Atkins RD. The antifungistatic effects of an aqueous garlic extract on medically important yeast-like fungi. Mycologia 1977; 69:341–345.
27. Caporaso N, Smith SM and Eng RHK. Antifungal activity in human urine and serum after ingestion of garlic (*Allium sativum*). Antimicrobial Agents and Chemotherapy 1983; 5:700–702.
28. Delaha EC, and Garagusi VF. Inhibition of mycobacteria by garlic extract (*Allium sativum*). Antimicrob Agents Chemother 1985; 27:485-486.
29. Chaiyasothi T and Rueaksopaa V. Antibacterial activity of some medicinal plants. Undergraduate Special Project Report 1975; 75:1–109.
30. Uchida Y, Takahashi T, and Sato N. The characteristics of the antibacterial activity of garlic . Jpn J. Antibiotics 1975;28: 638–642.
31. Daka D. Antibacterial effect of garlic (*Allium sativum*) on *Staphyloccus aureus*: An *in vitro* study. African Journal of Biotechnology 2011; 10 (4): 666-669.
32. Bolton S, Null G and Troetel WM. The medical uses of garlic-fact and fiction. J Am Pharm Assoc 1982; 22:40-43.
33. Rao RR, Rao, SS , Natarajan S and Venkataraman PR . Inhibition of *Mycobacterium tuberculosis* by garlic extract. Nature (London) 1946; 157:441.
34. Gonzalez-Fandos E, Garcia-Lopez ML, Sierra ML, and Otero A. Staphylococcal growth and enterotoxins (A-D) and thermonuclease synthesis in the presence of dehydrated garlic. J Appl Bacteriol 1994; 77: 549–552.
35. Cellini L, Di Campli E, Masulli M, Di Bartolomeo S, and Allocati N. Inhibition of *Helicobacter pylori* by garlic extract (*Allium sativum*). FEMS Immunol Med Micrbiol 1996;13 : 273–277.
36. Rabinkov A, Miron T, Konstantinovski L, Wilchek M, Mirelman D, and Weiner L. The mode of action of allicin: trapping of radicals and interaction with thiol containing proteins. Biochim Biophys Acta 1998; 1379: 233–244.
37. Kabelik J. Antimikrobielle Eigenschaften des Knoblauchs. Pharmazie 1970; 25, 266-270.
38. Farbman S. *et al.* Antibacterial activity of garlic and onions: a historical perspective. Pediatrics Infectious Disease Journal 1993; 12:613–614.
39. Focke M, Feld A, and Lichtenthaler K. Allicin, a naturally occurring antibiotic from garlic, specifically inhibits acetyl-CoA synthetase. FEBS Lett 1990; 261:106–108.
40. Adetumbi M, Javor GT and Lau BHS. *Allium sativum* (Garlic) inhibits lipid synthesis by Candida albicans. Antimicrob Agents Chemother 1986:499-501.
41. Hunan Medical CoUege. Garlic in cryptococcal meningitis. A preliminary report of 21 cases. Chin Med J 1980; 93: 123-126.
42. Davis LE, Shen J, and Royer RE. *In vitro* synergism of concentrated *Allium sativum* extract and amphotericin B against *Cryptococcus neoformans*, Planta Med 1994; 60: 546–549.

43. Yamada Y, Azuma K, Evaluation of the *in vitro* antifungal activity of allicin, Antimicrob Agents Chemother 1997; 11:743-749.
44. Nagai, K. Experimental studies on the preventive effect of garlic extract against infection with influenza virus. Jpn J Infect Dis 1973; 47: 321- 325.
45. Tsai Y, Cole LL, Davis LE, Lockwood SJ, Simmons V, and Wild GC. Antiviral properties of garlic: *in vitro* effects on influenza B, herpes simplex and coxsackie viruses, Planta Med 1985; 5 : 460–461.
46. Tatarintsev AV, Vrzhets PV, Ershov DE *et al*. The ajoene blockade of integrindependent processes in an HIV-infected cell system. Vestn Ross Akad Med Nauk1992; 11 : 6–10.
47. Anthony JP, Fyfe L, Smith H. Plant active components – a resource for antiparasitic agents. Trends Parasitol 2005; 21(10): 462-468.
48. Khademvatan S, Saki J , Gharavi MJ and Rahi F . *Allium sativum* extract induces apoptosis in *Leishmania major* (MRHO/IR/75/ER) promastigotes. Journal of Medicinal Plants Research 2011;5(16): 3725-3732.
49. Kempski HW. Zur kausalen Therapie chronischer Helminthen-Bronchitis. Medizinische Klinik 1967; 62:259-260.
50. Soh CT. The effects of natural food-preservative substances on the development and survival of intestinal helminth eggs and larvae. II. Action on *Ancylostoma duodenale* larvae. American journal of tropical medicine and hygiene 1960; 9:8-10.
51. Iqbal Z, Nadeem QK, Khan MN *et al. In Vitro* Anthelmintic Activity of *Allium sativum, Zingiber officinale, Curcurbita mexicana and Ficus religiosa.* International Journal of Agriculture and Biology 2001; 3(4): 454–457.
52. Worku M, Franco R, Baldwin K *et al.* Efficacy of Garlic as an Anthelmintic in Adult Boer Goats. Arch Biol Sci, Belgrade 2009; 61 (1):135-140.
53. Mirelman D, Monheit D and Varon S, Inhibition of growth of *Entamoeba histolytica* by Allicin, the active principle of garlic extract (*Allium sativum*). J Infect Dis 1987; 156:243-244.
54. Ankri S, Miron T, Rabinkov A *et al.* Allicin from garlic strongly inhibits cysteine proteinases and cytopathic effects of *Entamoeba histolytica*, Antimicrob Agents Chemother 1997; 10 : 2286-2288.
55. Wabwoba BW, Anjili CO, Ngeiywa MM *et al.* Experimental chemotherapy with *Allium sativum* (Liliaceae) methanolic extract in rodents infected with *Leishmania major* and *Leishmania donovani* . J Vector Borne Dis 2010 ;47:160-167.
56. Hong YS, Ham YA, Choi JH *et al.* Effects of allyl sulfur compounds and garlic extract on the expression of Bcl-2, Bax, and p53 in non small cell lung cancer cell lines. Experimental and Molecular Medicine 2000;32:127-134.
57. Druesne-Pecollo N, Pagniez A, Thomas M *et al.* Diallyl disulfide increases CDKN1A promoter-associated histone acetylation in human colon tumor cell lines. Journal of Agriculture Food Chemistry 2006;54:7503-7507.
58. Kwon KB, Yoo SJ, Ryu DG *et al.* Induction of apoptosis by diallyl disulfide through activation of caspase–3 in human leukemia HL-60 cells. Biochemical Pharmacology 2002; 63: 41-47.
59. Tsai CW, Chen HW, Yang JJ *et al.* Diallyl disulfide and diallyl trisulfide up-regulate the expression of the class of glutathione *S*transferase via an AP-1-dependent pathway. Journal of Agriculture Food Chemistry 2007; 55:1019-1026.
60. Wen J, Zhang YW, Chen XQ *et al.* Enhancement of diallyl disulfide-induced apoptosis by inhibitors of MAPKs in human HepG2 hepatoma cells. Biochemical Pharmacology 2004; 68: 323-331.
61. Sundaram SG and Milner JA. Diallyl disulfide induces apoptosis of human colon tumor cells. Carcinogenesis 1996 ;17: 669–673.
62. Schaffer EM, Liu JZ, Green J *et al.* Garlic and associated allyl sulfur components inhibit N-methyl-N-nitrosourea induced rat mammary carcinogenesis. Cancer Lett 1996; 102: 199–204.
63. Wargovich MJ. Diallyl sulfide, a flavor component of garlic (*Allium sativum*), inhibits dimethylhydrazine induced colon cancer. Carcinogenesis1987; 8: 487-489.
64. Hong JY, Wang ZY, Smith TJ *et al.* Inhibitory effects of diallyl sulfide on the metabolism and tumorigenicity of the tobacco-specific carcinogen 4-(methylnitrosamino)-1-(3-

pyridyl)-1-butanone (NNK) in A/J mouse lung. Carcinogenesis 1992; 13: 901-904.
65. You WC, Blot WJ, Chang YS *et al.* Allium vegetables and reduced risk of stomach cancer. J Natl Cancer Inst 1989; 81; 162-164.
66. Belman S. Onion and garlic oils inhibit tumor promotion. Carcinogenesis1983;4;1063-1065.
67. Hayes MA, Rushmore TH, and Goldberg MT. Inhibition of hepatocarcinogenic responses to 1,2-dimethylhydrazine by diallyl sulfide, a component of garlic oil. Carcinogenesis 1987; 8: 1155-1157.
68. Challier B, Perarnau JM, Viel JF. Garlic, onion and cereal fibre as protective factors for breast cancer: a French casecontrol study. Eur J Epidemiol 1998; 14: 737-747.
69. Fleischauer AT, Poole C and Arab L. Garlic consumption and cancer prevention: metaanalyses of colorectal and stomach cancers. Am J Clin Nutr 2000; 72: 1047–1052.
70. Fleischauer AT and Arab L. Garlic and cancer: a critical review of the epidemiologic literature. J Nutr 2001; 131: 1032S-1040S.
71. Key TJ, Silcocks PB, davey GK *et al.* A case-control study of diet and prostate cancer. Br J cancer 1997;76: 678-87.
72. Milner JA. A historical perspective on garlic and cancer. J Nutr 2001; 131, 1027S-31S.
73. You WC, Zhang L, Gail MH, *et al.* Helicobacter pylori infection, garlic intake and precancerous lesions in a Chinese population at low risk of gastric cancer. Int J Epidemiol 1998; 27: 941-4.
74. Pinto JT, Qiao C, Xing J, *et al.* Effects of garlic thioallyl derivatives on growth, glutathione concentration, and polyamine formation of human prostate carcinoma cells in culture. Am J Clin Nutr 1997; 6: 398-405.
75. Perchellet JP, Perchellet EM, Abney NL *et al.* Effects of garlic and onion oils on glutathione peroxidase activity, the ratio of reduced and oxidized glutathione and ornithine decarboxylase induction in isolated mouse epidermal cells treated with tumor promoters. Cancer Biochem Biophys 1986; 8: 299-312.
76. Keiss HP, Dirsch VM, Hartung T *et al.* Garlic (Allium sativum L.) modulates cytokine expression in lipopolysaccharide-activated human blood thereby inhibiting NF-kappa B activity. J Nutr 2003; 133: 2171– 2175.
77. Geng Z, Rong Y, and Lau BH. S-allyl cysteine inhibits activation of nuclear factor kappa B in human T cells. Free Radic Biol Med 1997; 23: 345-350.
78. Houin HS, Lim HJ, Lee HJ *et al.* Garlic (*Allium sativum*) extract Inhibits lipopolysaccharide-induced Toll-like receptor 4 dimerization. Biosci Biotechnol Biochem 2008; 72 (2): 368-375.
79. Jain RC. Onion and garlic an experimental cholesterol atherosclerosis in rabbits. Artery 1975;1:115–125.
80. Jain RC. Effect of garlic on serum lipids, coagulability and fibrinolytic activity of blood. Am J Clin Nutr 1977;30:1380-1381.
81. Bordia A, Verma SK, Vyas AK *et al.* Effect of essential oil of onion and garlic on experimental atherosclerosis in rabbits. Atherosclerosis 1977; 26:379-386.
82. Chang MLW, Johnson MA. Effect of garlic on carbohydrate metabolism and lipid synthesis in rats. J Nutr 1980;110:931-936.
83. Kamanna VS, Chandrasekhara N. Hypocholesteromic activity of different fractions of garlic. Ind J Medical Res 1984;79:580-583.
84. Mand JK, Gupta PP, Soni GL *et al.* Effect of garlic on experimental atherosclerosis in rabbits. Ind Heart J 1985;37:183-188.
85. Betz E, and Weidler R. Die Wirkung von Knoblauchextrakt auf die atheerogenese bei kaninchen. In: Betz E, editor. Die anwendung aktueller methoden in der arteriosklerose. Forschung. 1989 pp 304-311.
86. Rajasree CR, Rajmohan T and Agusti KT. Biochemical effects of garlic on lipid metabolism in alcohol fed rats. Ind J Exp Biol 1999;37:243-247.
87. Mathew BC and Daniel RS. Hypolipidemic effect of garlic protein substituted for caseinin diet of rats compared to those of garlic oil. Ind J Exp Biol 1996;34:337-340.
88. Qureshi AA, Din ZZ, Abuirameileh N *et al.* Suppression of avian hepatic lipid metabolism by solvent extracts of garlic: impact on serum lipids. J Nutr1983;113:1746-1755.
89. Kamanna VS and Chandrasekhara N. Effect of garlic on serum lipoproteins cholesterol levels in albino rats rendered hypercholesteremic by feeding cholesterol. Lipids 1982;17:483-488.
90. Chi MS. Effect of garlic products on lipid metabolism in cholesterol-fed rats. Proc Soc Exp Biol Med 1982;171:174-178.

91. Chi MS, Koh ET and Stewart TJ. Effect of garlic on lipid metabolism in rats fed cholesterol or lard. J Nutr 1982;112:241-248.
92. Gebhardt R. Multiple inhibitory effects of garlic extracts on cholesterol biosynthesis in hepatocytes. Lipids 1993;28:613-619.
93. Saxena KK, Gupta B, Kulshreshtha VK *et al.* Effect of garlic treatment on isoprenaline-induced myocordial necrosis in albino rats. Indian J Physiol Pharmacol 1980;24:233-236.
94. Bhushan S, Sharma SP, Singh SP *et al.* Study of the hypocholesterolemic effect of onion (*Allium cepa*) on normal human beings. Indian Med Gaz 1979;16:249-251.
95. Bordia A. Effect of garlic and blood lipids in patients with coronary heart disease. Am J Clin Nutr 1981;34:2100-2103.
96. Kojuri J, Vosoughi AR and Akrami M. Effects of *Anethum graveolens* and garlic on lipid profile in hyperlipidemic patients. Lipids Health Dis 2007;6:5.
97. Sainani GS, Desai DB, Gorhe NH *et al.* Effect of dietary garlic and onion on serum lipid profile in jain community. Indian J Med Res 1979;69:776-780.
98. Kiesewetter H, Jung F, Jung EM et al. Effects of garlic coated tablets in peripheral arterial occlusive disease. Clin Investig 1993; 71:383-386.
99. Siegel G, Walter A, Engel S *et al.* Pleiotropic effects of garlic. Wien Med Wochenschr 1999; 149:217-224.
100. Mohammad SF and Woodward SC. Characterization of a potent inhibitor of platelet aggregation and release reaction isolated from *Allium sativum* (garlic). Thromb Res 1986;44:793-796.
101. Mohammad SF, Brown S, Chuang HYK *et al.* Isolation, characterization, identification and synthesis of an inhibitor of platelet function from *Allium sativum*. Fed Proc 1980;,39:543A.
102. Srivastava KC and Justesen U. Isolation and effect of some garlic components on platelet aggregation and metabolism of arachidonic acid in human blood platelets. Wien Klin Wochenschr 1989,8:293-299.
103. Makheja AN and Bailey JM. Antiplatelet constituents of garlic and onion. Agents and actions 1990; 29:360-363.
104. WHO monographs on selected medicinal plants, Vol 1. WHO Library Cataloguing in Publication Data .WHO 2007 pp 6-7 , 16-32.
105. Srivastava KC. Effect of aqueous extract of onion, garlic and ginger on platelet aggregation and metabolism of arachidonic acid in blood vascular system: *in vitro* study. Prostaglandins Leukot Med 1984;13:227-235.
106. Kiesewetter H, Jung F, Wolf S *et al.* Effect of garlic on thrombocyte aggregation, microcirculation, and other risk factors. International Journal of Clinical pharmacology, Therapy and Toxicology 1991; 29:151-155.
107. Bordia AK, Joshi HK, Sanadhya YK and Bhu N. Effect of essential oil of garlic on serum fibrinolytic activity in patients with coronary heart disease. Atherosclerosis 1977;28:155-159.
108. Harenberg J, Giese C, and Zimmermann R. Effect of dried garlic on blood coagulation, fibrinolysis, platelet aggregation and serum cholesterol levels in patient with hyperlipoproteinemia. Atherosclerosis 1988;74:247-249.
109. Jung F, Wolf S, Kisewetter H *et al.* Wirkung von knoblauch auf die fließfahigkeit des Blutes, Ergebnisse placebokontrolllierter Pilotstudien an gesunden Probanden. Natur und Ganzheitsmed 1989;7:216-221.
110. Jung F, Jung EM, Pundir G and Kiesewetter H. Effect of different garlic preparations on the fluidity of blood, fibrinolytic activity and peripheral microcirculation in comparison with placebo. Planta Med 1990,56:668.
111. Lawson LD. Bioactive organosulfur compound of garlic and garlic products: role in reducing blood lipids. In: Kinghorn AD, Balandrin MF, editors. Human medicinal agents from plants. Washington. American Chemical Society 1993 pp 306-330.
112. MacDonald JA, Marchand ME and Langler RF. Improving upon the *in vitro* biological activity of antithrombotic disulfide. Blood Coagul Fibrinolysis 2004;15:447-450.
113. Srivastava KC. Evidence for the mechanism by which garlic inhibits platelet aggregation. Prostaglandins Leukot Med 1986;22:313-321.
114. Srivastava KC and Tyagi OD. Effects of a garlic derived principle (ajoene) on aggregation and arachidonic acid metabolism in human blood platelets. Prostaglandins Leukot Essent Fatty Acids 1993;49:587-595.
115. Al-Qattan KK, Alnaqeeb MA, Ali M *et al.* The antihypertensive effect of garlic (*Allium*

sativum) in the rat two-kidney–one-clip Goldblatt model. Journal of Ethno pharmacology 1999; 66: 217-222.
116. Ali M, Al-Qattan KK, Al-Enezi F *et al.* Effect of allicin from garlic powder on serum lipids and blood pressure in rats fed with a high cholesterol diet. Prostaglandins Leukotrienes and Essential Fatty Acids 2000; 62(4): 253-259.
117. Fallon MB, Abrams GA, Abdel-Razek TT *et al* . Garlic prevents hypoxic pulmonary hypertension in rats. Am J Physiol Lung Cell Mol Physiol 1998; 275: L283-L287.
118. Silagy CA and Neil HA. A meta-analysis of the effect of garlic on blood pressure. J Hypertens 1994; 12:463-468.
119. Aqel MB, Gharaibah MN and Salhab AS. Direct relaxant effects of garlic juice on smooth and cardiac muscles. J Ethnopharmacol 1991;33:13-19.
120. Anonymous. Zheziang Institute of Traditional Chinese Medicine. The effect of essential oil of garlic on hyperlipidemia and platelet aggregation. J Tradit Chin Med 1986;6:117-120.
121. Bolton S, Null G and Troetel WM. The medical uses of garlic-fact and fiction. Am Pharmacol 1982;22:40-43.
122. Pectov U. Plants with hypotensive, antiatheromatous and coronarodilating action. Am J Chin Med 1979;7:197-236.
123. Srivastava KC, Bordia A and Verma SK. Garlic (*Allium sativum*) for disease prevention. South Afr J Sci 1995;91:68-77.
124. Rahman MM, Fazlic V and Saad NW. Antioxidant properties of raw garlic *(Allium sativum)* extract. International Food Research Journal 2012; 19(2): 589-591.
125. Shrivastava A, Chaturvedi U, Singh SV *et al.* A mechanism based pharmacological evaluation of efficacy of Allium sativum in regulation of dyslipidemia and oxidative stress in hyperlipidemic rats. Asian J Pharm Clin Res 2012; 5(3):123-126.
126. Jamison JR. Garlic (Allium sativum). In: Clinical Guide to Nutrition and Dietary Supplements in Disease Management. London: Churchill Livingstone 2003: 541-546.
127. Sheela CG and Augusti KT. Antidiabetic effects of S-allyl cysteine sulphoxide isolated from garlic *Allium sativum* Linn. Indian J Exp Biol 1992; 30: 523-526.
128. Sheela CG, Kumud K and Augusti KT. Anti-diabetic effects of onion and garlic sulfoxide amino acids in rats. Planta Med 1995; 61: 356-357.
129. Liu CT, Hse H, Lii CK *et al.* Effects of garlic oil and diallyl trisulfide on glycemic control in diabetic rats. Eur J Pharmacol 2005; 516: 165-173.
130. Mathew PT and Augusti KT. Studies on the effect of allicin (diallyl disulphide-oxide) on alloxan diabetes I. Hypoglycaemic action and enhancement of serum insulin effect and glycogen synthesis. Indian J Biochem Biophys 1973; 10: 209-212.
131. Amrita DG, Das SN, Dhundasi SA and Das KK. Effect of Garlic (*Allium sativum*) on Heavy Metal (Nickel II and ChromiumVI) Induced Alteration of Serum Lipid Profile in Male Albino Rats. Intl J Environ Res Public Health 2008; 5: 147-151.
132. Metwally MAA. Effect of garlic (*Allium sativum*) on some heavy metal (copper and zinc) induced alteration in serum lipid profile of *Oreochromis niloticus*. World Journal of Fish and Marine Sciences 2009;1 (1): 1-6.
133. Ghalehkandi JG , Sis NM and Nobar RS. Anti-hepatotoxic Activity of Garlic (*Allium sativum*) Aqueous Extract compared with chromium chloride in male rats. Australian Journal of Basic and Applied Sciences 2012; 6(7): 80-84.
134. Hanafy MSM, Shalaby SM, Elfonly MMA *et al.* Effect of garlic on lead contents in chicken tissue. Dtsch Tierarztl Wochenschr 1994; 101: 157-158.
135. Senapati SK, Dey S , Dwivedi and Swarup D. Effect of garlic (*Allium sativum* L.) extract on tissue lead level in rats. J Ethnopharmacol 2001; 76: 229-232.
136. Badiei K, Mostaghni K , Nowrooziasl A and Naeini AT. Ameliorated effects of Allium sativum on subclinical lead toxicity in goats . Pakistan Vet J 2006; 26(4):184-186.
137. Papageorgiou C, Corbet JP, Menezes-Brandao F *et al.* Allergic contact dermatitis to garlic (Allium sativum L.). Identification of the allergens: the role of mono-, di-, and trisulfides present in garlic. A comparative study in man and animal (guinea-pig). Arch Dermatol Res 1983; 275:229-234.
138. Lybarger JA, Gallagher JS, Pulver DW *et al.* Occupational asthma induced by inhalation

and ingestion of garlic. J Allergy Clin Immunol 1982; 69:448-454.
139. Asero R, Mistrello G, Roncarolo D *et al.* A case of garlic allergy. J Allergy Clin Immunol 1998;101:427-428.
140. Couturier P and Bousquet J. Occupational allergy secondary inhalation of garlic dust . J Allergy Clin Immunol 1982;70:145.
141. Anonymous. Monographs on the medicinal uses of plants. Exeter: European Scientific Cooperative on Phytotherapy 1997.
142. Holzgartner H, Schmidt U and Kuhn U. Comparison of the efficacy and tolerance of a garlic preparation vs. bezafibrate. Arzneimittelforschung 1992; 42:1473-1477.
143. Desai HG, Kalro RH and Choksi AP. Effect of ginger and garlic on DNA content of gastric aspirate. Indian J Med Res 1990; 92:139-141.
144. Mennella JA, Johnson A and Beauchamp GK. Garlic ingestion by pregnant women alters the odor of amniotic fluid. Chem Senses 1995; 20:207-209.
145. Mennella JA and Beauchamp GK. The effects of repeated exposure to garlic-flavored milk on the nursling's behavior. Pediatr Res 1993; 34:805-808.
146. Newall CA, Anderson LA and Phillipson JD. Herbal medicines : a guide for health-care professionals. Pharmaceutical Press, London 1996:ix, 296.
147. Blumenthal M. The complete German Commission E monographs : therapeutic guide to herbal medicines. Austin: American Botanical Council, 1998.
148. Breu W, Dorsch W. *Allium cepa* L. (Onion): Chemistry, analysis and pharmacology. In: Wagner H, Farnsworth NR, eds. Economic and medicinal plants research, Vol. 6. London, Academic Press, 1994:115–147.
149. PDR for herbal medicines , Medical Economic Co. Montvale , New Jersey, 1998, P624- 625.
150. Ross IA. Medicinal Plants of the world: Chemical Constituents, Traditional and Modern Medicinal Uses, Humana Press, Totowa, Volume 2, 2001 pp 1-9.
151. Sampath Kuma KP , Bhowmik D , Biswajit C and Tiwari P . Allium cepa: A traditional medicinal herb and its health benefits. J Chem Pharm Res 2010; 2(1): 283-291.
152. Anonymous. The wealth of India, A Dictionary of Indian Raw Materials & Industrial Products, Council of Science & Information Research, New Delhi, Volume I:A 2003 pp 167-181.
153. Bruneton J. Pharmacognosy, phytochemistry, medicinal plants. Paris, Lavoisier 1995.
154. Ahluwalia P and Mohindroo A. Effect of oral ingestion of different fractions of *Allium cepa* on the blood and erythrocyte membrane lipids and certain membrane-bound enzymes in rats. Journal of Nutritional Science and Vitaminology 1989; 35: 155-161.
155. Srivastava KC. Aqueous extracts of onion, garlic and ginger inhibit platelet aggregation and alter arachidonic acid metabolism. Biomedica biochimica acta 1984; 43:S335-S346.
156. Chauhan LS *et al.* Effect of onion, garlic and clofibrate on coagulation and fibrinolytic activity of blood in cholesterol fed rabbits. Indian medical journal 1982; 76:126-127.
157. Makheja AN, Vanderhoek JY and Bailey JM. Inhibition of platelet aggregation and thromboxane synthesis by onion and garlic. Lancet, 1979; 1:781.
158. Ariga T and Oshiba S. Effects of the essential oil components of garlic cloves on rabbit platelet aggregation. Igaku to seibutsugaku 1981;102:169-174.
159. Vanderhoek JY, Makheja AN and Bailey JM. Inhibition of fatty acid oxygenases by onion and garlic oils. Evidence for the mechanism by which these oils inhibit platelet aggregation. Biochemical pharmacology 1980; 29:3169-3173.
160. Dorsch W, Ettl M, Hein G *et al.* Anti-asthmatic effects of onions: Inhibition of platelet-activating factor-induced bronchial construction by onion oils. Int Arch Allergy Appl Immunol 1987; 82: 535–536.
161. Dorsch W, Wagner H, Bayer T *et al.* Antiasthmatic effects of onions: Alk(en)ylsulfinothic acid alk(en)ylesters inhibit histamine release, leukotriene and thromboxane biosynthesis in vitro and counteract PAF- and allergen-induced bronchial obstruction *in vivo*. Biochem Pharmacol 1988; 37: 4479–85.
162. Sharma KK, Chowdhury NK and Sharma AL. Studies on hypocholesterolaemic activity of onion. II. Effect on serum cholesterol in rabbits maintained on high cholesterol diet.

Indian journal of nutrition and diet 1975:388-391.

163. Vatsala TM and Singh M. Effects of onion in induced atherosclerosis in rabbits. 2. Reduction of lipid levels in the eye. Current science 1982;51:230-232.
164. Ahluwalia P and Mohindroo A. Effect of oral ingestion of different fractions of *Allium cepa* on the blood and erythrocyte membrane lipids and certain membrane-bound enzymes in rats. Journal of nutrition science and vitaminology 1989; 35:155-161.
165. Sebastian KL *et al.* The hypolipidemic effect of onion (*Allium cepa* Linn.) in sucrose fed rabbits. Indian journal of physiology and pharmacology 1979; 23:27-29.
166. Adamu I, Joseph PK and Augusti KT. Hypolipidemic action of onion and garlic unsaturated oils in sucrose fed rats over a two-month period. Experimentia 1982; 38:899-901.
167. Bobboi A, Augusti KT, and Joseph PK. Hypolipidemic effects of onion oil and garlic oil in ethanol-fed rats. Indian journal of biochemistry and biophysics 1984; 21:211-213.
168. Didry N, Pinkas M and Dubreuil L. Activité antibactérienne d'espèces du genre *Allium.* Pharmazie 1987; 42:687-688.
169. Elnima EI *et al.* The antimicrobial activity of garlic and onion extracts. Pharmazie 1983; 38:747-748.
170. Sangmachachai K. Effect of onion and garlic extracts on the growth of certain bacteria. Thesis, Chiangmai University 1978.
171. Abou IA *et al.* Antimicrobial activities of *Allium sativum, Allium cepa, Raphanus sativus,Capsicum frutescens, Eruca sativa, Allium kurrat* on bacteria. Qualitas plantarum et materiae vegetabiles 1972; 22:29-35.
172. Nath KVS , Rao KNV, Sandhya S *et al. In vitro* antibacterial activity of dried scale leaves of *Allium cepa* linn . Der Pharmacia Lettre 2010; 2(5): 187-192.
173. Benkeblia N. Antimicrobial activity of essential oil extracts of various onions (*Allium cepa*) and garlic (*Allium sativum*). Lebensm.-Wiss. u.-Technol2004;37:263-268.
174. Humayun AT, Hussain MB , Yasir M and Sikandar S . *In vitro* antibacterial activity of onion (Allium cepa) against clinical isolates of Vibrio cholera. J Ayub Med Coll Abbottabad 2010, 22 (2):160-163.
175. Conner DE and Beuchat LR. Effects of essential oils from plants on growth of food spoilage yeasts. Journal of Food Science 1984; 49:429-434.
176. Small LD, Bailey JH and Cavalitto CJ. Alkylthiosulphinates. Journal of the American Chemical Society 1949; 69, 1710.
177. Willis ED. Enzyme inhibition by allicin, the active principle of garlic. Biochemical Journal 1969; 63,514.
178. Guarrera PM. Traditional antihelmintic, antiparasitic and repellent uses of plants in Central Italy. J Ethnopharmacol 1999; 68:183-192.
179. Tagboto S and Townson S. Antiparasitic properties of medicinal plants and other naturally occurring products. Adv Parasitol 2001; 50: 199-295.
180. Shrestha H. A plant monograph on onion (*Allium cepa*). The School of Pharmaceutical and Biomedical Sciences , Pokhara University ,Simalchaur, Pokhara, Nepal ,2007.
181. Abu El Ezz NM. Effect of Nigella sativa and *Allium cepa* oils on *Trichinella spiralis* in experimentally infected rats. J Egypt Soc Parasitol 2005; 35: 511-523.
182. Abu El Ezz NMT , Khalil FAM and Shaapan RM. Therapeutic effect of onion (*Allium cepa*) and cinnamon (*Cinnamomum zeylanicum*) oils on cryptosporidiosis in experimentally infected mice. Global Veterinaria 2011;7 (2):179-183.
183. Gharadaghi Y, Shojaee S, Khaki A *et al.* Antiprotozoal effect of *Allium cepa* on acute renal failure caused by *Toxoplasma gondii*. African Journal of Pharmacy and Pharmacology 2012; 6(10): 771-777.
184. Dion ME, Agler M and Milner JA. S-Allyl cysteine inhibits nitrosomorpholine formation and bioactivation. Nutr Cancer 1997; 28: 1-6.
185. Dirsch VM, Gerbes AL and Vollmar AM. Ajoene, a compound of garlic, induces apoptosis in human promyeloleukemic cells, accompanied by generation of reactive oxygen species and activation of nuclear factor kappaB. Mol Pharmacol 1998; 53: 402-407.
186. Li G, Qiao CH, Lin RI *et al.* Anti-proliferative effects of garlic constituents in cultured human breast cancer cells. Oncol Rep 1995; 2: 787-791.

187. Sakamoto K, Lawson LD and Milner J. Allyl sulfides from garlic suppress the *in vitro* proliferation of human A549 lung tumor cells. Nutr Cancer1997; 29: 152-156.
188. Scharfenberg K, Wagner R and Wagner KG. The cytotoxic effect of ajoene, a natural product from garlic, investigated with different cell lines. Cancer Lett 1990; 53: 103-8.
189. Scharfenberg K, Ryll T, Wagner R and Wagner KG. Injuries to cultivated BJA-B cells by ajoene, a garlic-derived natural compound: cell viability, glutathione metabolism, and pools of acidic amino acids. J Cell Physiol 1994; 158: 55-60.
190. Sundaram SG, and Milner JA. Impact of organosulfur compounds in garlic on canine mammary tumor cells in culture. Cancer Lett 1993; 74: 85-90.
191. Takeyama H, Hoon DS, Saxton RE *et al.* Growth inhibition and modulation of cell markers of melanoma by S-allyl cysteine. Oncology 1993; 50: 63-9.
192. Welch C, Wuarin L and Sidell N. Antiproliferative effect of the garlic compound S-allyl cysteine on human neuroblastoma cells *in vitro*. Cancer Lett 1992; 63:, 211-219.
193. Majewski S, Chadzynska M. Effects of heparin, allantoin and Cepae Extract on the proliferation of keloid fibroblasts and other cells *in vitro*. Dermatologische Monatsschrift 1988;174:106–129.
194. Avuso MJ and Saenz MT. Antimitotic activity of a protein fraction isolated from viscum-cruciatum on the root meristems of *Allium cepa*. Fitoterapia 1985; 56:308-311.
195. Shon MY, Choi SD, Kahng GG *et al.* Antimutagenic, antioxidant and free radical scavenging activity of ethyl acetate extracts from white, yellow and red onions. Food Chem Toxicol 2004; 42: 659-666.
196. Sengupta A, Ghosh S, and Bhattacharjee S. Allium vegetables in cancer pevention: An overview. Asian Pacific Journal of Cancer Prevention 2004; 5: 237-245.
197. Dorch W, Adam O, Weber J and Ziegeltrum T. Antiasthmatic effects of onion extracts-detection of benzyl- and other isothiocyanates (mustard oils) as antiasthmatic compounds of plant origin. European Journal of Pharmacology 1985; 107: 17-24.
198. Dorsch W and Wagner H. New antiasthmatic drugs from traditional medicine. International archives of allergy and applied immunology 1991; 94:262–265.
199. Dorsch W, Wagner H, Bayer Th *et al.* Anti-asthmatic effects of onions : Alk(en) ylsulfinothioic acid alk(en)yl-esters inhibit histamine release, leukotriene and thromboxane biosynthesis *in vitro* and counteract paf and allergen-induced bronchial obstruction *in vivo*. Biochemical pharmacology. http://dx.doi.org/10.1016/0006-2952(88)90663-6.
200. Dorsch W, Adam O, Weber J and Ziegeltrum T. Antiasthmatic effects of onion extracts - detection of benzyl- and other isothiocyanates (mustard oils) as antiasthmatic compounds of plant origin . European Journal of Pharmacology 1984;107(1):17-24.
201. Thakare VN, Kothavade PS, Dhote VV, and Deshpande AD. Antifertility Activity of Ethanolic Extract of *Allium cepa* Linn in Rats. International Journal of PharmTech Research 2009;1 (1): 73-78.
202. Gharadaghi Y, Shojaee S, Khaki A *et al.* Antiprotozoal effect of *Allium cepa* on acute renal failure caused by *Toxoplasma gondii*. African Journal of Pharmacy and Pharmacology 2012; 6(10):771-777.
203. El-Ashwah ET *et al.* Hypolycemic activity of different varieties of Egyption onion (*Allium cepa*) in alloxan diabetic rats. J Drug Res 1985;23: 137-145.
204. Karawya MS *et al.* Diphenylamine , an antihyperglycemic agent from onion and tea. J National Products 1984; 47 :775-780.
205. Mossa JS. Study on the crude antidiabetic drug used in Arabian folk medicine. International J Crude Drug Res 1985; 23:137-145 .
206. Angusti KT. Studies on the effects of a hypoglycemic principal from *Allium cepa* Linn. Indian J Med Res 1937; 61: 1066-1071.
207. Jain RC and Vyas CR. Hypolycemic action of onion on rabbits. Br Med J 1974; 2: 730.
208. Bhushan S. Effect of oral administration of raw onion on glucose tolerancetest of diabetics: a comparison with tolbutamide. Current Medical Practice 1984;28:712–715.
209. Imad M, Taj Eldin E, Ahmed M and Abd Elwahab HM. Hypoglycemic activity and regeneration of pancreatic Beta-cells produced by *Allium cepa* in alloxan-induced diabetic

rats. Omdurman Journal of Pharmaceutical 2009;1(5):562–8.
210. Gupta RK and Gupta S. Partial purification of the hypolycemic principle of onion . IRCS. Med Sci Library Compendium 1976; 4:410.
211. Ogumodede OS, Saalu LC, Ogunlad B *et al.* An evaluation of the hypoglycemic , antioxidant and hepatoprotection of onion (*Allium cepa* L.) on alloxan induced diabetic rabbits . International Journal of Pharmacology 2012; 8 (1):21-29.
212. Taj Eldin IM , Ahmed EM, and Abd Elwahab HM. Preliminary study of the clinical hypoglycemic effects of *Allium cepa* (Red Onion) in type 1 and type 2 diabetic patients. Environmental Health Insights 2010;4:71-77.
213. Nasri S, Anoush M and Khatami N. Evaluation of analgesic and anti-inflammatory effects of fresh onion juice in experimental animals. African Journal of Pharmacy and Pharmacology 2012; 6(23):1679-1684.
214. Wang BS, Huang GJ, Lu YH and Chang LW. Anti-inflammatory effects of an aqueous extract of Welsh onion green leaves in mice. Food Chem 2012;11 :106 .
215. Dorsch W, Schneider E, Bayer T *et al.* Anti-Inflammatory effects of onions: inhibition of chemotaxis of human polymorphonuclear leukocytes by thiosulfinates and cepaenes . Int Arch Allergy Immunol 1990; 92:39–42.
216. Yassaka RT, Hidetoshi H, Tsuchiyoshi FT. Enhanced activation of the transient receptor potential channel TRPA1 by ajoene, an allicin derivative. Neurosci Res 2010; 66(1):99-105.
217. Khare, CP. Indian-Medicinal-Plants – An-Illustrated dictionary. Springer Science and Business Media, LLC.2007 p 33.
218. United States Department of Agriculture. Agricultural Research Service, Beltsville Area. Germplasm Resources Information Network **.** GRIN Taxonomy for Plants .
219. Dugravot S, Mondy N, Mandon N, and Thibout E. Increased sulfur precursors and volatiles production by the leek *Allium porrum* in response to specialist insect attack. Journal of Chemical Ecology 2005; 31(6) :1299-1314.
220. The Dispensatory of the United States of America , 20th Edition. Edited by Joseph P. Remington *et al.* 1918.
221. Auger J, Lecomte C, and Thibout E. Leek odor analysis by gas chromatography and identification of the most active substance for the leek moth, Acrolepiopsis assectella. J Chem Ecol 1989; 15:1847-1854.
222. Block E. The organosulfur chemistry of the genus Allium . Implications for the organic chemistry of sulfur. Angew Chem Int Ed Engl 1992;31:1135-1178.
223. Jaillais B, Cadoux F, and Auger J. SPME-HPLC analysis of Allium lacrimatory factor and thiosulfinates. Talanta 1999; 50:423-431.
224. Virtanen AI. Studies on organic sulfur compounds and other labile substances in plants. Phytochemistry 1965; 4:207-228.
225. Athar N, Taylor G, McLaughlin J and Skinner J. Foodfiles 2004. In, New Zealand Institute for Crop & Food Research Limited and New Zealand Ministry of Health.
226. Ninfali P, Mea G, Giorgini S *et al.* Antioxidant capacity of vegetables, spices and dressings relevant to nutrition. British Journal of Nutrition 2005; 93(2): 257-266.
227. Turkmen N, Sari F and Velioglu YS. The effect of cooking methods on total phenolics and antioxidant activity of selected green vegetables. Food Chemistry 2005; 93(4): 713-718.
228. Starke H and Herrmann K. The phenolic compounds in fruit. Viii: Changes in flavonol contents during fruit development. Zeitschrift fur Lebensmittel-Untersuchung und – Forschung 1976; 161(2):131-135.
229. USDA 2003, USDA Database for the flavonoid content of selected foods.
230. Fattorusso E, Lanzotti V, Taglialatela-Scafati O, and Cicala C. The flavonoids of leek, *Allium porrum*. Phytochemistry 2001; 57(4):565-569.
231. Fattorusso E, Lanzotti V, Taglialatela-Scafati O *et al.* Cytotoxic saponins from bulbs of *Allium porrum* L. J Agric Food Chem 2000 ;48(8):3455-3462.
232. Carotenuto A, Fattorusso E, Lanzotti V, and Magno S. Spirostanol saponins of *Allium porrum* L. Phytochemistry 1999;51(8):1077-1082.
233. Davison PA , and Bray CM. Protein synthesis during osmopriming of leek (*Allium porrum* L.) seeds. Seed Science Research 1991;1(1): 29-35.
234. Movahedian A, Sadeghi H, Ghannadi A *et al.* Hypolipidemic activity of Allium porrum L. in

cholesterol-fed rabbits. J Med Food 2006 ;9(1):98-101.
235. Ninfali P, Mea G, Giorgini S *et al.* Antioxidant capacity of vegetables, spices and dressings relevant to nutrition. British Journal of Nutrition 2005; 93(2): 257-266.
236. Tsai TH , Tsai PJ and SC Ho *et al.* Antioxidant and anti-inflammatory activities of several commonly used spices. Journal of Food Science 2005; 70(1): C93-C97.
237. El-Shenawy SMA, Yassin NAZ, Badary OA *et al.* Study of the effect of *Allium porrum* on osteoporosis induced in rats . Der Pharmacia Lettre 2013; 5 (1):188-198 .
238. Whitemore BB, Naidu AS .Thiosulfinates. In: Naidu AS (ed) Natural Food Antimicrobial Systems, CRC Press, Boca Raton, Florida, USA 2000 pp 265- 380.
239. Yamada Y, and Azuma K. Evaluation of the *in vitro* antifungal activity of allicin. Antimicrobial Agents and Chemotherapy 1977; 11: 743-749.
240. Benkeblia N and Lanzotti V. Allium Thiosulfinates: chemistry, biological properties and their potential utilization in food preservation. Food 2007;1(2): 193-201.
241. Gairola S, Gupta V, Bansal P *et al.* Herbal antitussive and expectorants: A review. International Journal of Pharmaceutical Sciences Review and Research 2010 ;5 (2):5-9.
242. Zhou Y, Zhuang W, Hu W *et al.* Consumption of large amounts of Allium vegetables reduces risk for gastric cancer in a meta-analysis. Gastroenterology 2011;141(1):80-89.
243. Cadot P, Tits G, Bussels L and Ceupens JL. Asthma and hand dermatitis to leek. Allergy 2001;56:192-193.
244. Armentia A, Lombardero M, Fernndez S *et al.* Occupational rhinitis to leek (*Allium porrum*). Allergy 2005;60:132–133 .
245. Burrows GE, and Tyrl RJ. Liliaceae Juss. Toxic plants of North America. Ames: Iowa State Press 2001:751-805.
246. Amagase H, Petesch BL, Matsuura H *et al.* Intake of garlic and its bioactive components. J Nutr 2001;131:955S-962S.
247. Cope RB. Allium species poisoning in dogs and cats. Veterinary Medicine 2005:562-566.
248. Flora data , *Allium schoenoprasum* http://www.floridata.com/ref/a/alli_sch.cfm
249. Pure matters :Chives http://resources.purematters.com/herbs-supplements/c/chives#dosage
250. Gargen , MMS. Hortus Medicus . http://www.piam.com/mms_garden/plants.html
251. Kameoka H, and Hashimoto S. Two sulfur containing constituents from Allium schoenoprasum. Phytochemistry 1983; 22(1): 294-295.
252. Kubec R, Svobodová M and Velíšek J. Distribution of *S*-Alk(en)ylcysteine sulfoxides in some *Allium* species. Identification of a new flavor precursor: *S*-Ethylcysteine Sulfoxide (Ethiin). *J Agric Food Chem* 2000; 48 (2): 428–433.
253. Justesen U. Negative atmospheric pressure chemical ionisation low-energy collision activation mass spectrometry for the characterisation of flavonoids in extracts of fresh herbs. Journal of Chromatography 2000; A.902: 369-397.
254. Starke H. and Herrmann K. Flavonois and favones of vegetables, VII, Flavonois of leek, chive and garlic (author's trans.) (Flavonole und Flavone der Gem rten. VII. Flavonole des 11-Porrees, Schnittlauchs und Knoblauchs). Zeitschrift für Lebensmittel-untersuchung und -forschung 1976; 161(1):25–30.
255. Nitz GM, Grubmuller E. and Schnitzle WH. Differential Flavonoid Response to Par and UV-B Light in Chive. ISHS Acta Horticulture 2001; 659: VIII. S.
256. Fossen T, Slimestad R, Ovstedal DO and Andersen OM. Covalent anthocyanin-flavonol complexes from flowers of chive, *Allium schoenoprasum* L. Phytochemistry 2000;54 (3): 317-323.
257. Cantwell D and Reid M. Postharvest physiology and handling of fresh culinary herbs. J Herbs Spices Med Plant1993; 1: 83–127.
258. Štajner D, Canadanović-Brunet J, and Pavlović A. *Allium schoenoprasum* L., as a natural antioxidant. Phytother Res 2004;18(7):522-524.
259. Štajner D, Popović BM, Ćalić-Dragosavac D *et al.* Comparative Study on *Allium schoenoprasum* cultivated plant and *Allium schoenoprasum* tissue culture organs antioxidant status. Phytother Res 2011;25: 1618-1622.

260. Kucekova Z, Mlcek J, Humpolicek P *et al.* Phenolic compounds from *Allium schoenoprasum*, Tragopogon pratensis and Rumex acetosa and their antiproliferative effects. Molecules 2011;16(11):9207-9217.
261. Kuriyama I, Musumi K, Yonezawa Y *et al.* Inhibitory effects of glycolipids fraction from spinach on mammalian DNA polymerase activity and human cancer cell proliferation. J Nutr Biochem 2005;16(10):594-601.
262. Rattanachaikunsopon P, and Phumkhachorn P. Diallyl sulfide content and antimicrobial activity against food-borne pathogenic bacteria of chives (*Allium schoenoprasum*). Biosci Biotechnol Biochem 2008;72(11):2987-2991.