Pesticide Residue Monitoring and Food Safety

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1.Introduction

Pesticides may be used in a variety of different ways during the production of food. They may be used by farmers to control the growth of weeds, or prevent crop damage by insects, rodents and molds. They may be used on food crops after harvest to prolong their storage life. Pesticides may also be used on animal farms to control insect pests. Sometimes, small amounts of pesticides used in these ways can be found in or on foods. The pesticides found in or on foods are called**"residues".**Some pesticides, eventhough no longer used, persist and remain in the environment.Residues of these pesticides are sometimes found on foodgrown on contaminated soil, or in the fish that live incontaminated waters.

Pesticides can enter the human body through inhalation of aerosols, dust and vapor that contain pesticides; through oral exposure by consuming food and water; and through dermal exposure by direct contact of pesticides with skin. Roughly 90 percent of pesticide intake is ingested with food; much of the remainder has its source in pesticide-contaminated air and water.Across the globe pesticides have been found in human blood, urine, breast milk, semen, adipose tissue, amniotic fluid, infant meconium and umbilical cord blood.

Many fruits and vegetables test positive for pesticide residues, with about one-third of them showing up with multiple residues. Fish are an important part of a healthy diet. Some fish caught in lakes, rivers, oceans and estuarines, however, may contain pesticide residues that could pose health risks if these fish are eaten in large amounts. Eating fish containing pesticide residues may cause birth defects, liver damage, cancer, and other serious health problems.

Researchers reveals that prolonged exposure to pesticide residues may increase the risk of various cancers and neurological problems (such as Parkinson's disease), and impair the immune system. Studies have proved that farmers are at a potentially high risk of developing leukemia, lymphomas, and cancers of organs like the prostate, stomach, skin and brain. Pesticides are linked to chronic health disorders and ailments. Exposure to pesticides can range from mild skin irritation to birth defects, cancers, blood and nerve disorders, hormone disruption, and even coma or death.

In developed country like United States of America, a US delegation consisting of US Department of Agriculture(USDA), US Environmental Protection Agency (EPA) and Food and Drug Administration (FDA) representatives actively participates in setting international limits that are similar to tolerance levels for pesticide residues in food that is traded globally. EPA and FDA reviews the recent findings on pesticide residues in foods, and state and regional intelligence reports on how much pesticide is being used on crops or animals in a region.Similarly, FDA obtains information on pesticide usage from other countries that export foods to US. The informationhelps FDA plan on the types of foods to monitor and howmany samples to analyze. It prioritizes foods to be tested according to how much of it is typically eaten. The food is also monitored for pesticides that are no longer used in

thecountry but are long lasting in the environment, such as the insecticides DDT, chlordane, dieldrin and toxaphene. FDA has used methods that monitor food samples for different pesticides and break down products. A second type of monitoring is called "Incidence or Level Monitoring". Under this program, FDA tries to determine how often a certain pesticide is found on a particular crop.

FDA conducts a third kind of food monitoring called the "Total Diet Studies" to analyze pesticide residues that remain in a typical meal. Some examples are: chocolate milk, boiled eggs, chicken nuggets, pork and beans, bread, banana, french fries, macaroni and cheese, ice cream, popcorn, honey, butter, lemonade, and infant and children's foods.

2. Maximum Residue Limits (MRLs)

AMaximum Residue Limits (MRLs) for pesticides are established in most countries to safeguard consumer health and to promote Good Agricultural Practice (GAP) in the use of insecticides, fungicides, herbicides and other agricultural compounds.

Maximum residue limit or MRL is the maximum amount of residue legally permitted on food. Once residues are demonstrated to be safe for consumers, MRLs are set by independent scientists, based on rigorous evaluation of each pesticide legally authorized. They act as an indicator of the correct use of pesticides, and ensure compliance with legal requirements for low residues on unprocessed food. MRLs are trading standards used to ensure that imported and exported food is safe to eat. In practice, they allow the free movement of goods within the EU and from the rest of the world.

These MRLs vary from country to country depending on the pesticides available, the crops being treated and the way the pesticides are used. Food exporters must comply with these MRLs as a condition of market access.

3. The United Nations Codex AlimentariusCommission

The United Nations Codex Alimentarius Commission has recommended international standards for Maximum Residue Limits (MRLs), for individual pesticides in food. Since 1962, the Codex Alimentarius Commission (CAC) has been responsible for implementing the Joint FAO/WHO Food Standards Programme. The Commission's primary objectives are the protection of the health of consumers, the assurance of fair practices in food trade and the coordination of the work on food standards.

The CAC is an intergovernmental body with a membership of 165 Member governments. In addition, observers from international scientific organizations, food industry, food trade and consumer associations may attend sessions of the Commission and of its subsidiary bodies. An Executive Committee, six Regional Coordinating Committees and a Secretariat assist the Commission in administering its work programme and other activities.

The work of the Codex Alimentarius is divided between two basic types of committees: Nine general subject matter(s) Committees that deal with general principles, hygiene, veterinary drugs, pesticides, food additives, labelling, methods of analysis, nutrition and import/export inspection and certification systems and Twelve Commodity Committees which deal with a specific type of food class or group, such as dairy and dairy products, fats and oils, or fish and fish products.

The work of the Committees on hygiene, fish and fishery products, veterinary drugs and import/export inspection and certification systems is of paramount interest to the safety and quality of internationally traded fish and fishery products. The specific Codex food safety provision include the maximum residue limits for pesticides and veterinary drugs, the maximum level of use of food additives, the maximum levels of contaminants, and food hygiene requirements of Codex standards.

4. Safe level of a pesticide residue

In the United States of America**,** Environmental Protection Agency (EPA) evaluates tests done in experimental animals, and on plant, human or animal cells growing in the laboratory to estimate the health risk to humans from exposure to pesticides. EPA determines how much the pesticide is likely to remain in foods that are grown using the recommended guideline for pesticide use. It pays extra attention to foods that are eaten by children in large quantities, such as apple juice and milk.

To estimate the health risk to humans from exposure to pesticides, EPA determines how much of the pesticide is likely to remain in foods. A computer program is specially developed to estimate health risks, called the "Dietary Exposure Evaluation Model." EPA considers the exposure through food, drinking water, and home use of pesticides. EPA will set a tolerance level for food if the combined exposure from different sources is 100 to 1,000 times lower than the maximum residue limit (MRL) that shows no harmful effects in experimental animals.

5. Monitoring the residue levels of pesticides in food

In developed country like United States of America, Food and Drug Administration (FDA) monitors the levels of pesticides in raw agricultural produce, fish, dairy products and processed foods. Then Food Safety and Inspection Service (FSIS) of US Department of Agriculture (USDA) is responsible for monitoring pesticide residues in meat and certain egg and poultry products.

Both the FDA and USDA work with state agencies to collect and test for pesticide residues in food from different parts of the country. For imported foods, food samples are collected at the port of entry. If a food is found to have any pesticide residue at, or greater than the tolerance level, federal or state officials can remove the food and destroy it. Any pesticide residue that exceeds tolerance levels, or does not meet EPA regulations is reported as “violative”.

6. Maximum Residue Limits (MRLs) of some agricultural chemicals and environmental chemical contaminants on fish, mollusk, crustaceans and food

Maximum Residue Limits (MPL) of some agricultural chemicals and environmental chemical contaminants on fish, mollusk, crustaceans and food are shown in Table 1 to Table 4.

Table 1. Maximum Residue Limits (MRLs)(ppm) of some Agricultural Chemicals on fish in Japan. (Pesticide and food safety in Japan, 2009)

No	Agricultural Chemicals	Perciformes*	Salmoniformes**	Anguilliformes***
1	Aldrin	0.1	0.1	0.1
2	Cypermethrin	0.01	0.03	0.01
3	DDT	3.0	3.0	3.0
4	Endosulfan	0.004	0.004	0.004
5	Endrin	0.005	0.005	0.005
6	Heptachlor	0.05	0.05	0.05
7	Lindane	1.0	1.0	1.0
8	Malathion	0.5	0.5	0.5

***Perciformes** -bonito,horse mackerel,sea bass, sea bream and tuna
****Salmoniformes** –salmon and trout,*****Anguilliformes** –eel

Table 2. Environmental chemical contaminants. Maximum Residue Limits (MRLs) in fish, mollusk and crustaceans. (US. Food and Drug Administration, 1998)

No	Chemicals	US (ppm)	EU (mg/kg)	Food commodity
1	Arsenic	76-86	-	Mollusks, crustaceans
2	Cadmium	3-4	0.05-1.0	Fish,mollusks
3	Lead	1.5-1.7	0.2-1.0	Fish,mollusks
4	Methylmercury	1.0	1.0	all fish
5	PCB	2.0	-	all fish
6	DDT	5.0	-	all fish
7	Dieldrin	0.0	-	all fish
8	Dioxin	-	0.000004	all fish

Table 3. Analysis of wildcaught fish for trace elements and persistent organic pollutants (Food Standards, Australia New Zealand, 2005)

No	Fish	Residue	Average concentra-tion	MRLs
1	Eel	Dioxins Cadmium Copper Lead Mercury DDT PCB	0.00000030 0.005 0.343 0.007 0.211 0.015 0.033	No limit No limit No limit 0.5 0.5 1.0 0.5
2	Lobster	Cadmium Copper Lead Mercury	0.010 2.821 0.005 0.048	No limit No limit No limit 0.5
3	Mackerel	Dioxins Cadmium Copper Lead Mercury	0.00000031 0.023 0.685 0.006 0.072	No limit No limit No limit 0.5 0.5
4	Prawn	Cadmium Copper Lead Mercury	0.02 3.634 0.009 0.040	No limit No limit No limit 0.5
5	Trout	Dioxins Cadmium Copper Lead Mercury	0.00000025 0.006 2.230 0.009 0.126	No limit No limit No limit 0.5 0.5
6	Tuna	Dioxins Cadmium Copper Lead Mercury	0.00000044 0.007 1.515 0.012 0.343	No limit No limit No limit 0.5 1.0

Table 4. Some Maximum Residue Limits (MRLs) in mg/kg on onions registered for use in Australia (DAFF,Australian Government, 2010)

No	Pesticide	Australia	EU	Japan	Malaysia	Singapore
1	Diazinon	0.70	0.05	0.05	Not set	0.50
2	Methyl Parathion	Not set	0.02	1.00	Not set	Not set
3	Aldrin	0.1	0.05	1.00	Not set	Not set
4	DDT	1.0	0.05	0.50	Not set	1.00
5	Endosulfan	0.2	0.05	0.20	Not set	0.20
6	Endrin	Not set	0.01	0.01	Not set	Not set
7	HCH	Not set	0.01	Not set	Not set	Not set
8	Heptachlor	0.05	0.01	0.03	Not set	0.05
9	Lindane	2.0	0.01	2.0	Not set	Not set
10	Cypermethrin	0.01	0.10	0.10	Not set	0.10
11	Pyrethrins	1.0	1.0	1.0	Not set	1.0

Not set – denotes that no MRL has been established, refer to details above for each countries default value**.**

7. Analysis of environmental chemical residues in products of emerging aquaculture industry in Uganda(December 2008)

A study was conducted to analyse market-regulated heavy metals (lead, mercury and cadmium) and organochlorine pesticides in samples of 38 farmed fish comprising Nile tilapia (*Oreochromis niloticus*) (20 samples) and African catfish (*Clarias gariepinus*) (18 samples) from ten selected fish farms in Uganda.

- Lead was detected in all the 38 samples (maximum = 1.08 mg kg^{-1} (dry weight)),
-Mercury in 31 out of 38 samples (maximum= 0.35mg kg^{-1} (dry weight)),
-Cadmium in two samples (maximum = 0.03 mg kg^{-1} (dry weight)).
-Pesticides detected were: 4,4'-dichloro-diphenyl-trichloroethane (DDT) and endosulfan sulphate, which were found in one fish sample (both 0.002 mg kg^{-1} (wet weight)).

The levels of contaminants were below the US Food and Drug Administration (USFDA) action levels and European Union maximum residue limits (MRLs), indicating that such fish have the potential for export to Markets (Bagumire, 2008).

8. Trade problems arising from differing maximum residue levels for veterinary drug and pesticide residues

An international effort is underway to harmonize the procedures and assumptions used for establishing maximum residue levels (MRLs) for residues of veterinary drugs and pesticides. Apparent conflicts in MRLs may not actually reflect differing safety assessments for the residues but may be due to different safety factors, methods of analysis, consumption factors, etc.Equivalence is an important principle in the U.S. position on agricultural trade.

Countries wishing to export food products to the U.S. must demonstrate that their country's residue control programs are equivalent to the U.S. program. From the U.S. export perspective, there have been several instances of trade problems resulting from different MRLs. The most significant was the decision by the European Economic Community not to accept U.S. beef if the animals were administered anabolic steroids. Another example involved the Japanese rejection of U.S. pork because of sulfamethazine residues. These examples illustrate the importance of harmonization to future efforts to facilitate free trade and reduce the resource burden on government regulatory bodies (Carnevale, 2008).

9. Conclusion

Government of the Republic of the Union of Myanmar have expressed concerned about the toxic effects of pesticides on human and wildlife and have initiated regulatory policies to safeguard against these adverse effects of pesticides use. **Pesticide Law was enacted in 1990. Formation of Pesticide Registration Board was issued by the Government of the Union of Myanmar on 25th February 1992 by notification No 2/92.** Under Pesticide Registration Board the technical Committee, with technical personnel from ministries concerned, has been set up for evaluation of pesticide efficacy, quality, pesticide residue, toxicology, occupational and public health aspects and to recommend for registration to Pesticide Registration Board. According to the Law and Procedures, all pesticides to be marketed in the country are required to be registered providing documented data of pesticide identity, quality, efficacy, toxicity, handling and disposal prior to domestic use.

Myanmar has established a Pesticide Analytical Laboratory (PAL) with the technical and financial assistance of FAO. PAL is capable of carrying out product and residue analysis.Then pesticides are classified for general and restricted use. Some may be banned or suspended.

Myanmar is participating in PIC procedure implemented by United Nations Environmental Program/Food and Agriculture Organization (UNEP/FAO) and the Director General of Department of Agricultural Planning, Ministry of Agriculture and Irrigation is acting as designated national authority for pesticide import. The country is receiving the Decision Guidance Document (DGDs) from UNEP/FAO and responding to the decision of import accordingly. **Taking into account of the criteria in DGDs and the country's experience, pesticides of highly toxic to fish, wildlife and humans are banned from use in Myanmar (Table 5).**

Table 5.Banned pesticides in Myanmar
(Pesticide Registration Board, 2010)*

No	Pesticide	Used Category
1	Aldrin	Insecticide
2	BHC	Insecticide
3	Captafol	Fungicide
4	Chlordane	Insecticide
5	Chlordimeform	Insecticide
6	Cyhexatin	Insecticide
7	Dieldrin	Insecticide
8	Dinoseb	Herbicide
9	EDB	Fumigant
10	Endrin	Insecticide
11	EPN	Insecticide
12	Inorganic mercury compounds	Fungicide
13	Organic mercury compound	Fungicide
14	Parathion Ethyl	Insecticide
15	Strobane	Insecticide
16	2,4,5-T	Herbicide
17	Toxaphene	Insecticide
18	Monocrotophos	Insecticide

*** Personal communication**

In order to prevent an increasing number of pesticide-related human deaths, Myanmar Pesticide Registration Board is insisting that all pesticide applicators have proper training and certification.

The contamination of food from the indiscriminate use of pesticides is a common problem.The residues in crops at harvest must be maintained below the maximum residue limits. The government officials of Myanmar have expressed concerns over residue problem in both domestic and export markets.

The residues in crops at harvest must be maintained below the *Maximum Residue Limits* (MRLs) set by the Government of the Republic of the Union of Myanmar and international organization. Acceptable residue levels are based on an estimate of level of pesticide residue intake below which the risk to health is too small to be a concern. This level is known as the **"Acceptable Daily Intake" (ADI)** and is defined as the amount of residue that may be consumed every day during an individual's active lifetime that no harm will result. The FAO/WHO Codex Alimentarius Commission sets international standards of MRLs and ADIs for agricultural crops intended for international trade. **The Pesticide Registration Board of the Government of the Republic of the Union of Myanmar adopts these standards to ensure that safety levels of pesticide residues in food are not violated.**

References

Amaranini, S.R., (2009):***Concentrations of PesticideResidues in tissue of fish from Kolleru Lake inIndia***.**Environmental Toxicology and Water Quality.** 550-556

Bagumire, A.,(2008):***Analysis of Environmental Chemical Residues in Products of emerging Aquaculture Industry in Uganda***.**Food Additives and Contaminants**. 1(2): 153-160

Bingham,S.,(2007):***Pesticides exceedingenvironmental quality standards.*** **The EnvironmentAgency, UK.** Retrieved on 2007-10-10.

Carnevale, R.A., (2008):***Trade problems arising from different Maximum Residue Levels (MRLs)***.**International Journal of Toxicology. 418-421.**

Codex Alimentarius Commission. (2007): ***Code of Ethics for International Trade in Food.*** Retrieved on 2007-10-25.

Cope, O.B., (1965):***Agricultural Chemicals and Freshwater Ecological Systems***. **Research in Pesticides**, Academic Press. p. 113-128

DAFF. (2010):***Maximum Residue Limits (MRLs) for Pesticides registered for use on Australian Onion***.**Information Bulletin.** Australian Government, Department of Agriculture, Fisheries and Forestry.

Darco, G., (2007):***Levels of Organochlorine Pesticides Residues in Meat.*** **International Journal of Environmental Science and Technology.** 4(4): 521-524

Ecobichon, D.J., (1999):***Machanisms of Pesticide Toxicity.***Environmental Toxicology. Published by International Center for Environmental and Industrial Toxicology (ICEIT).2:3312-351

ECPA.(2000):**What is a Miximum Residual Level**. Published by European Crop Protection Association. Brussels. Belgium.

Environmental Health and Safety. (2009):***Health Effects of Toxic Chemicals***. **Human Resources and Equity.** University of Toronto.

FAO., (2008). **Assesment and Management of seafood Safety and Quality.** FAO CorporateDocument Repository.

Food Standards Australia New Zealand. (2005):***NationalResidue Survey Report on Wildcaught Fish and Aquaculture.***Report on a Survey of Chemical Residues in Domestic andImported Aquaculture Fish. Food regulatory agencies in all AustralianStates and Territories. 13-24

IPCS. (2008): **The *WHO Recommended Classification of Pesticides by Hazard and Guidelines toClassification 2007-2008*. FAO. International Code of Conduct on Distribution and use of Pesticides. Rome.**

Kyaw Myint Oo. (2001):***Half-lives of biological Activities of some pesticides in water***. **NAGA. ICLARM Quarterly. International Center for Living Aquatic Resource Management. Penang, Malaysia.** 24(3&4): 15-18.

Kyaw Myint Oo. (2006):***Safe use of some moderninsecticides in rice-fish culture***. **Journal of Myanmar Academy of Technology.** 6(1&2):1-7.

Pesticides and Food Safety in Japan. (2009): **Report of Maximum Residue Limits for Agricultural Chemicals in Food.** Government of Japan, Tokyo.

Pesticide Residues Committee. (2002**)**: **Pesticide Residues Monitoring Report, Quarterly Result.**

Somchit, N., (2009):***Persistent Organic Chemicals inMalaysian Waters.***Research Journal of Environmental Toxicology.** Academic Journal Inc.3(2): 101-112.

Than Aye. (2003):***Some Technical Aspects of Pesticide Registration in Myanmar.*** **Symposium on Poisoning and Toxicology.** Myanmar MedicalAssociation. Eleventh Medical SpecialitiesConference. 9-17.
US. Environmental Protection Agency. (2007):**Pesticides and Food: What the pesticide residue limits are on food**. Retrieved September 15, 2007.US.
US. Environmental Working Group for PesticideResidue. (2008):***Residue in Food and Vegetable***. Copyright. Food for Thought. Inc.
US. Food and Drug Administration. (1998):***Assessment and Management of Seafood Safetyand Quality***. US. Fisheries and Aquaculture Department.
http://www.apeda.com/tradejunction/Report/December_2009/Japan Pesticide_and_Food_Safety_regulation_report.pdf
http://www.docstoc.com/docs/25703622/Japanese-Safety-Regulation-System-on-Imported-Foods-and-Vegetables