Chapter 2

Review of Literature
The widespread use of insecticides in agriculture and public health programmes has led to environmental contamination. The organochlorides (OC), are widely used in agricultural and malarial control programmes from the 1940s to 1960s with dramatic beneficial effects, they have come into harmful because of the very persistence in the environment.

Chemicals, to increase agricultural yield, were introduced in Indian market soon after the Second World War. Insecticides, HCH (BHC, hexachlorocyclohexane) constitute bulk of the pesticides used. These molecules are stable in the environment. More than 2,70,000 tons of DDT has been added to the Indian environment, of which 2,20,000 tons from public health programmes and 50,000 tons from agricultural use. However, the use of DDT in agricultural sector is now banned and the current annual consumption is reduced nearly to 12,000 tons which is used in public health sector.36

Pesticides are an essential input in increasing agricultural production by preventing crop losses before and after harvesting. The production of basic pesticides during 1990-91 in India, accounts for 74,300 tons/annum.37 It is generally believed that less than 1% of the chemicals used in pest control operations really reach the target. The rest ultimately goes to the soil, water and to the whole environment.

When pesticides are applied to land, some amount is absorbed to soil, some amount be entered into water bodies through running water. The atmosphere, in particular, plays an important role in the fate of pesticides in the environment, both directly by drift, and indirectly as vapour from the surface of waters, soil and plants. A large portion of BHC used eventually reaches the
But the amount of BHC in the air is very small. In addition, BHC in the atmosphere is thought to undergo rapid degradation by sunlight. Since the earth is a closed system, degradation products of BHC, and its compounds derived from BHC, will eventually reach the land surface.

Pesticides reach the human body through food web and in case of organochlorides compound constitute the most serious threat to our fish and wildlife. Their persistence in the environment and in biological systems permits their accumulation and magnification. Through this process of biological magnification, it has been possible for many species of birds and some fish to accumulate sufficiently large levels of pesticides so as to threaten the very survival.

Benzene hexachloride (BHC) is an organochlorine insecticide, which is widely used to control various types of pests in agricultural fields because of its cheapness and easy availability. Technical grade BHC (1, 2, 3, 4, 5, 6 hexachlorocyclohexane) is a mixture of variable amounts of various isomers. Among the BHC isomers, the γ-isomer is most rapidly degraded, followed by the α, β and δ forms. Biota in the environment also accumulates BHC. β-BHC is the most persistent and most concentrated in animal tissues.

Organophosphate pesticides are also extensively used to control agricultural pests and diverse vectors. These pesticides are preferred to chlorinated hydrocarbon for field application because of their quick actions, relatively short half lives and non-accumulation in food-web. However, higher concentration of organophosphate pesticides is extremely toxic to animals. Organophosphates are potent neurotoxic agents which inhibit acetylcholinesterase (AchE) activity, causing an accumulation of acetylcholine at nerve synapses, that lead to subsequent disruption of neural transmission in both central and peripheral nervous system.
DDT is a compound of moderately acute toxicity compared with other chlorinated hydrocarbon insecticides. It is remarkable in being little absorbed by the skin. DDT has been used as an effective pesticide for controlling mosquitoes and other pests. DDT is stored in all tissues. Storage of the compound in blood, liver, kidney, heart and the central nervous system was reported by Smith and Stohlman.\(^\text{39}\)

The water, sediment and fish from rural ponds of Uttar Pradesh, India showed moderate to high level of HCH and DDT contamination.\(^\text{13}\) In Delhi, 94 human biopsy fat samples were assayed for DDT and DDE and found that DDT and DDE are ranging from 0.17 to 176.5 mg/kg body fat.\(^\text{40}\)

The survey carried out in different parts of India has indicated that the persistent and fat soluble chlorinated pesticides such as DDT and HCH are the common contaminants of dairy milk in India.\(^\text{41,42}\) The presence of organochlorine pesticides (α-HCH, β-HCH, lindane, aldrin, dieldrin, heptachlor, heptachlor epoxide, chlordane and the isomers and metabolites of DDT) in Spanish pasteurized milk were investigated and found that 95% of the samples contained one of the isomers of the HCH group and 12.9% of them exceeded the maximum residue limit permitted by the European Union.\(^\text{43}\) Khandekar et al. reported pesticide residues in eggs and milk in Bombay markets.\(^\text{44}\) Forty-one baby milk powder and sixteen infant food samples manufactured in Gujarat, New Delhi and Maharashtra were monitored for HCH and DDT residues during 1988-89, 1990-91 and 1991-92. The levels of γ-HCH and Σ-DDT in baby milk powder ranged from 0.024 to 0.39 μg/g and in Gujarat indicated maximum levels of HCH and Σ-DDT, wherein γ-HCH and Σ-DDT residues were above maximum residual limit in 5 and 10 baby milk powder samples respectively.\(^\text{45}\) Organochlorine contaminants in Swedish human milk\(^\text{46}\) and presence of DDT and DDT residues in human milk in the Kariba Valley of Zimbabwe were also reported.\(^\text{47}\)
HCH levels in curd from certain places in Uttar Pradesh, DDT and HCH residues in bovine milk of Himachal Pradesh, contamination of animal feed with residues of HCH and DDT were reported.

In the United States, despite the ban, DDT and its metabolites continue to be found in human milk at decreasing concentrations over time, demonstrating the remarkable biological persistence. In developing countries, DDT and its metabolites are often the most widespread contaminants in human milk, found as p,p'-DDT and p,p'-DDE. DDT and DDE residues in human blood samples were analysed in general population of Singapore and the geometric mean of serum level of DDT was 1.9 ppb (0.2-8.9 ppb) and that of DDE was 10.8 ppb (1.5-88.1 ppb). A few surveys carried out in developing countries have shown the presence of DDT and HCH residues in human milk at levels much higher than in Western countries.

The seasonal vegetables consisting of green leafy vegetables, tomato, potato, cauliflower, okra, cabbage etc. have been analysed mainly for residue content of organochlorine insecticides such as DDT, HCH, aldrin, dieldrin, heptachlor and lindane. The data have been generated in Delhi, Haryana, Punjab, Karnataka, Andhra Pradesh and Maharashtra and most of the samples have been found to be contaminated with DDT, HCH or both. Maximum level of DDT found was 10.2 ppm and of HCH was 5.42 ppm.

In general, the signs of poisoning produced by different chlorinated hydrocarbon insecticides are similar, that is, expressions of neuronal hyperactivity. Chlorinated hydrocarbons, after a single or repeated doses, most of the chemicals eventually reach their highest concentrations in adipose tissues with somewhat lower levels in other tissues with high contents of neutral lipids, such as adrenals. Chlorinated hydrocarbon insecticides act by altering the electrophysiological and associated enzymatic properties of nerve cell
membranes, causing a change in the kinetics of Na⁺ and K⁺ ion flow through the membrane. Disturbances of calcium transport or Ca²⁺-ATPase activity may also be involved, as well as phosphokinase activities. DDT and a number of other chlorinated hydrocarbon insecticides cause marked changes in the liver of various rodents and that these changes progress to tumour formation in some species, especially in mice.

Evidence for the carcinogenicity of chlorinated hydrocarbon insecticides has been reviewed by the International Agency for Research on Cancer (IARC) on a number of occasions during the last two decades. The IARC evaluation of these chemicals when administered by the oral route, most of the insecticides produce tumours in mice, but results in rats are less conclusive. None of the chemicals have been completely negative in both rats and mice. DDT and BHC are efficient promoters of the actions of recognized potent hepatocarcinogens such as diethylnitrosamine and 2-acetylaminofluorene. Besides affecting the liver and the nervous system, chlorinated hydrocarbon insecticides can cause disturbances in the function of other tissues of experimental animals.

Harold et al. reported that adult mice when fed orally with BHC at a dose of 50 mg/kg body weight every day for 1, 5 and 15 days, significant decrease in the pyruvate content was observed at all periods of treatment. Enzymes of TCA cycle namely isocitrate dehydrogenase (ICDH), succinate dehydrogenase (SDH) and malate dehydrogenase (MDH) were inhibited suggesting abnormality in mitochondrial oxidative metabolism as a consequence of BHC toxicity.

Biochemical toxicity of HCH and its γ-isomer were studied in albino mice and found that alanine aminotransferase (ALT), aspartate aminotransferase (AST) and alkaline phosphatase in blood were increased. Alkaline phosphatases and acid phosphatases were increased in the liver of animals.
There was a decrease in hepatic glucose-6-phosphatase activity when fed with HCH.\textsuperscript{59} The effect of lindane in mammals have resulted in neurochemical and metabolic changes.\textsuperscript{60,61}

Organic phosphorus anticholinesterases phosphorylate a number of other enzymes, including acid phosphatase, aliesterases, lipases, trypsin, chymotrypsin, succinooxidases, ascorbic acid oxidase, dehydrogenases sulfhydryl enzymes and others. The reaction with these enzymes is generally slower than that with cholinesterases. So far as is known, none of the other reactions has any clinical consequence.\textsuperscript{56}

The cause of death in poisoning by organic phosphorus compounds is usually respiratory failure and consequent anoxia but may be cardiovascular in origin. Four factors (excessive secretion of the respiratory tract, bronchoconstriction, weakness of the muscles of respiration, and failure of the respiratory centre) may contribute to respiratory failure. There are studies which reports about the visual effects of organophosphorus, their compounds and its atypical effects.\textsuperscript{62}

Malathion and other organic phosphorus insecticides are inhibitors of liver microsomal enzymes \textit{in vitro}, probably acting as alternative substrates. Husain and Matin have reported hyperglycaemia in female rats following intraperitoneal administration of 500 mg/kg malathion.\textsuperscript{63} The toxicity evaluation of malathion reveals that 2.0 ml/kg body weight is lethal to rat. Dietary intake of three oral doses of hexachlorocyclohexane (HCH) or malathion by normal and protein deficient diet fed pregnant rats on the 6, 10 and 14 day of gestation resulted in the impairment of lipid metabolism.\textsuperscript{64} A single oral dose of 58 mg (0.84 mg/kg) produced clinical effect to humans and 23% of it was recovered from the urine in the form of organic phosphorous.\textsuperscript{65} Vinodkumar and Uppal studied the effect of malathion on the anticonvulsant activity of
diphenylhydantoin in mice and found that malathion significantly enhanced the anticonvulsant effect of DPH in mice and increased its concentration in brain and liver.\textsuperscript{66}

A comparative evaluation of immunotoxicity of malathion after subchronic exposure in experimental animals, reveals that both cellular and humoral immune responses were decreased in a dose-time dependent pattern and a consistent trend was observed.\textsuperscript{67}

Haque \textit{et al.} observed that malathion induced alterations in the lipid profile in albino rats.\textsuperscript{68} An elevation in the level of lipid peroxides in nuclear, mitochondrial and microsomal fractions of chick liver was recorded 6 h after the hexachlorocyclohexane treatment.\textsuperscript{69}

Spices and condiments form one of the important food items in our diet and the value of these has been recognized since ancient times. Spices are used for flavouring foods and are also used in medicines, pharmaceuticals, perfumery, cosmetics and several other industries. There are 70 varieties of spices grown in India comprising plant components or parts such as floral, fruit, seed, rhizomes, roots, leaves, kernel, bark and bulbs. Spices are well-known appetizers and add flavour to otherwise insipid foods. Some of them possess antioxidant properties, while others are used as preservatives in some recipes like pickles and chutneys. Some spices display a series of biological properties important for human health including antioxidant and antiinflammatory effects as well as chemopreventive and anticarcinogenic properties. Some possess antimicrobial and antibiotic activity. The intake of various types of spices varies from individual to individual.

Garlic (\textit{Allium sativum}) is a common plant used as a food item in all parts of the world. Garlic has been shown to possess insecticidal, antibacterial, antifungal, antiviral, antitumour, hypoglycaemic, hypolipidemic and
antiatheroscleroletic properties. Garlic oil is said to be a powerful antiseptic. Biological action of *Allium* products are ascribed to organosulphur compounds having allyl (\(CH_2=CH−CH_2\)) or its isomer propenyl (\(CH_3−CH=CH\)) group which in turn gets its name from *Allium*. These organosulphur compounds react with other systems through their sulphur-sulphur or sulphur-oxygen linkages and alkenyl side chains (unsaturated propenyl or allyl groups).\(^7\) Garlic oil contains diallyldisulphide (60%), allylpropyldisulphide (6%) and various polysulfides and monosulfides. In garlic, S-allyl cysteine sulfoxide (\(CH_2=CH−CH_2−S−CH_2CHNH_2\)) (COOH) is the precursor for the antibiotic principle, allicin. SACS was originally called alliin. Allicin of garlic is known as Russian Penicillin as it is active against many bacteria that are resistant to antibiotics.\(^7\)

Garlic oil is being used in beverages, ice-cream, confectionery, baked foods, chewing gums and condiments. A wide range of \(\gamma\)-glutamyl derivatives of amino acids, predominantly those containing sulphur or their derivatives have been reported in onion and garlic.\(^7\) Certain amino acids like arginine in high quantities may have a role for the antiatherogenic effects of garlic proteins\(^7\) and amino acid composition of garlic protein have a hypolipidemic action. Jain *et al.* reported about the hypoglycaemic action of garlic on glucose feeding\(^7\) and its antidiabetic action was also reported by Sheela *et al.*\(^19\)

Several studies indicated that components of freshly cut garlic inhibit platelet aggregation and smooth muscle contraction through inhibition of cyclooxygenase and related enzymes.\(^7\) Methyl allyltrimethylsulphide (MATS) which is the minor component in natural garlic oil inhibits platelet aggregation.\(^7\) Mahkeja *et al.* reported that garlic and onion oil fractions containing allicin or polysulfides effectively inhibited ADP, arachidonic acid, or collagen-induced platelet aggregation.\(^7\)
Studies of garlic on carbohydrate metabolism and lipid synthesis in rats found that the dietary garlic inhibited the synthesis of lipids in liver and increased the level of serum insulin, thereby lowering serum glucose and increasing glycogen in liver. In a study to assess the effects of standardized garlic powder tablets on serum lipids and lipolemic glucose and blood pressure in forty-two healthy adults, it was found that, the baseline serum triglyceride level was reduced after 12 weeks of standard garlic treatment. Low-density lipoprotein cholesterol (LDL-C) was reduced by 11% by garlic treatment and 3% by placebo. There were no significant changes in high-density lipoprotein cholesterol, triglycerides, serum glucose and blood pressure.

The effect of an odour-modified liquid garlic extract on blood lipids was evaluated in human subjects over six months period and lowering of cholesterol, triglycerides, low density and very low density lipoproteins (LDL, VLDL) with rise of high density lipoprotein (HDL). Garlic protein (16% of diet) and garlic oil (100 mg/kg body weight/day) exhibited significant lipid lowering effects in albino rats when hyperlipidaemia was induced by cholesterol containing diets.

The tumour yield and incidence of phorbol-myristate acetate promotion were inhibited in a dose-dependent manner on garlic oil supplied to mice. Reports suggests that garlic have a role in the prevention of human cancer. Garlic has been shown to inhibit the growth of transplantable tumours and to reduce the incidence of certain spontaneously occurring tumours. Components of garlic have also been found to inhibit the activity of diverse chemical carcinogens during both the initiation and promotion phases of carcinogenesis. Garlic modulate specific and non-specific antitumour immunity.

An extract obtained from garlic bulb was shown to inhibit hepatic and serum glutamic-oxaloacetic transaminase, glutamic-pyruvate transaminase, lactic dehydrogenase and cholinesterase in vitro in cow, sheep or rabbit. The
garlic extract stimulated the activity of guinea-pigs liver adenosine triphosphatase in intact mitochondria.\textsuperscript{83}

The hypocholesterolemic activity of garlic was well proved by many workers.\textsuperscript{84,85} The activity was tested by incorporating freeze-dried garlic power at 0.5, 1.0, 2.0 and 3.0 levels in an artherogenic diet fed to rats and found that increased levels of low density lipoproteins and LDL-cholesterol in rats fed the atherogenic diet were reversed in rats receiving supplement of 2% garlic powder.\textsuperscript{86} The administration of garlic on serum cholesterol in butter fat-induced lipaemia, prevent the increase in serum cholesterol and its fractions which follows a butter fat meal,\textsuperscript{87} garlic may have an inhibitory effect on atherosclerosis. Jain \textit{et al.} studied the role of garlic in cholesterol-induced atherosclerosis in rabbits and found that supplementation of garlic to rabbits fed with cholesterol resulted in significantly lower cholesterol levels and less atherosclerosis.\textsuperscript{88} A study was conducted on the effect of garlic on blood lipids in patients with coronary heart disease, shows a distinct hypolipidemic action in both healthy individuals and patients of coronary heart disease.\textsuperscript{89}

It is reported that garlic reduces plasma lipids by inhibiting hepatic cholesterol and triacylglycerol synthesis. That is, hypocholesterolemic effect of garlic stems decreased hepatic cholesterogenesis whereas the triacylglycerol lowering effect was due to the inhibition of fatty acid synthesis.\textsuperscript{90} Gebhardt reports the multiple inhibitory effects of garlic extracts at several steps in the cholesterol biosynthetic pathway and the extent of inhibition depends strongly on the concentration of the extracts. Firstly inhibition of total sterol biosynthesis was recognized as a biplasic phenomenon caused mainly on the level of HMG-CoA reductase. Secondly, exposure of rat hepatocytes or HePG\textsubscript{2} cells to higher concentrations of garlic extracts resulted in a pronounced shift in the composition of sterol fraction indicating inhibition at later stages of cholesterol biosynthesis.\textsuperscript{91} Garlic extracts exert their lowering effect through the inhibition
of HMG-CoA reductase. A similar inhibition with water soluble extracts had previously been observed with the chicken liver enzyme.\textsuperscript{92}

Sheen \textit{et al.} studied the effect of active principles of garlic diallyl sulfide (DAS) on cell viability, detoxification capability and antioxidation system of primary rat hepatocytes and found that 1 mM DAS did not affect the membranes of hepatocytes during 24 h treatment and when hepatocytes were treated with DAS at 0.5 or 1 mM, intracellular GSH levels were 8-23% higher than in the controls at 24 h. This phenomenon is beneficial to detoxification and antioxidation capabilities of hepatocytes.\textsuperscript{93}

Garlic extracts (ethanolic extract) were found to increase the amplitude and frequency of uterine contractions and muscle tone was also increased lightly.\textsuperscript{94} The oxytocic effect of an alcoholic extract of garlic was also corroborated by Scotomayer.\textsuperscript{95}

Turmeric (\textit{Curcuma longa}) is widely used as a spice in India, for its colouring, flavouring and medicinal properties. Curcumin, the main colouring component of turmeric, has a wide range of effects – it is antihepatotoxic\textsuperscript{96} and antiinflammatory.\textsuperscript{97} The major pigment and phenolic compound in turmeric or the ethanolic extract of turmeric have been shown to inhibit tumour induction by diverse carcinogens in various organs of mice\textsuperscript{98,99} and rats.\textsuperscript{100}

Nagabhushan \textit{et al.} studied \textit{in vitro} antimutagenicity of curcumin against environmental mutagens and curcumin inhibited the mutagenicity of bidi and cigarette smoke condensates, tobacco and masheri extracts, benzo(a)pyrene and dimethyl benzo(a)anthracene in a dose-dependent manner.\textsuperscript{101} The anticarcinogenic effect of dietary turmeric on benzo(a)pyrene (BP)-induced forestomach neoplasia and 7, 12-dimethylbenz(a)anthracene (DMBA)-induced skin tumourogenesis in female Swiss mice were studied by Azuine \textit{et al.}\textsuperscript{102} The curcumin has a distinctive hypocholesterolemic effect both in serum and liver in
induced hypercholesterolemic rats. Hypolipidaemic effects of turmeric in triton-induced hyperlipidaemic rats were studied by Dixit et al. and found that it has the property of cholesterol and triglyceride lowering activity. In view of the protective action of HDL against heart disease and atherogenecity, consumption of turmeric is recommended. The volatile oil of C. longa is having anti-inflammatory and antiarthritic activity. Arora et al. evaluated the antiinflammatory activity of turmeric in rats and compared with hydrocortisone acetate and phenylbutazone.

The protective effect of turmeric extract in diet on CCl₄ treated rats was studied and found that CCl₄ caused a maximum increase of serum levels of bilirubin, cholesterol, aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase and a short pre-treatment of turmeric extract showed reduction in cholesterol, bilirubin, AST, ALT and alkaline phosphatase activity.

Sodium curcuminate, the sodium salt of the pigment curcumin, isolated from C. longa, has been found to be an active choleretic, inducing nearly 100% increase of bile production in anaesthetized dogs, in doses non-toxic to the animal. The intragastric administration of 50 mg curcumin (125 mg/kg body weight) per rat increased the bile secretion rate. There was a marked decrease in bile solids with the lower dose of curcumin. Cholesterol and total bile acids content of the bile were significantly higher only in rats that were given 100 mg curcumin and phospholipid concentration in bile was not affected by curcumin.

Acute toxicity studies conducted on different species of animals including non-rodents reveal that turmeric or its alcoholic extract consumption is not toxic even at very high level (2.5 g/kg and 300 mg/kg body weight) respectively. Absorption and tissue distribution of curcumin in rats showed that after oral
administration of 400 mg curcumin to rats, about 60% of the dose was absorbed and no curcumin was detected in urine. Only traces (less than 5 µg/ml) in portal blood and negligible quantities in liver and kidney (20 µg/tissue) were absorbed from 15 minutes up to 24 h after administration of curcumin.\textsuperscript{112}

Reports are available on the antioxidant activity of curcumin and related compounds\textsuperscript{113} and anticarcinogenic effects.\textsuperscript{114} Curcumin is able to modulate \textit{in vitro} expression and function of hepatic P-glycoprotein (Pgp) and also it can be considered as a candidate chemosensitizer of mdr phenotype.\textsuperscript{115}

Effect of dietary turmeric on iron-induced lipid peroxidation in the rat liver were studied by Pulla Reddy \textit{et al.} when rats fed a control diet supplemented with 1% (by weight) turmeric for 10 week. In rats ingested with 30 mg Fe\textsuperscript{2+}/kg body weight, lipid peroxidation was 29 and 35% lower in liver homogenates and microsomes, respectively of turmeric fed rats than in those of rats fed with the control diet.\textsuperscript{116} The activities of superoxide dismutase, catalase and glutathione peroxidase were higher in liver homogenates of rats fed with the turmeric diet in comparison with the control. The studies indicate that dietary turmeric lower lipid peroxidation by enhancing the activities of antioxidant enzymes.\textsuperscript{116}

The studies show that curcumin has stimulatory effect on the musculature of the gall bladder, an additional advantage as a therapeutic agent in biliary stasis, tendency for cholelithiasis and other affections needing an emptying of the gall bladder contents.\textsuperscript{117} Curcumin has powerful antibacterial action on \textit{Staphylococcus aureus}. Many infections of the gastrointestinal tract, the biliary system and gall bladder are contributed to staphylococcal infection. Drugs like urotrpine are now combined with choleretics in therapy of such conditions and curcumin seems to combine the choleretic and hydrocholagogic action with the antiseptic property and probably would be an ideal therapeutic agent in conditions due to staphylococcal infection.\textsuperscript{117}
Ginger (*Zingiber officinale*) is a commonly used spice and is considered as a valuable medicine because of its action as a rubefactant, diuretic and stimulant to the gastrointestinal tract. Ginger is used in many different foods and drinks. Ginger oil also finds limited use in the cosmetic, pharmaceutical and perfume industry. Ginger valued primarily for its aroma and characteristics contribute to the flavour of ginger. A few investigations were carried out on the identity of the volatiles responsible for the characteristic ginger aroma.\(^{118}\)

Ginger inhibits some biological activities. It is used as a carminative and a stimulant to the gastrointestinal tract. It has been shown that the water or organic solvent extract of ginger possesses antioxidative and antiinflammatory properties.\(^{119,120}\) Ethanol extract of ginger possesses antitumour promoting effects on a mouse skin tumourogenesis and the mechanism of effects may involve inhibition of tumour promoter-caused cellular, biochemical and molecular changes in mouse skin.\(^{121}\)

Ginger is described in Ayurvedic as a medicine to be useful in inflammation and rheumatism. In 56 patients (28 with rheumatoid arthritis, 18 with osteoarthritis and 10 with muscular discomfort) used powdered ginger against their afflictions. Amongst the arthritic patients more than three quarters experienced to varying degrees, relief in pain and swelling. All the patients with muscular discomfort experienced relief in pain. None of the patients reported adverse effects during the period of ginger consumption, which ranged from 3.3 months to 2.5 years. It is suggested that at least one of the mechanisms by which ginger show its ameliorative effects could be related to inhibition of prostaglandin and leukotriene biosynthesis. That is, it works as a dual inhibitor of eicosanoid biosynthesis.\(^{31}\)

The powdered rhizome of ginger has been a traditional remedy for gastrointestinal complaints. Ginger (the powdered root) is an effective and promising prophylactic antiemetic, and may be useful for day case surgery.\(^{122}\) Effect of ginger on serum cholesterol levels of rats fed cholesterol for 24 days
were studied and found that administration of 10% ginger along with cholesterol decreased cholesterol level in serum markedly. Adult male rats when fed with 2% garlic and 0.5% ginger and a combination of garlic plus ginger for 4 weeks were studied. A significant increase in body weight was observed in all groups except that fed ginger alone. A significant decrease in blood glucose and total cholesterol and serum alkaline phosphatase were found in all groups whereas serum triglycerides were decreased significantly in group with combination of garlic and ginger. Serum HDL-cholesterol was significantly increased in ginger and ginger plus garlic groups. HDL-cholesterol, VLDL-cholesterol and atherogenic index were significantly decreased in animals fed with combination of the two compared to garlic/ginger alone. Bordia et al. reported a placebo-controlled study of the effect of ginger and fenugreek on blood lipids, blood sugar, platelet aggregation, fibrinogen and fibrinolytic activity in patients with coronary artery disease. The effect of feeding curcumin, capsaicin, ginger, mustard, black pepper and cumin on cholesterol and bile acid metabolism was studied in rats by Srinivasan and Sambaiah. The study suggested that turmeric, pepper, ginger and mustard can stimulate the conversion of cholesterol to bile acids, an important pathway of elimination of cholesterol from the body. Some pungent constituents present in ginger and other Zingiberaceous plants have potent antioxidant and antiinflammatory effects and some of them exhibit antitumour promotional activity in experimental carcinogenesis.

Garlic, turmeric and ginger have been valued as a flavouring agent since ancient times they all have several medicinal properties and are recommended for various diseases. But the detoxification of the toxic effects of pesticides has not been studied so far.