

## Health Perspective of Pesticide Exposure and Dietary Management

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### ABSTRACT

Among the chemicals, pesticides which are mainly used in agriculture pose major health problems to human beings. Indiscriminate use of pesticides belonging to the class organophosphate, organochlorine, carbamate, and pyrethroid leads to various health problems affecting the nervous, endocrine, reproductive and immune systems. The toxicity of pesticide in human beings is influenced by various factors such as age, gender and health status of the individual in addition to the intensity and frequency of pesticide used. Comparatively, children are at greater risk than the adults. The human detoxification system plays a vital role in reducing the harmful effects of the pesticides. However, when the toxic level is increased beyond the capacity of the detoxification system, health condition deteriorates. Human diet plays a crucial role in maintaining the overall health of a person. Vitamins such as Vitamin C and E are effective in preventing DNA damage because of their antioxidant properties. Intake of fruits and vegetables improves the antioxidants level in the blood. Phenolic substances present in certain spices possess potent anticarcinogenic activities. Organic farming may be a viable solution to reduce the toxic effects of chemicals.

### INTRODUCTION

The modern man is constantly exposed to a variety of toxic chemicals primarily due to changes in life style. The food we eat, the water we drink, the air we breathe, and the environment we live in are contaminated with toxic xenobiotics. Humans are exposed to such chemicals while still in the womb of the mother. A number of studies have revealed the presence of pesticides in human milk, water, cow's milk and dairy product samples (Lederman, 1996). The contamination of human milk by xenobiotics is a common problem worldwide; it is affected by geographical, climate and cultural and socio-economic variations in each individual location. In the last hundred years or so, human activities have been destroying the natural system upon which life depends. In fact after the advent of the Green Revolution, pesticide use was considered a sign of progress and modernization. The concepts of the Green revolution, excessive dependence on chemical fertilizers and synthetic insecticides, have proved to be a major cause of environmental concern. Rapid industrialization and ever increasing transport emissions magnified the a major

cause of environmental concern. Rapid industrialization and ever increasing transport emissions magnified the environmental problems severalfold. Nevertheless, pesticide use has been a major concern, since the publication of *The Silent Spring* by the prophetic environmentalist Carson (1962). Substantial scientific evidence is now available since then, indicating the negative impact of inorganic pesticides including neuro-toxicity, renal toxicity, respiratory toxicity, immunotoxicity, reproductive toxicity, teratogenicity, genotoxicity and carcinogenicity. The Third World uses 80% of the world's pesticide and the World Health Organization (WHO, 1998) estimates that all of the 220,000 annual pesticide related deaths occur in the Third World.

## PESTICIDES

A pesticide is a chemical substance intended for preventing, destroying, repelling or mitigating any pest such as insects, bacteria, fungi, nematodes, weeds, rodents etc. Globally, the use of synthetic pesticides has increased rapidly in the last fifty years due to intensification of farming in order to obtain higher yields. However, over dependence on chemicals not only resulted in a high cost of production but also irreparable damage to the environment and long term health problems to humans and other forms of life including marine organisms.

Currently about 759 chemical and biological pesticides are used worldwide in the agriculture and health sectors. Of this, 33 pesticides have been classified by World Health Organization (WHO, 1998) as extremely hazardous to human health (class Ia), 48 as highly hazardous (class Ib), 118 as moderately hazardous (class II) and 239 as slightly hazardous (class III) and 149 pesticides have been considered as unlikely to cause acute hazard in normal use (class IV). According to World Resource Institute, in 1995, world pesticide consumption reached 2.6 million metric tons of active ingredients with a market value of USD 38 000 million. An estimated 85% of this consumption was used in agriculture. About three-quarters of pesticide use occurs in developed countries, mostly in North America, Western Europe and Japan. Although the volume of pesticide used in developing countries is small relative to the developed countries, it is nonetheless substantial and is growing rapidly. Furthermore, the World Resources Institute has estimated that the pesticide market in developing countries is dominated by insecticides, which have higher acute toxicity than herbicides, the main pesticides used in the developed countries (WHO, 1998).

Pesticides may induce oxidative stress leading to the generation of free radicals and alteration in antioxidant or oxygen free radical scavenging enzymes such as superoxide dismutase, catalase, glutathione peroxidase, glutathione reductase and glutathione transferase (Ahmed *et al.*, 2000).

The four main groups of pesticides such as the organochlorine, organophosphate, carbamate, and pyrethroid insecticides (Smith & Gangolli, 2002; Ahmed *et al.*, 2000) are of particular concern because of their toxicity and persistence in the environment; however several of the banned pesticides are still used on a large scale in developing countries and continue to pose severe health and environmental problems. Farmers in developing regions seem to treat pesticides as substitutes for fertilizers and there is a need to create awareness among the farmers on Integrated Pest Management (Sanzidur Rahman, 2003). Pesticide toxicity can result from ingestion, inhalation or dermal absorption.

The technological development and cheap availability of raw materials led to the production of a wide range of organochlorine insecticides. Unfortunately these chemicals are non biodegradable, persistent and get accumulated in the environment and thus into the human food chain. Despite regulatory measures, these compounds continue to be detected in measurable amounts in the ecosystem including marine life (Smith & Gangolli, 2002). The “miracle pesticide” DDT when used saved 25 million lives protecting them against the malarial mosquito and typhus fever. Simultaneously, the biological phenomena of insect resistance to DDT was also developed in addition to its long standing persistence in the environment and its negative impact on marine life. Organochlorine pesticides DDT, DDD, DDE, aldrin, lindane and heptachlor residues, were detected in the muscle tissue of cat fish (Das *et al.* 2002). The presence of organochlorine pesticides in breast milk has been documented in many studies around the world (Hoyer *et al.*, 2000).

Organophosphates are well known toxicants affecting the nervous system through the inhibition of acetyl cholinesterase. Most of the health problems due to acute poisoning of organophosphorus compounds with sensitive targets in the human body have been attributed to inhibition of enzyme acetyl cholinesterase in a range of nerve, neuromuscular and glandular tissues where this enzyme plays a key role in cell to cell communications (Karalliedde, Edards & Mars, 2003). Organophosphate insecticides are metabolically activated to the corresponding oxon. The oxon selectively and strongly inhibits acetyl cholinesterase in cholinergic synapses resulting in accumulation of acetylcholine and subsequently, cholinergic hyper excitation. The oxon is hydrolysed by A-esterases as a key detoxification step at high doses. The first line of defense is gut detoxification and p-glycoprotein exclusion of the oxon. The second line of defense is hepatic metabolism; the third line of defense is binding of oxon to B-esterases (butyl-acetyl-and carboxyl- esterase), when all these defenses are breached by high doses, then A-esterase becomes important. There is a marked interspecies difference in the enzymatic handling of paraoxon and humans may be less adept than rodents at detoxification (Kaliste-Korhone, 1997).

## **PESTICIDE RELATED HEALTH PROBLEMS**

Over 300 foreign chemicals, including several known carcinogens have been identified in the adipose tissue and other organs including brain cells and nervous system. The brain and the endocrine (hormonal) glands are the target site for the fat-soluble toxins to accumulate. Continued exposure to these chemicals for a long period may result in symptoms of mild cognitive dysfunction (including problems in identifying words, colours or numbers and unable to speak fluently) and hormonal imbalances leading to infertility, breast pain, menstrual disturbances, adrenal gland exhaustions and early menopause. Eventually these toxins are stored in the fatty body tissues and in cells of the brain. These stored toxins may be slowly released and recirculated in the blood, contributing to many chronic illnesses. Whenever the body is under stress, the stored fat is released along with the toxins and circulates freely through out the body. The resulting exposure can target various organs and body systems, contributing to many chronic illnesses.

### **Endocrine disruptors**

Endocrine disruptors are exogenous chemical substances that cause adverse effects in the endocrine system. The pesticides can cause health problems thus acting as endocrine disruptors, resulting in reproductive defects, and immune dysfunction. These chemicals mimic the action of hormones and can damage or disrupt the normal functioning of an organism. In humans, endocrine glands which include adrenal, thyroid, pancreas, ovary and testis produce hormones which are distributed to receptors through the blood stream. Many pesticides acts as endocrine disruptors and affect sperm quality and reproductive development. There is now considerable evidence that male reproductive function is declining in human and wild life populations (Petrelli & Mantovani, 2002), that the mechanism of action may be disturbed testicular apoptosis and altered hepatic biotransformation of steroids. Animal studies that provide a range of effects that can be attributed to *in utero* EDC exposure include (i) a vast number of chemicals found to be EDC; (ii) the ability of chemicals to bioaccumulate in the body lipid; and (iii) metabolism of body lipid during pregnancy releasing the mother's life time EDC into circulation (Murray *et al.* 2001). Sexual differentiation is regulated by reproductive hormones. Diethylstilbestrol is the best known endocrine disrupter and has caused abnormalities of sexual differentiation in both exposed female and male human fetuses (Toppari, 2002). Organochlorine contaminants in the human diets relate to the potential ability of many of these chemicals at low doses to act as "endocrine disruptors" (Smith & Gangolli, 2002). Such chemicals are capable of disrupting the normal functioning of endocrine system and may pose a growing threat to human and wild life health. These compounds can modulate both the endocrine and immune systems resulting in alteration of homeostasis, reproduction, development and behavior. The chemicals in the environment cause endocrine disruption and result in pathological effects on the male and female reproductive system, thyroid function and the central nervous system (Amaral-Mendes, 2002).

### **Effect on reproductive system**

There is a growing concern that environmental chemicals, both natural and man made, having estrogenic property may cause a variety of reproductive disorders in wild life and human populations. Recent *in vitro* data suggest that the interaction between some weak estrogenic organochlorines, dieldrin, endosulfan, toxaphene and chlordane cause a synergistic increase in their estrogenic potency, an effect due to joint action on estrogenic receptors (Wade *et al.*, 1997).

Exposure to environmental toxicants may play a role in adverse pregnancy outcomes. (Fowler, 2001). It has been shown that there is detectable levels of 2,4-D and MCPA ([4 chloro-2 methylphenoxy] acetic acid in the semen of farmers who recently used the pesticides. As these pesticides can be excreted in the semen, they could be toxic to sperm cells and be transported to the woman and developing embryo/fetus (Tye *et al.*, 1994). Farm workers attending the plant protection operations and persons working in the pesticide manufacturing units are more prone to pesticide toxicity. In brief, exposure to pesticides with endocrine disrupting potential raises a particular concern for male fertility because of the possible occurrence of effects at low concentrations and additive interactions with other environmental risk factors. Epidemiological studies have confirmed an increased risk of delayed conception associated with exposure to pesticides. Moreover, an increased risk of spontaneous abortion has been noted among wives of exposed workers (Petrelli & Mantovani, 2002). Birth abnormalities were reported in the offspring of registered users of pesticide as well as the general population living around agricultural areas (Garry, 1996). Studies show a stronger association between fetal death due to

congenital abnormalities and residential proximity to applications of pyrethroid and observed elevated risk when the exposure occurred during the third – eighth week of pregnancy (Bell *et al.*, 2001). In a study, umbilical cord blood was analyzed in a new-born, whose parents had been exposed to pesticides. The results indicated the presence of detectable DDE, the main metabolite of DDT. There was a positive correlation between maternal DDE and the consumption of fish (Sarcinelli *et al.*, 2003). A cohort study of serum shortly after delivery indicated that DDE and other organochlorine pesticides may pose a risk to preterm birth in countries that continue to use such insecticides for malaria control (Torres-Sanchez *et al.*, 2003).

### **Immune dysfunction**

There is substantial experimental and epidemiological evidence that many pesticides in widespread use around the world are immunosuppressive. This poses potentially serious health risks in populations highly exposed to infectious and parasitic diseases, subject to malnutrition and inadequately served by curative health programmes (Repetto & Baliga, 1997). Numerous animal studies show a variety of effects of pesticides on the immune system, including decreased antibody formation by 70% after exposure to pesticides such as captan, lindane and malathion; decreased cell mediated immunity is also indicated. Frequent exposure of multiple toxins causes the detoxification system to be overloaded and inefficient, leading to the accumulation of toxins, dead cells and microorganism build up in the blood. To combat these foreign bodies, the immune system will produce excessive inflammatory chemicals. Under a hyper excited state, the immune system will produce auto antibodies. This may lead to symptoms of immune dysfunction such as allergies, inflammatory states, swollen glands, recurrent infections, chronic fatigue syndrome and auto immune diseases. The immune system can be rejuvenated only by improving the liver function through proper dietary management.

### **Parkinson's disease**

Parkinson's disease (PD) is the most common neuro degenerative disorder. It is now proposed that environmental factors in conjunction with genetic susceptibility may form the underlying molecular basis for idiopathic PD (Uversky *et al.*, 2002). Epidemiological and experimental data suggest the potential involvement of specific agents as neuro toxicants such as pesticides (organochlorine and organophosphorus) in the pathogenesis of nigrostriatal degeneration, supporting a relationship between the environment and Parkinson's disease. Neuro degeneration results from multiple events and interactive mechanisms which include (i) the synergistic action of endogenous and exogenous toxins such as the ability of the pesticide diethyl dithio carbamate to promote the toxicity of other compounds; (ii) the interaction of toxic agents with endogenous elements such as the protein alpha synuclein; and (iii) the effect of environmental factors on the background of genetic predisposition and aging (Di Monte *et al.*, 2002). Epidemiological studies provide evidence for an association between Parkinson's disease and past exposure to pesticides and other putative neurotoxins depends on variability in exposure to environmental agents including pesticides. Recent studies show clearly that genetic factors play a minor role in determining whether an individual develops this disease, rekindling an interest in the etiological significance of environmental factors (Lockwood, 2000). *In vitro* studies have provided proof that several pesticides including rotenone stimulate the formation of alpha-synuclein fibrils (one of the principal constituents of Lewy bodies). Moreover, a meta analysis of all case control

studies so far showed a positive, statistically significant association between pesticide exposure and Parkinson's disease (Vanacore *et al.*, 2002).

## Cancer

A number of studies have observed an association between brain cancers and pesticides as well as soft tissue sarcomas. Beginning in the late 1970s, there have been reports linking pesticides to leukemia in children. Case-control studies have linked pesticide exposure to childhood cancer (Zahm *et al.*, 1997). A number of studies have demonstrated that maternal employment in agriculture has a link with leukemia. The most convincing evidence that herbicides are human carcinogens comes from epidemiological studies (Hoar & Blair, 1986). It is reported that the population living around the active agricultural regions are highly prone to cancer. Thyroid and bone cancers are prevalent in agricultural regions where fungicides are extensively used (Schreinemachers *et al.*, 1999). Recent studies have shown that the incidence of hormone related organ cancers or hormonal cancers has increased among farmers. Exposure to endocrine disrupting pesticides, particularly to DDT and phenoxy herbicides, is the suspected cause in some of these hormonal cancers (Buranatrevedh & Roy, 2001). The association between different types of pesticides and prostate cancer shows moderate risk among farmers exposed to organochlorine insecticides and acaricides specifically DDT and Dicofol (Settimi *et al.*, 2003). Over the last 10 years, breast cancer in women has increased worldwide by 33%. Various studies have linked our environment and the substances we are exposed to as prime suspects. There is growing evidence that the breast cancer epidemic is related to exposure to a wide range of environmental contaminants including DDT, other carcinogenic pesticides and oestrogenic stimulants. Organochlorine pesticides such as DDT and its metabolites DDD and DDE, dieldrin, heptachlor, HCH and its isomers were detected in the blood of breast cancer patients, irrespective of age, diet and geographic locations when compared to normal women (Mathur *et al.*, 2002).

## Cytotoxic defects

The potential genetic hazard of pesticides to human beings is of great concern. Results from the biological monitoring or cytogenetic methods for the detection of health risks to pesticides have showed DNA damage in peripheral lymphocytes among workers employed in municipality. The observed DNA damage was found to be significantly lower in workers taking some of the necessary safety precautions during their work (Undeger & Basaran 2002). Malaoxon is the first and main metabolite that is more toxic than the parental compound, Malathion. Malaoxon can damage DNA in human lymphocyte, by various mechanisms including oxidative damage. Hydrogen peroxide and reactive oxygen species may be involved in the formation of DNA lesions induced by Malaoxon. Malaoxon can also methylate DNA bases (Janusz & Dorota, 2001).

Increased chromatid breaks and chromosomal aberrations in human lymphocytes were observed in workers occupationally exposed to pesticides. Bolognesi *et al.* (2002) observed micronuclei frequency in peripheral blood lymphocytes among the farm workers, which was more evident among workers who avoided protective measures. Genetic damage, particularly gene loss, is a central cause of aging. Aging involves altered cellular and humoral immunological functions which include (i) decreased number of lymphoid precursor T- and B- cells; (ii) reduced

proliferative capacity of T-cells, loss of lymphocyte sub groups as a consequence of shortening of telomers; (iii) qualitative deficiency of B-lymphocytes with reduced response to exogenous antigens; (iv) compromised activity of the accessory cells, both by directly depressing the chemotactic and phagocytic responses and indirectly by increasing the prostaglandin production which inhibit the proliferation of T-cells; and (v) alteration in the production and secretion of various cytokines (Malaguarnera *et al.*, 2001).

### **Factors influencing toxicity**

A central tenet of the science of toxicology is that the toxic effect of any material monotonically increases with the amount of toxic material delivered to the target tissue. The factors to be considered include physicochemical properties, solvents, impurities of the pesticide, duration and route of exposure and also factors related to the individual exposed including variation in the metabolic, sequestration and excretory processes and health status, age, gender, and environmental factors (Karalliedde *et al.*, 2003). The effect of pesticides on human health depends on quantity of pesticide accumulated, the length and frequency of exposure and potential toxicity of the pesticide. Effects also depend on health of a person at the time of exposure. It is suggested that specific chronic pesticide effects may develop in elderly people because of the long latency period between exposure and disease. Organophosphate pesticides exert toxic effect on bone marrow and may be associated with hematopoietic cancer after a latency of 10–25 years (Hardell & Eriksson 1999).

### **Toxicity in children**

Infants and children are at great risk from the effects of pesticides. Children are exposed to potentially carcinogenic pesticides from use in school, home, other buildings, lawns and gardens, through food and contaminated drinking water, from agricultural application drift, overspray or off-gassing and from carry home exposure of parents occupationally exposed to pesticides. Parental exposure during the child's gestation or even pre-conception may also be important. Malignancies linked to pesticides include leukemia, neuroblastoma, Wilm's tumor, soft-tissue sarcoma, Ewig's sarcoma, non-Hodgkin's lymphoma and cancer of brain, colorectum and testes. Several studies suggest that children may be particularly sensitive to the carcinogenic effect of pesticides. There is a potential to prevent at least some childhood cancer by reducing or eliminating pesticide exposure (Zahm & Ward, 1998). Pesticides are effective in killing the pests through their neurotoxic effects. Infants appear to be particularly susceptible to the effect of these pesticides because they have an incompletely developed acetyl cholinesterase system and their immature liver cannot detoxify the compounds. Infants and children are especially sensitive to health risks posed by pesticides for several reasons. Their internal organs are still developing and maturing. Children eat and drink more than adults, in relation to their body weight, possibly increasing their exposure to pesticides in food and water.

Experimental evidence suggests that specific chronic pesticide effects may develop in adults because of the long latency period between exposure and disease (Hardell & Eriksson, 1999). The use of animal data on toxicity is not sufficient for predicting human risk. The evidences suggest that human infants and children are much more susceptible, particularly to organophosphates and carbamates than animal species. The present assessment of the risk of pesticides

is almost exclusively based on animal studies and this may greatly underestimate the risk to humans, particularly infants and children. Risk assessment must be based on human physiology and metabolism. The proportionate organ development period and the impact of pesticides at different developmental stages vary widely between human children and test animals.

#### *Human detoxification system*

Inherently the human body is endowed with an efficient detoxifying system, which can handle minimum toxic exposure. The liver plays a pivotal role in breaking down the harmful substances that can be excreted by various means. The enzymes of the liver first deactivate the toxic substance and then convert the toxin into water soluble forms which are eliminated through urine, bile in the feces, sweat, lung vapour and sebum. At least two enzyme steps are involved in the processing of toxicants in the liver of humans; the first involves cytochrome p450 enzymes and the second involves glutathione S transferases (GST). Glyphosate, a systemic herbicide inhibits enzymes involved in the detoxification of chemicals in the body. Antioxidant enzymes (super oxide dismutase, catalase and glutathione peroxidase) are components of an organism's mechanisms for combating oxidative stress which is generated in normal metabolism and which may also be a reaction in response to external stimuli (Johnson, 2002). However, this function of the liver can be damaged by repeated exposure to chemicals and toxins in food, water and air. Another major threat is the excessive private and public use of volatile organic compounds (VOC), which due to their high lipophilic nature, get stored in the brain and cell membranes. The detoxification process of VOC largely depends on the activity of cytochrome oxidase p450 which converts the VOC into more water soluble forms to be excreted through urine. However, if the conjugation process is not efficient, the hydrophilic form will prove to be more toxic than the parent chemical.

### **DIETARY MANAGEMENT**

Human diet plays a crucial role in maintaining the overall health of a person. Diet, as a key factor in determining genomic stability, exerts its impact on all important pathways such as exposure to dietary carcinogens, DNA repair, DNA synthesis and apoptosis. Current dietary recommendations are based on disease prevention; still the allowances can be increased on a detoxification consideration (Fenech, 2002) A majority of the pesticides are fat soluble and can be stored in the fatty tissue. The human body has evolved to withstand a low level of toxic insult. A judicious choice of food will counteract noxious agents. Generally the consumption of fruits and vegetables is lowest among those who are sedentary, heavy smokers, heavy drinkers and who never cared to test their blood cholesterol (Serdula, 1996). Water is an important detoxifying agent in our body. Studies in animals have shown that the frequency in urination is inversely associated with the level of potential carcinogen in the urethelium. In humans, an increase in total fluid intake may reduce contact time between carcinogens and urothelium by diluting urinary metabolites and increasing the frequency of voiding. Total daily fluid intake is inversely associated with the risk of bladder cancer (Michaud *et al.*, 1999). Increasing liquids and decreasing fat and protein in our diets will shift the balance strongly towards improved toxic elimination and less toxin buildup.

Reducing dietary exposure to pesticide residue is a major step for a healthy life. Organic farming, with its strictures against the use of synthetic chemical inputs, seems to offer a low residue alternative to conventionally grown produce. The bio-insecticides widely applied in organic farming, tend to break down rapidly in the environment and are comparatively nontoxic and leave no residue in the food (Baker *et al.*, 2002).

### **Vitamins**

Vitamins are organic molecules that mainly function as a catalyst for metabolic reactions within the body. Vitamin C inhibits the DNA damaging effect of maloxon. Alpha tocopherol (Vitamin E), a potent antioxidant is effective in removing the damage to DNA and eliminating the cytotoxic effect of maloxon (Janusz & Dorota, 2001). The protective action of  $\alpha$ -tocopherol stems from its interaction with DNA or with maloxon bound DNA or the lymphocytes (Janusz & Dorota, 2001) and which act as a protective agent against DNA damage in persons occupationally exposed to malathion and maloxon. Aqueous extracts of *Phyllanthus emblica* L., a major source of Vitamin C was found to be an effective agent in protecting against the clastogenicity of the metal salt (Ghosh *et al.*, 1992).

### **Fruits and vegetables**

Dietary antioxidant levels in the blood depend on the intake of fruits and vegetables which offer protection against DNA oxidation. Fruits and vegetables that are not treated with pesticides contain higher concentrations of cancer fighting compounds such as flavanoids than conventionally grown produce, which prevent the accumulation of free radicals in the cells. The second phase of detoxification is the conjugation pathway, whereby the liver adds substances such as cysteine, glycine or a sulphur molecule to the toxins to make it water soluble for subsequent excretion from the body. For efficient Phase II detoxification, the liver cells require sulphur containing amino acids such as taurine and cysteine along with glycine, glutamine, choline and inositol. Eggs, cruciferous vegetables such as broccoli (sulphoraphane), cabbage, brussels sprouts and cauliflower, raw garlic, onions, leek and shallots are good sources of natural sulphur compounds to enhance the Phase II detoxification. Thus, these foods can be considered to have a cleansing action. The acidic solutions (radish, citric acid, ascorbic acid, acetic acid and hydrogen peroxide) are efficient in elimination of organochlorine and organophosphorus pesticides from naturally contaminated potatoes (Zohair, 2001). Sulfur containing phytochemicals glucosinolates and S-methylcysteine sulfoxide in cruciferous vegetables are effective carcinogens (Stoewsand, 1995). Legumes such as soya beans, peas and lentils contain plant hormones called phytoestrogens which will significantly reduce the incidence of hormone dependent cancers of the prostate, uterus and breast (Ingram *et al.*, 1997).

### **Spices**

The phenolic substances derived from certain spices possess potent anticarcinogenic activities. Curcumin in tumeric (*Curcuma longa* L., Zingiberaceae), 6-gingerol in ginger (*Zingiber officinale* Roscoe, Zingiberaceae) and capsaicin in chilli (*Capsicum annum* L. Solanaceae) have effective anticarcinogenic activities. In addition, these phytochemicals exert chemoprotective effects primarily through their anti oxidative and anti-inflammatory activities. Cyclo-oxygenase-

2 (COX-2) is the molecular target of many chemopreventive as well as anti-inflammatory agents. It is suggested that these phytochemicals also play a crucial role in signaling pathways (Young-Joon Surh, 2002). Ginger also significantly attenuates malathion induced lipid peroxidation and oxidative stress in rats (Ahmed *et al.*, 2000). Cumin seeds (*Cuminum cyminum* Linn), basil leaves (*Ocimum sanctum*) and poppy seeds (*Papaver somniferum*) are found to exhibit anticarcinogenic properties. The bell pepper and black pepper are effective in reducing the mutational events induced by ethyl carbamate (El Hamss *et al.*, 2003).

Increasing interest in the health benefits of tea has led to the inclusion of tea extracts in dietary supplements and functional foods. Tea contains a number of bio-active chemicals that are particularly rich in catechins of which epigallo catechin gallate (EGCG) is the most abundant. Catechin and their derivatives are thought to contribute to the beneficial effects ascribed to tea. Tea catechins and polyphenols are effective scavengers of reactive oxygen species *in vitro* and may also function indirectly as antioxidants through their effects on transcription factors and enzyme activities. The fact that catechins are rapidly and extensively metabolized emphasizes the importance of their antioxidant activity *in vivo*. In humans, modest transient increases in plasma antioxidant capacity have been demonstrated following the consumption of tea and green tea catechins (Jane & Balz, 2003).

In a study on histologically confirmed female gastric cancer cases in Japan, it was confirmed that female gastric cancers are preventable by frequent intake of vegetables and fruits, fish and soybean products suggesting to be common protective factors (Lucy *et al.*, 2003).

## **SOLUTIONS TO OVERCOME THE PROBLEMS**

Global thinking is needed to find out alternatives to pesticides to relieve the biosphere from the serious negative impacts of the pesticide. Farmer's knowledge concerning the health dangers of pesticide is not sufficient to change behavior. Their overriding concern is crop damage that leads to economic loss, not health. Integrated pest management (IPM) field school training offers farmers available alternatives by concretely demonstrating the health, agricultural, environmental and economic advantages of eliminating unnecessary pesticide use (Kishi, 2002). Ecological plant protection in accordance with the environment will be one of the most important factors in guaranteeing future human food. A three-pronged strategy to reduce health impacts include (i) a community based process of education and provision of personal protective equipment to reduce exposure; (ii) educating farmers to enhance agro-ecosystem understanding and to reduce pesticide use; and (iii) policy intervention to restructure incentives and reduce availability of highly toxic insecticides (Cole *et al.*, 2002).

Having sufficient pesticide regulatory measures are an important area of concern. It is reported that United States has exported 3.2 billion pounds of pesticide products, an average rate of 45 tons per hour. Nearly 65 million pounds of exported pesticide were either forbidden or severely restricted in the United States. There has been high rates of export of pesticides designated "extremely hazardous" by the WHO (89 million pounds) pesticides associated with cancer (170 million pounds) and pesticides associated with endocrine disrupting effects (368 million pounds)

mostly to developing countries. From public health and environmental protection perspectives, exports of hazardous pesticides remain unacceptably high (Smith, 2001).

Organic farming is the viable alternative in mitigating the harmful effects of pesticides. Organic produce contains fewer pesticide residues than either conventionally-grown produce or produce grown using IPM techniques. It is estimated that 23%, 47%, and 73% of organic, IPM and conventional farming samples, contain pesticide residues respectively. Banned organochlorine compounds which are residual in soils accounted for 40% of pesticide detection in organic produce. The increasing use of alternate therapies that rely on organically grown foods has renewed interest in the relationship between agricultural methods and food quality. Studies suggest that there is higher nutrient content in organically grown crops with higher levels of ascorbic acid, lower levels of nitrate and improved protein quality compared with conventionally grown food (Worthington, 1998).

## **CONCLUSION**

The universe has increasingly become chemicalized primarily due to the introduction of various chemicals in almost all processes. Agriculture is the major sector where chemicals in the form of pesticides and fertilizers are extensively used. The human population is exposed to these chemicals primarily through the consumption of pesticide contaminated farm produce, leading to long term health hazards. The ill effects of chemicals in humans can be alleviated by value added farm products such as fruits, vegetables including certain spices, which supply the vital antioxidants and other therapeutic molecules. However, these farm produce must obviously be free from pesticide contamination, which is possible primarily through organic farming. In addition, global social awareness of proper and minimal need based use of these chemicals, to some extent may reduce health related problems. Development of new biomolecules which can substitute the pesticides can be another pathway for healthy living.

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