Coriandrum sativum: A Daily Use Spice with Great Medicinal Effect

Poonam Mahendra,* Shradha Bisht

Department of Pharmacology, School of Pharmacy, Suresh Gyan Vihar University, Jaipur 302004, India

ABSTRACT

Coriandrum sativum Linn. has been credited with many medicinal properties. The green leaves of coriander are known as "asotu" in the Eastern Anatolian region or "cilantro" in the United States and are consumed as fresh herb. The essential oil obtained from its fruits at amounts ranging from approximately 0.5 to 2.5% is used both in flavours and in the manufacture of perfumes and soaps. The plant is grown widely all over the world for seed, as a spice, or for essential oil production. It is one of the earliest spices used by mankind. It has been used as a flavouring agent in food products, perfumes and cosmetics. It is used for various purposes such as for flavouring sweets, beverages, tobacco products and baked goods and as a basic ingredient for curry powder. It has been used as an analgesic, carminative, digestive, anti-rheumatic and antispasmodic agent.

Key words: *Coriandrum sativum Linn*, essential oil, flavouring agent.

INTRODUCTION

Coriander (*Coriandrum sativum L*) is an annual and herbaceous plant, belonging to the Apiaceae family (carrot family). Its name is derived from the Greek Koris, meaning bedbug, because of the unpleasant, fetid, bug-like odour of the green herb and unripened fruits. Green coriander (also called cilantro or Chinese, Mexican or Japanese parsley) has been called the most commonly used flavouring in the world due to its usage across the Middle East into all of southern Asia as well as in most parts of Latin America. It is native of southern Europe and the western Mediterranean region. This widely used herb is cultivated worldwide.[1] Today it is grown extensively in India, the Soviet States, central Europe, Asia, Morocco, and South and Western Australia. Its fruits (commonly called 'seeds') are used for flavouring candies, in cookery, perfumery and beverages and in the tobacco industry. *C. sativum* is approximately 30-100 cm in height, with glabrous, greatly divided, strong-smelling leaves. The odour and flavour of mature seed and fresh herbage are completely different. The mature fruits have a fresh and pleasant flavour and are largely used all over the world in ground or volatile isolate form. The composition of the essential oil of coriander fruits in some of the world has been studied and found differs from each other. The coriander plant yields two primary products which are employed for flavouring purposes: the fresh green herb and the spice (mature dried seed capsule or fruit). The odour and flavour of these two products are markedly different. In additional to its traditional use as a spice and medicinal plant, the plant has an economic importance as it is used as a flavouring agent in food products, perfumes, cosmetics and soaps.[2,3,4,5] It is widely used in India in food and as a medicine in Indian systems of medicine. It has been held in great esteem amongst indigenous medicines, particularly many medicine systems from the earliest times.

Classification

Kingdom	– Plantae
Subkingdom	– Tracheobionta
Superdivision	– Spermatophyta
Division	– Magnoliophyta –
Class	– Magnoliopsida
Subclass	– Rosidae
Order	– Apiales
Family	– Apiaceae
Genus	– Coriandrum L.
Species	– Coriandrum sativum L.

Address for correspondence:
Cell: +91 9252256367
E-mail: poonammahendra84@gmail.com

DOI: 10.5530/pj.2011.21.16

CHEMICAL CONSTITUENTS

Eighty one compounds were identified from the coriander leaf essential oil with two- dimensional gas chromatography.[6] Dried, ripe coriander fruit contain steam volatile oil, fixed (fatty) oil, proteins, cellulose, pentosans, tannins, calcium oxalate and minerals. At one time, coriander was among the world's leading essential oil plants.[7] The major constituents are fibre (23-36%), carbohydrates (about 20%), fatty oil (16-28%) and proteins (11-17%). The residues remaining after distillation of the essential oil contain high fat and protein, which is useful as animal feed. The most important constituents of coriander seeds are the essential oil and the fatty oil.[8] The chemical composition and the percentage of the components in the essential oil of the coriander fruits depend on the different stages of maturity.[4] It is reported that coriander seed oil contains linalool (60-70%) and 20% hydrocarbons and the composition of the herb oil completely differs from the seed oil. The essential oil content of the weight of ripe and a dried fruit of coriander varies between 0.03 and 2.6%, and the content of fatty oil varies between 9.9 and 27.7%. Dried coriander seeds contain as essential oil (0.03-2.6%) with linalool as the main component.[8,10,11] Other components of the essential oil are: α-thujene, sabinene, β-pinene, myrcene, p-vymene, limonene, z-β-ocimene, y-terpenin, terpinolene, camphor, citronellal, trpinene-4-ol, decanal. Cumin aldehyde, terpenene-7-al (α), terpenene-7-al (y) and geranyl acetate.[8,10,12] About 13-18% dry weight of the seed is fatty oil, of which up to 75% can be petroselenic acid which has an industrial usage as to form lauric acid in soaps and detergents and also C6 dicarboxylic acid is use as a feedstock in the manufacture of nylon.[13, 14] Other constituent of dried seeds are crude protein (11.5-21.3%), fat (17.8-19.15%), crude fiber (28.4-29.1%) and ash (4.9-6.0%)[8] Selenium contents were reported to be higher in coriander than in other herbs and herbal teas[15] The presence of minerals, such as Mg, Al. Si, P, Cl,, K Ca, Ti, Mn, Fe, Cu, and Zn were also reported[16] Anti-nutritive compounds such as glucosinolates (27.5 μmol/g), sinapine (4 mg/g), condensed tannins (1.1 mg/g) and inositol phosphates (17.4 mg/g) also present in *C. sativum* seeds.[17]

TRADITIONAL USE

At one time, coriander was among the world's leading essential oil plants[7] The traditional uses of the plant, which are based on the primary products, i.e. the fruits and the green herb, are two-fold: medicinal and culinary. *C. sativum* is a popular spice and is finely grounded to be a major ingredient of curry powder.[2] The fruits are used in the preparation of fish, meat and also for baking.[10] The seed has also been used to treat indigestion, worm infections, rheumatism, loss of appetite, convulsion, insomnia, anxiety and pain in the joints[2,4,10] Coriander is used traditionally in Morocco as a diuretic plant.[18] In Iranian folk medicine, it has been recommended for relief of anxiety and insomnia.[19] It is widely used as folk medicine as carminative, spasmolytic, digestive and galactagogue; seed extract antimicrobial; used in lotions and shampoos; with castor oil useful in rheumatism.[20-24]

PHARMACOLOGICAL USE

Antidiabetic activity

C. sativum showed significant hypoglycaemic action in rats fed with high cholesterol diet. The activity of glycogen phosphorylase and gluconeogenic enzymes revealed a decrease in the rate of glycogenolysis and glucogenesis. There was also an increased activity of glucose-6-phosphate dehydrogenase and glycolytic enzymes used glucose by the pentose phosphate pathway and glycolysis respectively.[25] In an in-vitro study to assess the possible effects of aqueous coriander plant extract (50 g plant extract/L) on glucose diffusion across the gastrointestinal tract, it was found that the extract significantly decreased glucose diffusion compared to control with mean external glucose concentration of 6.4 ± 0.2 mmol/L at 26 h. Part of the antihyperglycemic action of *C. sativum* may be due to decreased glucose absorption in vivo.[26] Pre-treatment with *C. sativum* protected Wistar albino rats against gastric mucosal damage induced by ethanol. The protective effect might be related to the free-radical scavenging property of the different antioxidant constituent present in *C. sativum*.[27] Other studies also shows that C. sativum has antidiabetic activity.[28-29]

Antioxidant activity

The ethanol extract of *C. sativum* leaves is an excellent which is stable at high temperature and can serve as a substitute for synthetic antioxidants.[30] The aqueous extract of coriander seed inhibited peroxidised lipid-induced lysis (induced by $FeSO_4$-ascorbate, 10:100 μmol/system) by 72% in human erythrocyte membranes.[31] Extract of coriander seeds obtained with supercritical carbon dioxide in semi continuous lab-scale equipment with low density (0.60 g/mL) CO_2 and high density (0.73-0.83 g/mL) CO_2 (pressure from 116 to 280 bar and temperature from 311 to 331 K for the latter) exhibited significant activity in removing free radicals present in a methanol solution of DPPH in a manner which was comparable to those of commercial antioxidants.[32]

The antioxidant capacity of phenolic compounds in coriander leaves was higher than that of the seeds in three different bioassays, namely scavenging of free radical by DPPH, inhibition of 15-lipoxygenase (15-LO) and

inhibition of Fe^{2+} induced phospholipids peroxidation in brain. The seed lipid content which was extracted with dichloromethane gave low activities in radical scavenging and inhibition of lipid peroxidation. The ethyl acetate extract of the leaves exhibited the most potent activity.[2] Assessment of the total antioxidant activity of methanol and water extracts of coriander leaves and stems using an iron-induced linoleic acid oxidation model system showed that the methanol-derived leaf extracts exhibited significantly greater radical-scavenging activity towards both lipid and water soluble radicals, which was attributed to the total phenolic content.[33] Further studies by Melo et al. indicated that the four coriander extract fraction obtained from the crude extract using chromatography in silica gel possessed similar antioxidant activities that can be measured by the β-carotene/linolic acid system. The antioxidant activity was due to several phenolic acids and caffeic acid which were contained in all four fractions.[34] Extracts of different polarity from leaves and seeds of *C.sativum* and its oil have potential as a natural antioxidant and thus inhibit unwanted oxidation processes.[35] The antioxidative effect of coriander seeds against HCH-induced formation of free radicals in rat liver.[36]

Antimutagenicity activity

Coriander played a protective role against the deleterious effects in lipid metabolism in experimental colon cancer induced by 1, 2-dimethyl hydrazine in rats.[37] The antimutagenicity of coriander juice against the mutagenic activity of 4-nitro-o-phenylenediamine, m-phenylenediamine and 2-aminofluorene was investigated using the Ames reversion mutagenesis assay with the *S. Typhimurium* TA98 strain as the indicator organism. It was found that aqueous crude coriander juice significantly decreased the mutagenicity of metabolised amines. An aqueous juice of C. sativum showed antimutagenic effect on the three tested amines, decreasing its mutagenic effect in a dose-dependent manner. In the case of 4-nitroo-phenylenediamine (NOP), an 83.21% in mutagenesis reduction was observed at the highest extract concentration, an 87.71% for m-PDA and a 92.43% for 2-AF.[38] The capacity of coriander essential oil to induce nuclear DNA damage-responsive genes was tested using suitable Lac-Z fusion strains for RNR3 and RAD51, which are genes involved in DNA metabolism and repair, respectively. At equitoxic dose, the essential oil demonstrated significant gene induction, approximately the same as that caused by hydrogen peroxide, but much lower than that caused by methyl methanesulfonate (MMS). It affected the mitochondrial structure and function and can stimulate the transcriptional expression of DNA damage-responsive genes. It appeared that the induction of microbial damage was closely linked to overall cellular cytotoxicity by the essential oil which also appeared to mask the occurrence of nuclear genetic events.[39]

Immunomodulatory activity

The aqueous crude extracts of *C. sativum* stimulated the proliferation of human peripheral blood mononuclear cells (PBMC) and the secretion of IFN-y at concentration between 50 and 200 μg/ml. Further studies on several bioactive compounds known to be of the extract, shown that flavonoids quercetin stimulated the proliferation of human PBMC and the secretion of IFN-y. However, the flavonoid rutin, coumarins bergapten and xanthotoxin modulate the secretion of IFN-y but did not enhance the proliferation of human PBMC while the coumarin isopimpinellin, promoted the proliferation of PBMC but did not modulate the secretion of IFN-y.[40, 34]

Anthelmintic activity

Crude aqueous and hydro-alcoholic extract of the seeds of *C. sativum* completely inhibited hatching of nematode eggs at concentration lower than 0.5 mg/mL with no statistically significant difference between both extracts. However, the hydroalcoholic extract showed better *in vitro* activity against adult parasites than the aqueous one. Efficacy of anthelmintic activity in vivo was tested by faecal egg count reduction (FECR) and total worm count reduction (TWCR) in sheep's artificially infected with *Haemonchus contortus*. Significantly FECR was detected on day 2 after treatment with 0.9 g/kg of crude aqueous extract of *C. sativum*. On days 7 and 14, FECR was also detected at 0.45 g/kg dose of crude aqueous extract. A significant TWCR was only detected with 0.9 g/kg dose of crude aqueous extract.[41]

Antimicrobial activity

Coriander oil strongly inhibited gram-positive bacteria (*Listeria monocytogenes and Staphylococcus aureus*) and *S. cerevisiae,* but had little effect gram-negative bacteria (*Pseudomonas fragi, Echerichia coli, Salmonella typhimurium*).[42] Methanol and water extracts of coriander leaves and stems were tested for antimicrobial activity towards *Bacillus subtills* and *Escherichia coli* by determining cell damage. The greater bacterial cell damage caused by the methanol stem extract resulted in a greater growth inhibition of the bacteria, which corresponded to the ferrous sequestering activity of the methanol-derived stem extracts.[33] The essential oil of *C. sativum* showed antimicrobial activity, varying from 125 lg/ml (C. parapsilosis CBS 604) to 500 lg/ml (*C. albicans* CBS 562), against most of the Candida species tested, except for *C. tropicalis* CBS 94.[43] This antimicrobial activity against bacteria and fungi has also been demonstrated in essential oils extracted from *C. sativum* seed.[44]

Anxiolytic effect

The aqueous extract of *C. sativum* seed has anxiolytic effect and may have potential sedative and muscle relaxation effect. The aqueous extract (100 mg/kg, i.p.) showed an anxiolytic effect in male albino mice using the elevated plus-maze

model by increasing the time spent on open arms and the percentage of open arm coordination. Furthermore, the aqueous extract (50, 100 and 500 mg/kg) significantly reduced spontaneous activity and neuromuscular coordination compared to the control group.[19]

Antidiuretic effect

The aqueous extract of coriander increased dieresis and the urinary excretion of sodium, potassium, chloride and the glomerular filtration rate at doses of 40 and 100 mg/kg administered by intravenous infusion (120 min) in anesthetised Wistar rats. The mechanism of diuretic action of coriander appeared to be similar to that of furosemide.[18] Rodents treated with *C.sativum* crude extract (Cs.Cr), a mild increase in the urine out put was observed at the dose of 30 mg/kg (5.1 ± 0.60 ml), while a significant diuretic effect ($p < 0.01$) was caused by the dose of 100 mg/kg (6.47 ± 0.44 ml). An increase in the urine volume was evident within 1 h of administration of furosemide, while the onset of diuretic effect was 3-4 hr with Cs.Cr.[45]

Anti-fungal activity

Coriander oil did not have an effect on mycelia growth (*A. Parasiticus*) and did not affect the aflatoxin content of the fungus.[46] This antimicrobial activity against bacteria and fungi has also been demonstrated in essential oils extracted from C. sativum seed.[44]

Other studies and effects

A polyherbal Ayurvedic formulation containing ripe fruits of coriander as one of its major ingredient was tested on two different experimental animal models of inflammatory bowel disease (acetic acid induced colitis in mice and indomethacin induced enterocolitis in rats). Obtained results shown that the formulation was efficacious against inflammatory bowel disease.[47] Coriander also suggested having preventive effect on localised lead decomposition in ICR mice. The administration of *C. sativum* significantly decreased lead decomposition in the femur and reduced the severe lead-induced injury in the kidney of ICR mice which were given lead (1000 ppm) as lead acetate trihydrate in drinking water for 32 days.[48] The effect of the aqueous extract of fresh coriander seeds on female fertility in rats was studied. The extract (250 and 500 mg/kg orally) produced a dose-dependent significant anti-implantation effect, but failed to produce complete infertility.[49]

REFERENCES

1. Weiss, E.A. *Spice Crops*. CAB International, Wallingford, UK. 2002; 411.
2. Wangensteen H, Samuelsen AB, Malterud KE. Antioxidant activity in extracts from coriander. Food Chemistry. 2006; 88:293-297.
3. Baba K, Xiao YQ, Taniguchi M, Ohishi H, Kozawa M. Isocoumarins from *Coriandrum sativum*. Phytochemistry. 1991; 30(12):4143-4146.
4. Msaada K, Hosni K, Taarit MB, Chahed T, Kchouk ME, Marzouk B. Changes on essential oil composition of coriander (*Coriandrum sativum* L.) fruits during three stages of maturity. Food Chemistry. 2007; 102:1131-1134.
5. Aluko RE, McIntosh T, Reaney M. Comparative study of the emulsifying and foaming properties of defatted coriander (*Coriandrum sativum*) seed flour and protein concentrate. Food Research International. 2001; 34:733-738.
6. Eyres G, Marriott PJ, Dufour JP. The combination of gas chromatography-olfactometry and multidimensional gas chromatography for the characterisation of essential oils. Journal of Chromatography A. 2007; 1150:70-77.
7. Lawrence BM. A planning scheme to evaluate new aromatic plants for the flavor and fragrance industries. In: New crops. Janick J, Simon JE (eds). New York, Wiley, p. 620-27; 1993.
8. Coskuner Y, Karababa E. Physical properties of coriander seeds (*Coriandrum sativum* L.). Journal of Food Engineering. 2006; 80:408-416.
9. Guenther E. The essential oil. Vol. IV. Florida, USA, REK Publishing Company, p. 602-15; 1950.
10. Eikani MH, Golmohammad F, Rowshanzamir S. Subcritical water extraction of essential oils from coriander seeds (*Coriandrum sativum* L.). Journal of Food Engineering. 2007; 80:735-740.
11. Rastogi RP, Mehrotra BN. Compendium of Indian medicinal Plants. Vol. II. Lucknow, CDRI, p. 212; 1993.
12. Telci I, Gul TO, Sahbaz N. Yield, essential oil content and composition of Coriandrum sativum varieties (var. Vulgare Alef and var. microcarpum DC.) grown in two different locations. J Essentl Oil Res. 2006; 18:189-93.
13. Millam S, Mitchell S, Craig A, Paoli M, Moscheni E, Angelini L. *In vitro* manipulation as a means for accelerated improvement of some new potential oil crop species. Industrial Crops and Products. 1997; 6:213-219.
14. Kim SW, Park MK, Bae KS, Rhee MS, Liu JR. Production of petroselenic acid from cell suspension cultures of *Coriandrum sativum*. Phytochemistry. 1996; 42(6):1581-1582.
15. Ozcan MM, Unver A, Uçar T, Arslan D. Mineral content of some herbs and herbal teas by infusion and decoction. Food Chemistry. 2008; 106:1120-1127.
16. Al-Bataina BA, Maslat AO, Al-Kofahi MM. Element analysis and biological studies on ten oriental spices using XRF and Ames test. J. Trace Elem. Med Biol. 2003; 17(2):85-90.
17. Matthaus B, Angelini LG. Anti-nutritive constituents in oilseed crop from Italy. Industrial Crops and Products. 2005; 21:89-99.
18. Aissaoui A, El-Hilaly J, Israili ZH, Lyoussi B. Acute diuretic effect of continuous intravenous infusion of an aqueous extract of *Coriandrum sativum* L. in anesthetized rats. J of Ethnopharmacol. 2008; 115:89-95.
19. Emamghoreishi M, Khasaki Aazam MF. *Coriandrum sativum*: evaluation of its anxiolytic effect in the elevated plus-maze. J of Ethnopharmacol. 2005; 96:365-370.
20. Anonymous. The wealth of India: Raw materials. Vol. II, CSIR, New Delhi, India, p. 347-50; 1950.
21. Asolkar LV, Kakkar KK, Chakre OJ. Glossary of Indian medicinal plants with active principles. Part I. New Delhi, India, P & I Directorate, CSIR. p. 232-33; 1992.
22. Chopra RN, Nayar SL, Chopra IC. Glossary of Indian medicinal plants. New Delhi, India, CSIR,. p. 77-78; 1956.
23. Yusuf M, Chowdhuty JU, Wahab MA, Begum J. Medicinal plants of Bangladesh. Bangladesh, Bangladesh Council of Scientific and Industrial Research, p. 66; 1994.
24. Ghani A. Medicinal plants of Bangladesh: Chemical constituents and uses. 2nd ed. Dhaka, Asiatic Society of Bangladesh, p. 183; 2003.
25. Chitra V, Leelamma S. *Coriandrum sativum* – mechanism of hypoglycemic action. Food Chemistry. 1999; 67:229-231.
26. Gallagher AM, Flatt PR, Duffy G, Abdel-Wahab YHA. The effects of traditional antidiabetic plants on *in vitro* glucose diffusion. Nutrition Research. 2009; 23:413-424.

27. Al-Mofleh IA, Alhaider AA, Mossa JS, Al-Sohaibani MO, Rafatullah S, Qureshi S. Protection of gastric mucosal damage by *Coriandrum sativum* L. Pretreatment in Wistar albino rats. Environmental Toxicology and Pharmacology. 2006; 22:64-69.
28. Gray AM, Flatt PR. Insulin-releasing and insulin-like activity of the traditional anti-diabetic plant Coriandrum sativum (coriander). Br J Nutr. 1999; 81:203-9.
29. Swanston-Flatt SK, Day C, Bailey CJ, Flatt PR. Traditional plant treatments for diabetes: studies in normal and streptozotocin diabetic mice. Diabetologia. 1990; 33:462-4
30. Shyamala BN, Gupta S, Lakshmi AJ, Prakash J. Leafy vegetable extracts – antioxidant activity and effect on storage stability of heated oils. Innovative Food Science and Emerging Technologies. 2005; 6:239-245.
31. Sujatha R, Srinivas L. Modulation of lipid peroxidation by dietary components. Toxic *in vitro*. 1995; 9(3):231-236.
32. Yepez B, Espinosa M, Lopez S, Bolanos G. Producing antioxidant fractions from herbacious matrices by supercritical fluid extraction. Fluid Phase Equilibria. 2002; 184-197:879-884.
33. Wong PYY, Kitts DD. Studies on the dual antioxidant and antibacterial properties of parsley (*Petroselenium crispum*) and cilantro (*Coriandrum sativum*) extracts. Food Chemistry. 2006; 97:505-515.
34. Melo EA, Filho JM, Guerra NB. Characterization of antioxidant compounds in aqueous coriander extract (*Coriandrum sativum* L.). Lebensm.-Wiss. u.-Technol. 2005; 38:15-19.
35. Wangensteen H, Samuelsen AB, Malterud KE. Antioxidant activity in extracts from coriander. Food Chemistry. 2004; 88:293-297.
36. Anilakumar KR, Nagaraj NS, Santhanam K. Effect of coriander seeds on hexachlorocyclohexane induced lipid peroxidation in rat liver. Nutrition Research. 2001; 21:1455-1462.
37. Chitra V, Leelamma. *Coriandrum sativum* – effect on lipid metabolism in 1,2-dimethyl hydrazine induced colon cancer. J of Ethnopharmacol. 2000; 71:457-463.
38. Cortes-Eslava J, Gomez-Arroyo S, Villalobos-Pietrini R, Espinosa-Aguirre JJ. Antimutagenicity of coriander (Coriandrum sativum) juice on the mutagenesis produced by plant metabolites of aromatic amines. Toxicology Letters. 2004; 153:283-292.
39. Bakkali F, Averbeck S, Averbeck D, Zhiri A, Idaomar M. Cytotoxicity and gene induction by some essential oils in the yeast *Saccharomyces cerevisiae*. Mutation Research. 2005; 585:1-13.
40. Cherng JM, Chiang W, Chiang LC. Immunomodulatory activities of common vegetables and spices of Umbel liferae and its related coumarins and flavonoids. Food Chemistry. 2008; 106:944-950.
41. Eguale T, Tilahun G, Debella A, Feleke A, Makonnen E. *In vitro* and *in vivo* anthelmintic activity of crude extracts of *Coriandrum sativum* against *Haemonchus contortus*. J of Ethnopharmacol. 2007; 110:428-433.
42. Delaquis PJ, Stanich K, Girard B, Mazza G. Antimicrobial activity of individual and mixed fractions of dill, cilantro, coriander and eucalyptus essential oils. International Journal of Food Microbiology. 2002; 74: 101-109.
43. Begnami AF, Duarte MCT, Furletti V, Rehder VLG. Antimicrobial potential of Coriandrum sativum L. against different Candida species *in vitro*. Food Chemistry. 2010; 118:74-77.
44. Cantore L, Iacobellis P, Marco DP, Capasso A, & Senatore F. (2004). Antibacterial activity of Coriandrum sativum L. and Foeniculum vulgare miller var. vulgare (miller) essential oils. Journal of Agricultural and Food Chemistry. 2004; 52:7862-786.
45. Jabeen Q, Bashir S, Lyoussi B, Gilani AH. Coriander fruit exhibits gut modulatory, blood pressure lowering and diuretic activities. Journal of Ethnopharmacology. 2009; 122:123-130.
46. Atanda OO, Akpan I, Oluwafemi F. The potential of some spice essential oils in the control of *A. Parasiticus* CFR 223 and aflatoxin production. Food Control. 2007; 18:601-607.
47. Jagtap AG, Shirke SS, Phadke AS. Effect of polyherbal formulation on experimental models of inflammatory bowel diseases. J Ethnopharmacol. 2004; 90:195-204.
48. Aga M, Iwaki K, Ueda Y, Ushio S, Masaki N, Fukuda S et al,. Preventive effect of *Coriandrum sativum* (Chinese parsley) on localized lead deposition in ICR mice. J of Ethnopharmacol. 2001; 77:203-208.
49. Al-Said MS, Al-Khamis KI, Islam MW, Parmar NS, Tariq M, Ageel AM. Post-coital antifertility activity of the seeds of *Coriandrum sativum* in rats. J of Ethnopharmacol. 1987; 21:165-173.