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Contamination and Safety Status of Plant Food in Arab Countries

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Abstract: Contamination of crop samples by organic chemicals has become a pressing problem in many Arab countries. This paper reviews the contamination levels of plant food in and correlates it with the associated health risk. Safety status was assessed by comparing the current contamination level with that of world health organization (WHO) maximum residue limits (MRL). A range of low contamination levels were detected in cucumber and tomato in Palestine, Jordan and Egypt. Elevated levels of contamination were detected in vegetables from Pakistan, Egypt and in grapes from Jordan. Several poisonous cases and plant food contamination were reported in Morocco, Egypt, Iraq, Saudi Arabia, Sudan, Syria, Jordan, UAE, Pakistan and Yemen in the past years. Further detailed studies of these problem showed accumulation of these organic contaminants in food consumer bodies and farm workers who deal directly with agricultural products. This problem occurred probably due misuse and/or overuse of pesticides in the environment. These contaminants were classified as moderately to highly toxic compounds. These contaminants may have adverse health effects. The suggested satisfactory solutions to these problems is that countries on concerns may implement control measures to reduce pesticide use and awareness programs to enhance food safety.

Key words: Contamination, safety of plant food, contaminants, MRL

INTRODUCTION

Synthetic pesticides has been in wide use for many years ago. Their use has contributed greatly to the increase in world wide food, at the same time improved human and animal health. However, their side effects to non-target organism, including humans. The production of persistent residues in soil, water and plant samples. Some of these pesticides were commercially banned, but many of them are still in use because of their efficacy. Since pesticides are biologicaly active agents are practicaly dangerous when they inter water flux in significant quantities, accumulate in plant samples, or build up in animal tissues. However, pesticides may be introduced to plants from various sources such as direct application, absorption of residues from water and soil and from atmospheric deposition. Environmental contamination by agrochemicals is of growing concern and the level of research directed at improving our understanding of contaminant behavior has increased. However, the progressive increase of production and application of pesticides for agricultural activities has converted the problem of environmental contamination into a national and international issue. For instance, a number of pesticides have been detected in ground water in the United States, Europe and elsewhere in the past year. Contamination of plant food by pesticides has become a problem of growing concerns. This may occur due to either a direct application of pesticides in the agriculture for the purpose of plant protection from pests infestation or from a non-point source of contamination. However, pesticide residues in plant foods have been reported in Egypt[1-5], Jordan[6,7], Palestine[8], Kuwait ,[9] Iran[10] and Pakistan[11]. Non-target application of pesticides may resulted in contamination of 1) honey samples from Lebanon[12] and Jordan[13], 2) human milk in Lebanon[14], Jordan[15], Eygpt [16-18] and Iran [19], 3) chicken eggs from Iran[20] and 4) fish from Jordan[21], Eygpt[22] and Sudan[23]. Application of agrochemicals has resulted in serious problems to non-target organisms and human beings leading to a number of pathological and disturbed biochemical processes[24-29].

This paper reviews contamination of food samples; classification of contaminants to different chemical groups discuss health risk and suggest solutions to reduces contamination levels of food in Arab countries.

Contamination of food samples: Dogheim *et al.*[30] analyzed 2318 fruit and vegetable samples collected from eight Egyptian markets for possible detection of organic contaminants. They showed that 81.5% of the samples were free of organic contaminants and 18.5% of the

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samples contained various concentrations of organic contaminants. Only 1.9% of the contaminated samples had concentrations exceeded MRLs.

Root and leafy vegetables had the lowest contamination rates (4.2%) whereas fruit samples had slightly higher proportion of contamination than vegetables (14.3%). Previous analysis[2] of 397 fruit and vegetable samples showed that 42.8% of samples contained various concentrations of organic contaminants, of which 1.8% exceeded MRLs. The contaminants determined were DDT, HCH, dimethoate and carbaryl.

Common Egyptian foods such as nuts and seeds, spices, herbs and medicinal plants, dried vegetables and cereal grains were contaminated with aflatoxins[31]. The highest prevalence of aflatoxin B1 was found in nuts and seeds (82%), followed by spices (40%), herbs and medicinal plants (29%), dried vegetables (25%) and cereal grains (21%). The highest mean concentration of aflatoxin B1 was in herb and medicinal plants (49 ppb), followed by cereals (36 ppb), spices (25 ppb), nuts and seeds (24 ppb) and dried vegetables (20 ppb). The lowest prevalence and concentrations were in hommos (garbanzo beans). The highest concentrations of aflatoxin B1 were detected in foods that had no potential for field contamination but required drying during processing and storage, such as pomegranate peel, watermelon seeds and molokhia.

Human milk in Egypt were contaminated with DDT gamma-HCH and polychlorinated biphenyls[32]. The DDT complex was the most frequently found, followed by total hexachlorocyclohexane isomers. The organic contaminants had concentration exceeded MRLs. These findings suggest that consumption of such food samples may not be safe at any rate for infants and associated with some health risk due to carcinogenicity of the organic contaminants found.

Imported fish samples (sardine and mackerel) collected from the Egyptian governorate were contaminated with chlorinated hydrocarbon[33]. The detected contaminants were dimethoate, lindane, endrin, heptachlor and malathion. However, a lower frequency was found with aldrin, beta-benzene hexachlor (beta-BHC) and methyl parathion. Imported sardine and mackerel had higher concentrations of lead and chromium than the permissible limits proposed by FAO. However, other metals (cadmium, copper, iron, manganese and zinc) were found at levels lower than the proposed permissible limits.

DDE (1,1-dichloro-2,2-bis(p-chlorophenyl) ethylene) and polychlorinated biphenyls (PCBs) were detected in blood serum samples collected from a 43 females diagnosed with invasive adenocarcinoma of the breast, 21 female suffering benign breast disease and 11 normal healthy females, Port Said region of Egypt[34]. Mean concentrations of DDE detected in the three examined groups of females were 41±5.2, 48±6.2 and 31±2.5 g^{-1} for breast cancer cases, benign breast disease cases and normal healthy females, respectively, indicating significantly less concentrations in blood serum of healthy females. These results show evidence between contamination of DDT and/or its metabolites and developing cancer cases in Egypt.

Grape samples collected from various locations in Jordan contained various contaminants[6]. Data emphasized that 73% of the grape samples contained high concentration of DDT and HCH, only 8.3% of the samples contained high concentrations of organophosphorus (OP) that exceeded MRLs. The wide spread detection of organic contaminants in different plant samples indicate the potential heath risk associated with food consumption. Previous analysis to cucumber samples grown in both plastic house and tunnels showed a decrease of dicofol concentration over time[7]. These findings suggest a safe consumption of cucumber may be reached few weeks after pesticide application. Concentrations of dicofol detected were far below the MRL.

Grape samples from Lebanon were contaminated with HCH, DDT, DDD and parathion[35]. Concentration of the contaminants were below the MRL. Nevertheless, HCH, DDT and DDD are chlorinated hydrocarbon and banned for use in agriculture since 1973 grape due to their carcinogenicity. However, contaminants of gape samples may be associated with health hazards due to possible accumulation of contaminants in the human adipose tissue and cause cancer. Recent analysis determined 5 organic contaminants in honey samples[12]. An explanation of these data suggests a non-point source of contamination occurred either during handling, storage of honey samples or due to a direct treatment of bee cages to eradicate parasites. Some samples contained concentrations violated the value of MRL. Furthermore, breast milk of nursing mothers in Lebanon was contaminated with DDE[14]. Contamination of milk with chlorinated hydrocarbon comes from the fact that milk contains about 5% fat content which can be a partitioning media for low or non-soluble contaminants such as DDT and storied it. Thus consumption of milk may be associated with health risk to infants at any rate. A positive correlation was found between the consumption of either high fat meat, or tuna fish and DDE levels in milk.

Prawns and sea urchin eggs were contaminated with lead in Lebanon[37]. Acra *et al.*[36] emphasized the potential health hazards generated from Lead-glazed pottery when it was used for acidic foods in Lebanon.

The growing incidence of cancer cases among children in Lebanon (average cancer cases 786 case/year)[38] might be attributed to the consumption of contaminated milk samples.

Various contaminants were found in plant samples in Kuwait[9,39]. High concentrations (5-0.66 mg kg^{-1}) of carbofuran were found in apricots and kiwi that exceeded the MRL. Grape samples were contaminated with procymidone (0.32 mg kg^{-1}) and carbendazim (0.5 mg kg^{-1}). Pear samples were contaminated with low concentrations of captain (0.013 mg kg^{-1}) and thiabendazole (0.013 mg kg^{-1}). Orange samples were contaminated with carbendazim (0.4 mg kg^{-1}). Plums samples were contaminated with low concentrations of captain (0.035 mg kg^{-1}) and carrot samples were contaminated with relatively high concentrations of 1-naphthol (1.4 mg kg^{-1}) and 3H-carbofuran (0.64 mg kg^{-1}). Pears, orange, plums and carrots contained low concentrations of 5 contaminants whereas apricots and kiwi samples have concentrations exceeded MRLs. The contaminants that have higher concentration than MRL are extremely toxic class (Table 1).

Thus consumption of these food samples may be risky at present time. However, it is still not obvious weather these samples represent a large section of food consumption. Recent analysis found chlorpyrifos-methyl, fenitrothion, diazinon, chlorpyrifos monocrotophos, dimethoate, omethoate in food samples in Kuwait and revealed a positive correlation between consumption of contaminated food and dietary surveys. Early studies determined various contaminants in breast milk samples, randomly collected from 32 Kuwait donors[40]. DDE concentrations ranged from 127-3333 μg kg^{-1}, averaging, 833 μg kg^{-1}, expressed on a fat weight basis. DDT concentration ranged from 0.6-67 μg kg^{-1} fat and averaged 12.4 μg kg^{-1} fat. The high DDE/DDT ratios may indicate a previous exposure to DDT. Many of the samples contained isomers of HCH, heptachlor-epoxide, aldrin, dieldrin and endrin. These data emphasized the importance of non-point source of contamination. The risk factor associated with consumption of these milk samples comes from the fact that chlorinated organic contaminants found, might be magnified in the human body and pose health hazards.

A wide range of dimethioate concentrations (0.032-1.8 mg kg^{-1}) in apple, banana, brinjal, arvi and Cauliflower samples collected from Islamabad market has been reported[11]. Low concentration (0.004 mg kg^{-1}) of chlorpyrifos was found in brinjal samples. Low concentration of dimethoate and fenvelarate were found in apple and brinjal samples. A relatively high concentration of dimethoate was found in cauliflower, banana and arvi samples. Although the determined concentration of organic contaminants were below the MRl it is still not advisable for consumption due possible bio-accumulations in the adipose tissue.

Early studies in Iran revealed contamination of human milk samples with DDT, HCH and dieldrin at various concentrations ranged between 0.028-0.333 mg L^{-1}[21]. Non of the contaminants concentrations exceeded the MRL. As discussed above consumption of these milk samples may result in health hazards. Nevertheless, accumulative health hazards may occur due to possible bio-concentration of the contaminants in the human adipose tissue. Furthermore, DDT, DDE, BHC, aldren, dieldrin and heptachlor were also found in egg samples[20] and fish samples[11]. Only 5% of the chicken egg samples contained concentrations exceeded MRL value. These findings indicated the importance of non-point source of food contamination and the possible bio-accumulation in human bodies.

Low concentrations of penconazole, endosulfan and triadimenol (3-8 μg kg^{-1}) were found in cucumber samples in Palestine[9,41]. Attabron, triadiminol and endusulfan were found in tomato, potato and peas samples. The results revealed that non of the contaminants have a concentration exceeded MRL. Furthermore, metal accumulation by juvenile land snails, Helix engaddensis and the effect heavy metal contaminated food on mortality rates were recently reported in Palestine[42]. The mortality rates were 20, 27, 30 and 38% among snails fed Cu-, Pb-, Zn- and Cd-contaminated food, respectively. These results indicate the possible accumulation of the heavy metals in the snails and its built up in the food chain. Nevertheless, heavy metals contaminated food may be extremely toxic to human bodies specially children.

Fish samples from Saudi Arabia were contaminated with polycyclic aromatic hydrocarbons (PAH)[43]. The total concentrations of PAHs (benzo(a)anthracene, chrysene and benzo(b)fluoranthene) ranged from non-detectable to 44.9 μg kg^{-1}. PAH contents in fish vary considerably with species; Double bar bream contains the highest while shrimps contain the lowest. These results clearly show that the consumption of fish could be a source of exposure of the local population to PAHs. Since there is a consensus on the substantial contribution of PAHs to cancer in humans. Early studies reported contamination of agricultural commodities (465 samples) and animal feeds (378 samples) with aflatoxine[44]. The contaminants determined were: Diacetoxyscirpenol (3.31-50 μg kg^{-1}); Neosolaniol (6.25-200 μg kg^{-1}); HT-2 toxin (3.31-18.75 μg kg^{-1}); T-2 toxin (6.25 μg kg^{-1}); Nivalenol (3.31 600 μg kg^{-1}); Fusarenon-x (3.25-500 μg kg^{-1}) and Deoxynivalenol (2-4000 μg kg^{-1}). Cadmium (<DL-178.02),

Table 1: Classification of contaminants found

Group A	Group B	Group C	Group D
Aldicarb (0.93) I	Aldren (67) I	Dimethoate (387) I	Bromopropylate (5000) A
Parathion (2) I	HCH (88) I	Fenvalarate (451) I	Thiabendazim (3600) F
Carbufuran (8) I	DDT (113) I	Dicofole (595) A	Captain (5000) F
Monocrotophos (18)	Heptachlor (100) I	Fenitrothion (1700) I	Procymidone (6800) F
	Chlorpyrifos (135) I	Fluvalinate (2000) I	Carbendazim (15000) F
	Dieldrin (46) I	Penconazole (2444) F	Fenuron (6400) H
	Endosulfan (70) I	Triadimenol (1500) F	Thiabendazole (3100) F
	Butocarboxime (153) I	Propargite (2800) A	Vinclozolin (15000) F
	Lindane (900) I	Diazinon (1250) I	
	Endrin I	Malathion (1375) I	

Table 2: Food contamination and associated health risk

Country	Food sample	Contaminant found	Health risk
Morocco	Food oil	TOCP	10,000 death case
Egypt	Wheat flour	Toxafine	1000 death case (caw)
	Exposure to spry	Vosve	25 man
		Tamaron	
Iraq	Wheat seed	Mercury compd.	450 death case
Saudi Arabia	Wheat flower	Endrine	Poison
Sudan	Fish	DDT	Abortion
	Dairy product	Toxafine	
	Wheat flour	Zinc	
Syria	OC and OP		Man and goats
Jordan			Man and wild types
UAE	Animal food	EPN	Cows
Yemen	Qat plant	OP	Man, child, women
		Furdan	Farm workers
		Aldren	Caws
Palestine	Plant foods	Most of pesticide	Cancer
			Biochemical disorders

lead (23.1-1529.) and mercury (<DL-43.573) were reported in rice samples in Saudi[45]. Because the bulk of literature warns against the cumulative effects of prolonged heavy metal exposure, regular consumption of rice by local populations might pose potential health problems.

A positive association was found between pattern of food consumption and the increasing incidence of coronary heart disease in Saudi Arabia[46]. The traditional diet, characterized by a high-fiber content and low in fat and cholesterol has changed to a more westernized diet with high content of fat, free sugars, sodium and cholesterol. Daily per capita fat supplies showed an impressive increase in most of these countries, ranging from 13.6% in Sudan to 143.3% in Saudi Arabia. A high intake of cholesterol is reported in some of these countries.

El-Hag *et al.*[47] studied the pattern and the incidence of cancer in North Saudi Arabia. The incidence of cancer in Al Jouf region appears to be the lowest incidence published to date. The over all pattern of cancer is however similar to the findings in other regions of KSA. Carcinoma of breast, lymphomas and leukemias and color ectal cancers are the leading cancers in the region. These data are similar to those found in Palestine[29,41] and correlated as consequences of overuse of banned pesticides. However, the cases reported in Saudi Arabia may be attributed to the consumption of high fat food[46] which might be contaminated with mycotoxine[44] and/or poly aromatic hydrocarbon[43].

Organic contaminants, DDT and PCBs were determined in milk samples in Iraq[48]. Due to the high fat content of milk and as its acidity is higher than that of plasma, nearly all liposoluble and basic agents consumed by the mother will be excreted in the milk. Contamination of human milk in Iraq occurred due to consumption of fungicide-treated seed wheat by pregnant and lactating mothers. Impact of lead pollution on the environment of Rabat-Sale', Morocco, was reported[49]. It was found that concentrations of lead decreased significantly as we moved away from urban areas. Accumulation and biomagnification of DDT and its metabolites in molluscs and fish of the Moulay Bouselham lagoon, Morocco was reported[50]. DDT and its metabolites, DDE and DDD, were accumulated in the lipids of all specimens. Concentration in clams was highest for samples taken from the mouth of channels draining agricultural land. Organochlorine content was more than 100 ng g^{-1} in some cases in this area, whereas it was less than 40 ng g^{-1} in the rest of the lagoon. Organochlorine content peaked in May and then decreased after egg laying. The higher proportion of DDE than of DDT shows that most of the contamination is not recent. BHC and cyclodienes were also detected, at low concentrations. The contamination of eels and clams in the Moulay Bouselham does not currently pose a threat to public health.

Health impact effects of contaminated food: It is well documented that chlorinated hydrocarbons have been shown to induce mutagenicity, teratogenicity and carcinogenicity to human health. In addition Aflatoxin been shown to cause mutagenicity, teratogenicity and carcenogenicity[51]. Furthermore, acute fatal aflatoxin poisoning may appear as hepatitis[52].

According to acute lethal dose to rat[53] the found organic contaminants can be classified into 4 groups (Table 1).

The numbers between bracts showed the value of lethal does (LD_{50}) that killed 50% of the tested animal. Smaller number indicate higher extreme toxicity.

A) Extremely toxic contaminants such as (Aldicarb, parathion, carbufuran and monocrotophos) which has LD_{50} values less than 20 mg kg^{-1}, B) Highly toxic contaminants (LD_{50} less than 200 mg kg^{-1}), C) Moderately toxic contaminants and D) less toxic contaminants. Identification of organic contaminants (Table 1) show that contaminants of groups A and B are extremely toxic and highly toxic insecticides (I). Contaminants of groups C and D are moderately and less toxic agents and are I, fungicides (F), herbicides (H) or acaricide (A).

It is obvious that contaminated food samples may result in a tremendous death cases, paralysis, or biochemical disorders (Table 2).

Groups A and B are organophosphorus, oxim-carbamate and Organochlorine compounds and are insecticides. Groups C and D are from different chemical classes and are fungicides, herbicide, metabolites and aflatoxin.

The contaminants found are pesticides commonly used in agricultural sectors in many Arab countries for pest control. Thus food contamination occurred via direct application of pesticides to reduce pest infestation during growth season, storage steps or indirect application in public health sector to eradicate mosquitoes and flies.

These food contaminants are hydrophobic compound, thus it could be accumulated in the adipose tissue in the body and build up to a toxic level. Thus food samples containing even low concentration of chlorinated hydrocarbon may be excluded from consumption to reduce associated health risk or exposure. However, food samples should be free from these contaminants to assure safe consumption.

It is obvious that vegetable and fruit samples from all Arab countries are contaminated with several types of contaminants. Milk, fish and egg samples were contaminated with relatively the same chlorinated hydrocarbons. These results indicated the importance of build up of contaminants in the food chain. However, the similarity of the contaminants found in food samples emphasizes similar health risk associated with consumption. It becomes obvious from the growing incidence of non communicable diseases (cancer cases or heart disease) in Saudi Arabia, Egypt, Lebanon and Palestine that a strong positive correlation may exist between consumption of contaminated food and the mentioned diseases. The following steps can be implemented to reduce the contamination levels of food and its associated health risk:

1. Reduced application rate and frequency of pesticide use in agriculture.
2. Use of new formulations and spraying technologies.
3. Use of integrated pest and crop management systems.
4. Enforcement of pesticide and contamination low.
5. Enforcement of post harvest stay after pesticide application.
6. Use of organic agriculture.
7. Washing fruit and vegetable samples with water containing low concentrations of cationic surfactants
8. Reduce consumption of fat rich food or enhance or consumption of fat free foods.

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