Organochlorine pesticide residues in vegetables of three major markets in Uttar Pradesh, India

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ABSTRACT

The aim of this study was to investigate pesticide residues in market foods in Uttar Pradesh, India. A total of 120 samples of four different fresh vegetables from domestic production were analyzed. Pesticide residues were determined by gas chromatography with Electron capture detector (GC-ECD). A total of 15 pesticides from different chemical groups in four types of different domestic vegetables collected from different places from three major cities located in Uttar Pradesh State of India. Sample extract was cleaned up using gel permeation chromatography (GPC). In 58.33% of the samples no residues were found, 28.33% of samples contained pesticide residues at or below MRL, and 13.33% of samples contained pesticide residues above MRL. Brinjal was the most positive followed by cabbage, tomato and lady's finger. In view of their potential toxic and persistent nature, there is a pressing need for their control and monitoring in the environment.

Keywords: pesticides, gas chromatography, toxicity, biomagnification, vegetables.

INTRODUCTION

The application of pesticides to agriculture has greatly improved the food production worldwide. India is the second largest producer of vegetables after China, and accounts for 13.4% of world production. Surveys carried out by institutions spread throughout the country indicate that 50-70% of vegetables are contaminated with insecticide residues. India has a wide variety of climate and soils on which a range of vegetable crops can be grown. During the last two decades considerable emphasis has been laid on production of these crops in our country and vegetable exports have been stepped up [1]. However, the development of the export market is hindered by concerns about chemical residues and inadequate monitoring.

Pesticides are widely used to ensure high crop yields. They are used during production and post-harvest treatment of agricultural commodities [2]. However, increased use of chemical pesticides has resulted in contamination of the environment and also caused many associated long-term effects on human health [3]. The presence of pesticide residues in food commodities has always been a matter of serious concern. The problem is especially serious when these commodities are consumed [4]. Pesticides have been associated with a wide spectrum of human health hazards, ranging from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm and endocrine disruption [5]. The heavy use of pesticides may result in environmental problems like disturbance of the natural balance, widespread pest resistance, environmental pollution, hazards to non-target organisms and wildlife, and hazards to humans.

Control programmes for pesticide residues in the developing countries are often limited due to lack of resources and rigorous legislation is not in place. The use of pesticides is essential to control pests in horticultural crops for the production of an adequate food supply for an increasing world population and for the control of insect-borne diseases. These pesticides are used to decrease crop loss both before and after harvest [6]. Pesticide residues in food and crops are a direct result of application of pesticides to crops growing in the field, and to a lesser extent from pesticide residues remaining in the soil [7].

In addition, long persistence of some agrochemicals in the environment sets in a series of undesirable effects through contamination of food and feed. The 30 million non-target bioforms, so far safe in the cradle of nature, are rocked with threat of extinction and their numbers are reducing. Bioaccumulation of pesticides and biomagnification processes has become the weak links in the food chain. Among the pesticides that have acquired notoriety, DDT and BHC (HCH, Gammaxane, Lindane) are particularly important. In India, DDT and BHC were the two major chemicals used in agriculture and public health programs. Although now partially banned, they are still very much in use because of their wide spectrum of activity and ready availability at low cost. Our biggest concern is that these molecules are stable in the environment. It is suspected that most of our water bodies and soils are contaminated with these chemicals or with their degradation products [8].

MATERIALS AND METHODS

A mixed stock standard solution of organochlorine pesticide samples containing each at a concentration of 1000 μg/ml were purchased from Supelco (Bellfonte, USA). Organic solvents (residue analysis grade) for dissolving and extracting were acetone, ethyl acetate and cyclohexane purchased from Merck (Darmstadt, Germany). Stock standard solutions were prepared by exact weighing of pesticide reference material and dissolution in acetone. Working standard solutions were prepared by appropriate dilution with a mixture of ethyl acetate/cyclohexane (v/v, 1:1). Stock standard solutions and working standard solutions were stored under refrigeration (4ºC).

Three cities (Hardoi 27°25′N 80°07′E, Faizabad 26°47′N 82°08′E and Barabanki 26°55′N 81°12′E) of Uttar Pradesh, India were selected as the study area. A total of 120 samples of different kind of fresh vegetables (cabbage, lady's finger, brinjal and tomato) were collected from different places of three cities of Uttar Pradesh, India. Samples were analyzed within 24 h, stored at 4ºC until the analysis. All samples were collected according to the method of taking representative sample [9]. All solvents were redistilled from analytical grade supplies while sodium sulphate was soxhlet-extracted before use. Solvent and reagent blanks did not show any peaks when chromatographed. Vegetables were extracted in duplicate using the procedure of already in use [10]. It is also described for hexane soluble insecticides in vegetables [11].

A twenty-five gram sample was macerated with 25 ml of acetone and 100 ml of hexane (3 min). The upper layer was washed in a separating funnel successively with 1×200 ml and 2×100 ml portions of 2% sodium sulphate solution; 75 ml of the hexane layer was dried with anhydrous sodium sulphate and concentrated to 5 ml, ready for clean-up. A Shimadzu GC-2010 (Japan) GC-ECD system equipped with autosampler, split injector with Capillary Column Rtx®-5MS (30 m long 0.25 mm diameter and 0.25μ m film thickness). Column temperature program was from 190^0C to 230^0C at 1.5^0C min^{-1} with hold time for 2 min and 22 minute respectively. The carrier gas was helium with flow rate of 1.2 ml/minute and split ratio was 10:1.

RESULTS AND DISCUSSION

A total 120 samples of vegetables (cabbage, lady's finger, tomato and brinjal) were analyzed. In the analyzed samples 14 different pesticides were found. Frequency, concentration and identity of pesticides found in the analyzed samples are outlined in table 1. Of the 120 samples analyzed, in 70 (58.33%) no pesticide residues were detected. 34 (28.33%) samples contained pesticide residues at or below MRLs established by either the Croatian Legislation or the European Union (EU). 16 samples (13.33.%) contained pesticide residues above MRL. MRL values were exceeded most often in Brinjal. The highest concentration of pesticide residue was 12.6 mg/kg of α-benzene hexachloride. The combination of two pesticide residues was frequent and nine samples (14.52%) contained three pesticide residues. The present study shows a high incidence rate of pesticide residues (mostly fungicides and insecticides) in analyzed samples of vegetables. The most critical commodity is brinjal (Table 2).

Table 1. Pesticide concentration ranges found in the samples.

Pesticide name	Number of positive samples	Min-Max (mg/kg)
Tetrachloro-*m*-xylene	5	0.08
α- benzene hexachloride (BHC)	14	10.87-12.65
β- benzene hexachloride (BHC)	13	4.43-3.23
γ- benzene hexachloride (BHC)	15	3.23-4.54
δ- benzene hexachloride (BHC)	10	5.43-5.98
Heptachlor (HEPT)	4	-
Heptachlor epoxide (HEPX)	6	-
*Trans*chlordane (TC)	6	-
Cis-chlordane (CC)	5	-
α-endosulfan	4	3.23-4.54
β-endosulfan	3	0.54-0.76
p,p-di-chlorodiphenyldichloroethylene (DDE)	7	0.76-0.98
p, p-di-chlorodiphenyldichloroethane (DDD)	12	4.34-5.76
p,p-dichlorodiphenyltrichloroethane (DDT)	11	8.34-5.45

Table 2. Incidence of organochlorine pesticide residues in vegetables of three major markets in Uttar Pradesh.

Vegetable	Number of sample analysed	Number of sample with residues	Incidence of residence (%)
Cabbage	30	25	83.33
Lady's finger	30	23	76.66
Brinjal	30	26	86.66
Tomato	30	20	66.66

The contamination level of pesticide residues could be considered as a possible public health problem. The results also emphasize the need for regular monitoring of a greater number of samples for pesticide residues, especially sample which has to be exported. It is a global concern, as most of the vegetable produced is supplied to different states within a particular country and to different countries all over the globe; hence monitoring of pesticides at local level is very important. Occasionally, residues of pesticides which are not approved for use on a particular crop or food in general were found. Furthermore, the use of most of the OCPs have been banned or highly restricted in such countries as Canada, USA, European countries and Russia since the 1970s [12], replacing them with the less persistent organophosphates and carbamates. Contrary to these, the OCPs are still in use in the developing countries, such as India and Nigeria for increased food production and disease control for the growing population. In 1990 for example, Nigeria, imported 1.65 million tons of insecticides made up mainly of the OCPs. Hence their residue levels in foods were higher in Nigeria and India than in the USA. The residue levels were higher in indian foods [13], compared with most other developing countries.

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