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Translocation of pesticide residues in cabbage

Agyekum, A.A., Ayernor, G.S., Saalia, F.K and Bediako-Amoa, B
Department of Nutrition and Food Science, University of Ghana.

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ABSTRACT
The occurrence of pesticide residues in food matrices has become a necessity due to the toxicity and permanence of these xenobiotics. Translocation of pesticides in local and imported cabbage samples was investigated using Gas Chromatography/Mass Spectrophotometer (GC/MS) procedures. Cabbage samples were fractionated with respect to distance from the skin to the core and prepared for analysis. Results showed that organochlorine, organophosphate and synthetic pyrethroid residues were translocated in cabbage samples analyzed. With respect to cabbage fractions, the outer pulp retained more of the residues than the pulp and the central core. On chemicals species, organochlorines were retained more in the outer pulp than the other fractions of the vegetable. Synthetic pyrethroid residues were restricted to the outer and inner pulp samples. All the chemical species identified were translocatable across the fractional parts of the vegetable with the exception of synthetic pyrethroid residues. There were significant differences in translocation and residue accumulation of pesticide among the fractional parts of the vegetable.

Introduction

Pesticides have been used in agriculture for several decades to control and eradicate pests. Vegetables are prone to insect and disease attacks and pesticides are used widely. Therefore, residues of pesticide could affect the ultimate consumer's health especially when freshly consumed. Pesticides have been linked to 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. Chronic health effects may occur years after even minimal exposure to them in the environment, or result from their residues ingested through food and water (Fong, Moye, Siber, & Toth, 1999). The incidence of pesticides in food receives worldwide attention because they are widely used in agriculture to control organisms that spoil the crops.

Pesticide residues may be translocated via the non-living continuous cell wall phase (apoplast), via the living continuous protoplasmic phase (symplast) or across the mesophyll and into the phloem and then be translocated in the assimilation stream (Ebeling, 1963). The kind of such chemical residues depends on the nature of the pesticide, on the pre-harvest interval, and the conditions under which the crops are stored.

This paper looks at the translocation of chemical pesticides across the fractional parts of cabbage.

Materials and Methods

Sampling

Freshly harvested cabbage was sampled from farms in the Akuapem and Accra areas. Imported samples were obtained from three supermarkets in Accra.

Sample Preparation

Where appropriate stones and stalks were removed and each sample homogenized. Appropriate representative sub-samples were bagged, sealed and labelled accordingly based on their treatments for analysis and storage. Cabbage samples was given three treatments; whole, outer pulp and inner pulp. The outer pulp measured three centimeters (3cm) from the core.

Extraction

Sub samples of the prepared matrices (20 ± 0.1g) were weighed into sample bottles. Forty mL (40± 0.2 ml) of ethyl acetate were added to the sample and macerated for 30 seconds. Twenty grams (20± 0.1g) of anhydrous sodium sulphate and five grams (5 ± 0.1g) sodium hydrogen carbonate were added to the sample and macerated for a further 90 seconds. Samples were centrifuged at 3000rpm for 5 minutes. Aliquots of (4ml ≡ 2.0g) for organochlorines and (10ml ≡ 5.0g) for organophosphates and synthetic pyrethroids were pipetted into a round-bottomed flask (50ml). Extracts were evaporated to dryness in a rotary film evaporator (RFE, Bibby RE 200) at 35°C.

Determination / Quantification of Synthetic

Pyrethroid/Organochlorine and Organophosphate, Pesticide. Quantification of synthetic pyrethroid/ organochlorine/ organophosphate pesticides were performed using a Varian CP-3800 GC-MS with a CP-8400 Autosampler with an analytical gas column (30m + 10m) EZ guard 0.25mm internal diameter fused silica capillary coated with VF- 5ms (0.25µm film).

Aliquots of 1-2µl were injected into a GC/MS Model. The oven temperature was programmed from 80°C to 180°C at a rate of 25°C/minute for synthetic pyrethroids, 70°C to 200°C for organophosphates and70°C to 180°C and then increased to 300°C at a rate of 5°C/minute for organochlorine and organophosphates and increased to 250°C, held for one minute. Injector temperature was 250°C. The gas flow rate was: Helium 1.3ml/minute constant flow.

To examine the efficacy of extraction and cleanup, three samples of each batch were spiked with known concentrations (2µg/ml) of organochlorine, organophosphorous and synthetic pyrethroid standards. The limit of determination was set at 0.1mg/kg which equates to a calibration standard concentration

Tele:
E-mail addresses: agyekumakwasiakomeah@yahoo.com

of 0.125µg/ml. Blank analyses were performed in order to check interference from the sample. All analyses were carried out in triplicates and the mean concentrations were calculated based on the total number of samples.

Reagents

All solvents were purchased from BDH Laboratory Supplies, England and were of analytical, HPLC and pesticide grades. All equipments in the laboratory analysis were washed with water and soap, and rinsed with acetone before use.

Results and Discussion

Cabbage

The figure below shows the distribution of pesticide residues in fractional parts of cabbage. The outer pulp had the highest frequency of organophosphate and organochlorine pesticides. Synthetic residues were found in inner and outer pulp samples.

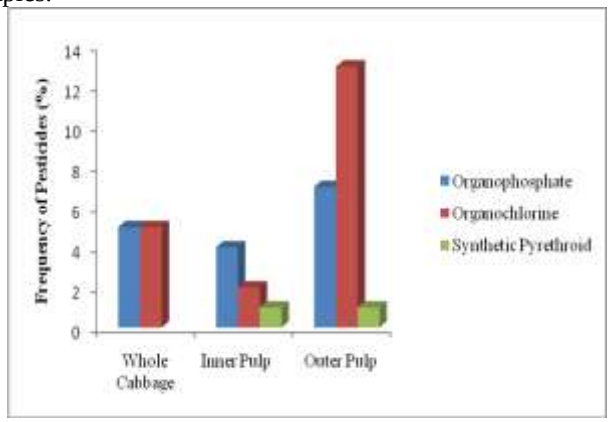

Fig 1.0 Distribution of pesticide residues in fractional parts of cabbage

The outer pulp and whole cabbage samples were found to have the highest level of organochlorine and organophosphate residue contamination. Ethoprophos, fenitrothion and parathion were specific to the outer pulp and this may be due to the hydrophobicity of the pesticides. The absence of ethoprophos, parathion and fenitrothion in whole cabbage and inner pulp samples may be attributed to the dilution of the chemical and the sensitivity of the mass spectrometer. The outer pulp samples were found to have the highest levels of organochlorine contamination.

These pesticides are the extracuticular residue, which adheres to the waxy layer or resident on the peels (Abou-Arab, 1998). However aldrin, delta (δ)-HCH, beta (β) - HCH, γ-chlordane, heptachlor, β-endosulfan, endosulfan sulfate and lindane are persistent in soils, global transport, distribution and toxicity and their occurrence could be due to previous use (Gonzalez *et al*., 2003). The presence of detectable residues of HCB in samples may indicate that HCB has been released into the environment as a by-product from industrial processes and waste incineration (van Birgden, 1998) rather than from its agricultural use as a fungicide. Beta (β)-HCH and δ-HCH isomers detected in most of the samples indicate that technical HCH and Lindane has been used widely. It may also be attributed to the persistent nature of these chemicals which are lipophilic in nature and may move long distances in surface runoff or groundwater thereby contaminating water bodies that are used for irrigating most horticultural crops. The differences in residue levels across fractional parts of the crop can be attributed to plant morphology which affects organochlorine uptake and distribution.

The residue level of organochlorine pesticides (OCPs) depends on the balance of inputs and dissipation (such as decomposition, leaching and volatilization) and is affected by many factors including application history, agric practices (Boul *et al*., 1994; Spener *et al*., 1996, Wang *et al*., 2006), physiochemical properties of soil such as soil organic matter; pH and water content (Boul 1996; Wenzel *et al*., 2002; Gong *et al*., 2003, 2004 Zhang *et al.*, 2006).

Conclusion

Through translocation or diffusion, pesticide residues were found across the fractional parts of cabbage. There were differences in residues across the fractional parts.

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