REPORT OF EXPERT GROUP ON

APPROPRIATE TECHNOLOGY FOR IDENTIFYING CHEMICAL CONTAMINATION IN DIFFERENT CONDITIONS

THAILAND

Technical Division
Food and Drug Administration
Ministry of Public Health

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Contents

1. Acknowledgments

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Abstract

Expert group on appropriate technology for identifying chemical contamination in different conditions

The objectives of this expert group are to review and select appropriate technology for determination of chemical contaminants of various types in food to be recommended for wide use in rural areas. The general situation in the country is reviewed and the major groups of chemical contaminants in food are identified, i.e. pesticides, heavy metals, natural toxins, veterinary residues, chemicals misused in food, and toxic chemicals originating from containers. Questionnaires were designed and sent out to forty-four concerned agencies of which 41 responded, in order to survey type of studies, methods of analysis, references and instruments used. In addition, the expert group recommended that appropriate technology for assessing chemical contamination be simple, practical, rapid, reliable, economical,sensitive, and accurate.

The only tests found to meet these criteria were sodium dithionite, benzoic acid, nitrate, nitrite, sodium bisulfite. For determination of pesticide residues most concerned experts recommended the thin layer chromatography method. In addition, the Minicolumn-UV-Vis. Spectrophotometer was selected as the best method for field survey and primary screening of Aflatoxin and spectrophotometer was recommended for determination of antibiotic in meat.

3. Introduction

Chemicals have become basic elements and indispensable parts of present day societies, sustaining human activities and development. Their consumption increases every year in conjunction with modern technological development. Although the applications and benefits of these chemicals are well-established, they may exert adverse effects on human health and environmental integrity. One of the problems facing all governments is the increase in number of cases of poisoning. Methods must be developed to more easily recognize the association between the incidence of certain diseases and exposure to certain natural and synthetic chemicals. Many scientists and regulatory agencies have expressed concern over the presence of chemical residues in food, water and the environment, and their potential health hazards, particularly exposure to genotoxic chemicals which may result in cancer or heritable mutation disorders.

In response to this concern, the WHO project on controlling and reducing health hazards of consumers, workers and environment has provided support for an expert group on appropriate technology for identifying chemical contaminants in different conditions. The Food and Drug Administration was appointed by the Ministry of Public Health to undertake this project.

The main task of this expert group is to review and select the appropriate technology for various types of chemical contamination in foods to be recommended for wide use in rural areas. Hence, consumers may be better protected against health hazards improved monitoring of food and food products.

4. Objectives

General Objectives of this study are to reduce health hazards of comsumers, workers and the environment by using appropriate technology to assess chemical contamination of various types. A specific objective is to review and select appropriate technology for determination of chemical contamination of various types of food to be recommended for wide use in rural areas.

Further specific aims are as follows:-

(a) To promote consumer protection by enabling the FDA to carry out faster enforcement by keeping contaminated food off the market.

(b) To support the implementation of research and development of new technology in the field of health and medicine.

(c) To help prevent diseases and reduce health hazards of occupational workers.

5. Procedure for Assessing Technology

5.1 Review the present status of the study of chemical contamination of food and methods for assessing chemical contamination

Since the need for pesticides to maintain food production is beyond dispute, it is therefore necessary to insure that the level of chemical residue is acceptable toxicologically. Pesticides have been used widely in Thailand and the question arises whether pesticide residues pose a threat to human health. An appropriate technology for identifying contamination of pesticides in different conditions is therefore necessary. In addition, contamination by heavy metals such as lead, mercury, arsenic, and tin has caused great concern. Recently, there was an outbreak of arsenic poisoning due to inorganic arsenic contamination in well waters which involved more than a thousand cases at Ron Phiboon, Nakorn Srithammarat Province . Skin effects in the form of hyperkeratosis, hyperpigmentation and depigmentation were observed after exposure to drinking water containing arsenic. Hundreds of water samples were analysed for the level of arsenic. Test-kits for arsenic are now therefore being developed in order to cope with this urgent problem.

Improvement in the efficiency of protecting the health of consumers relies heavily on the ability to determine the kind and quantity of chemical contaminants in food. Even though permissable residues have been established for such chemicals, enforcement efforts are hampered by limitations and prohibitive costs of the analytical methods. In Thailand, the Food and Drug Administration is responsible for establishing chemical contamination levels allowable in food under the Food Act, B.E. 2522, while the Department of Medical Science is responsible for carrying out the analyses. Pesticides are among chemical at great concern nowadays due to their accumulation as food residues that may be harmful to human health, especially in causing high incidence of poisoning in farmers. Methodological improvements are necessary in order to reduce analysis time to keep pace with the development of new pesticides and also to enable faster enforcement by keeping contaminated

foof off the market. At present, the detection of pesticide residues in food relies primarily on multiresidue methods (MRM) which are able to detect large numbers of pesticides in a single food sample (1).

In 1981, Batora et al reviewed simplified analytical methods for pesticide residues and their metabolites (2). One criterion used in judging suitability for screening food and environmental samples is that these methods should accommodate the needs of developing countries. The basic criteria considered in selecting suitable methods were :

1. Methods should be reasonably comparable in sensitivity, precision and accuracy to the gas chromatographic (GC) or liquid chromatographic (LC) methods.
2. Methods should give reliable information in screening for parent pesticides and important transformation and degradation products.
3. Methods should be capable of quantifying residue levels by different techniques with different degrees of sophistication.
4. Methods should be useful for important commodities in international trade and domestic food supplies with an unknown pesticide history.
5. Methods should not require compressed gases or large volumes or high purity organic solvents.
6. Equipment should be relatively inexpensive as compared with GC or LC

By comparing data on the accuracy of TLC and GC it was concluded that TLC is the most convenient procedure for screening and determining groups of pesticides in multiresidue analysis.

Some test kits are now available for commercial use. One is the Enzytec TM which uses the enzyme cholinesterase to detect organophosphorus and carbamate pesticides. It can be used to perform tests for residues on fruits and vegetables, check wheat and other stored grains to assure that residues are within tolerance limits and that sufficient pesticide is present to prevent infestation, to test for pesticides on foliage as a basis for re-entry to sprayed areas,to test for pesticides on the clothing or skin of persons suspected of pesticides poisoning, monitor environments and cleanup after pesticide spills, and detection of pesticides in water supplies. The Enzytec Detection System was evaluated for its applicability by the U.S. FDA (3). It was found that for regulatory purposes, this test system has disadvantages since it can give false negatives and the test procedure used by Enzytec TM on unchopped products and grains cannot detect systemic residues.

Recent developments in test kits are aimed at environmental protection and are designed to test household water and wastewater, quality of natural waters,fish ponds, irrigation water. One example is the Hach test kits.

In Thailand, several simple test kits are being developed by some governmental agencies in order to make the tests more convenient for use in rural areas. Example of such test kits are as follows:

1. A Test-kit for water analysis was developed by the Environmental Health Division, Department of Health, Ministry of Public Health, for use on drinking water in rural areas where no tap water is available. There are two methods used, namely:

1.1 Color reaction method: This method is used to identify or detect acidity, alkalinity, iron, manganese, nitrate, fluoride, chlorine etc. content in water samples. The kit is composed of

- calibrated tube and vessels
- standard color sheet or standard color solutions
- specific chemical reagents or chemicals used for developing a specific color with certain elements in the water sample

1.2 Volume determination of standard solution method: This method is used to determine hardness and chloride ion. The kit is composed of:

- calibrated tubes or bottles for chemical reaction
- indicator (solid or solution)
- known concentration of standard solutions

Sensitivity values of this method are:

- Acidity-alkalinity is effective at the pH range of 4.0-10.0
- Iron in drinking water is sensitive at concentrations of 0-3.0 mg/litre
- Manganese is sensitive at concentrations 0-2.0 mg/litre
- Nitrate is sensitive at concentrations within 0-5.0 mg/litre
- Chlorine is sensitive at concentrations within 0-3.0 mg/litre

2. An Organophosphate insecticide diagnostic kit was developed by the Occupational Health Division, Department of Health, Ministry of Public Health. The kit is used to measure cholinesterase activity in plasma. The principle is based on digestion of acetylcholine on reactive paper by the enzyme cholinesterase. The acetic acid formed by this reaction causes a color change in an indicator correlated directly with the ratio of cholinesterase activity. This method had been studied for specificity, sensitivity, and positive predictive value and found that its ratings for these characteristics are 95.6%, 81.4%,and 94.6%,respectively. The stability of this kit is one year and it must be stored at 4°C. The method is simple and the result can be interpreted within 7 minutes. Each kit contains reaction paper, sterile lancet, forceps, alcohol, dropper, cotton wool and a capillary tube. It is commercially available for 300 baht per kit (for 100 samples).

Another organophosphate insecticide diagnostic kit is the "Tintometer", Which uses the same principle as the above-mentioned kit, the reaction of plasma and acetylcholine perchlorate, with bromothymol blue as an indicator. Its specificity, sensitivity and efficiency values are 97.89%,100%, and 97-92%, respectively. The Tintometer is easy to operate with the result can be interpreted within 20-30 minutes. It is commercially available for 1,000 baht per kit (produced by Occupational Health Division), and 30,000 baht per kit (B.D.H. Lovibond nessleriser, England).

An organophosphate test kit has also been developed to test air samples. The principle is to form a reaction between thiophosphate ester and palladium chloride. It has a sensitivity of 5 ug/ml, and a reliability of 95%.

3. A Lead poisoning diagnostic kit was also developed by the Occupational Health Division to detect lead accumulation by analysing for the presence of urinary coproporphyrin expressed as lead. The principle is based on coproporphyrin accumulation caused by lead interference of blood cell synthesis. Its sensitivity is 84-85%, and efficiency is 98-23%

4. The Department of Medical Sciences, Ministry of Public Health, had developed a plastic minicolumn method to detect aflatoxin contamination in food. This method was scientifically modified from chromatography as used in well-equipped laboratory into a simple minicolumn chromatograph. (4). Results can be interpreted under fluorescence by comparing with a standard tube of aflatoxin at 20 ppb. concentration.

The plastic minicolumn method for aflatoxin detection is used for determination of aflatoxin in food and agricultural products and is suitable for testing the quality of products in rural laboratories. The method should use only inexpensive equipment, be easy to operate by inexperienced persons, and be sensitive enough to detect aflatoxin as low as 20 ppb. (microgram/kilogram) since this level has been established as the limit for food products. With the plastic minicolumn method, aflatoxin can be measured within two hours with an accuracy of lower than 10 ppb.

In Thailand, under the Food Act. B.E. 2522, the Food and Drug Administration has been authorized to establish acceptable levels of chemical contamination as well as to carry out sampling, including the raw intermediate and final products, and exhaustive inspection of food manufacturing storage and distribution facilities. Many agencies have expressed their concern over the presence of chemical contamination in food and drinking water. A large number of research projects as well as some dissertations by graduate students, have been carried out such as the following:

A study in 1972 tested for DDT and its metabolites DDD and DDE in a species of rock oyster, harvested directly from the sea and from a farm culture area . The results showed no detectable amounts of the DDT or its metabolites in the oyster samples. The method used was gas liquid chromatography (5).

The concentrations of nitrate and nitrite in various Thai preserved protein foods containing common salt and water were determined by using the AOAC (1975) method. Nitrate was found in all kinds of preserved foods examined in rather high concentration (between 0-24,354 ppm.), whereas nitrite was found at lower concentrations (0-104 ppm.) (6).

The Pesticide Research Laboratory of the Department of Agriculture and Department of Medical Science investigated pesticide residues on and in vegetables and fruits by using gas chromatography from 1962 to 1980, (7). Dr.Prayoon Deema (8), Department of Agriculture reported that 66.6% of 39 vegetable samples analysed by pesticide analytical method found to have pesticide residue over the USDA tolerance limits. The residues found were DDT, dieldrin, endrin and parathion. Vegetable and fruit samples with pesticide residue not more than FAO/WHO tolerances were reported by the Department of Medical Science, but the percentage of vegetable and fruit samples with chlorinated hydrocarbon residue found to increase gradually more than organophosphate residue. The most common residue was DDT. In addition, heavy metals such as Zn, Cd, Cu, Cr, Hg, Pb as well as nitrate, and borax residues, were also reported.

The Background level of borax in Thai food has also been studied (9). Five hundred and forty samples of 180 kinds of food items were tested for the presence of boron expressed as borax, using a colorimetric method which forms a color reaction with an acidic curcumin solution. They found that borax levels in most of the analyzed samples, except beans and spices, were 0.08-39.50 mg/kg. Borax was found in soybean more than in other kinds of bean. However, the highest level (152 mg/kg.) was detected in fennel seed.

In 1983-1986, food additives in 129 northern food samples were determined (10). Benzoic acid or benzoate salt was used as preservative in Moo Yor (Thai style pork sausage), meat-ball and preserved fruits. The amounts of benzoic acid detected in Moo Yor were varied from 0 ppm. to 6,354 ppm. Salicylic acid was found in 2-samples. The 88 percent of Moo Yor samples did not conform the standard. Of meat-balls, 18 percent of samples were not within the standard limit (not exceed 1000 mg/kg) and borax was found in one sample. Saccharin and benzoic acid were found in preserved fruits and vegetable. Nitrate and/or nitrite was detected in 38 samples of Nam (preserved pork, northern region style) the amount of sodium nitrate was 0-1,279 ppm. and the amount of nitrite was 0-518 ppm. Besides, in 2 of 5 samples of chinese sausage, nitrite was over the standard limit. The methods used were as follows :

(a) Borax: Procedure of Ito and Iwaida by the ashed method, using tumeric paper.

(b) Synthetic dye: Paper chromatography

(c) Benzoic acid: TLC and UV-VIS Spectrophotometry, AOAC (1980)

(d) Salicic acid and Saccharin: TLC Chemical Test AOAC (1975)

(e) Nitrate and Nitrite: Diazotization, Tanimura, A. et al, J. Food Hyg. Soc. (Japan) 1975, 18 (1): 11

A study on concentrations of total tin, iron, zinc, cadmium, copper and lead were determined in some types of commercially canned foods including sardines in tomato sauce, green mustard pickles, pineapple in syrup, rambutans in syrup, pineapple juice, tomato juice, sweetened condensed milk and

evaporated milk, by using the AAS method. The results showed that metal contents in all samples did not exceed the tolerance limits established by the Ministry of Public Health, the Thai Industrial Standard Institute and the Codex Alimentaries Commission FAO/WHO (11).

A research study was carried out to ensure the safety of raw materials used in the food supplement production programme i.e. pesticide residues in mung beans, soybeans and sesame seeds grown in Thailand during the rainy season (12). Crop samples representing 80, 70 and 50% of annual production for mung beans, soybeans and sesame seeds, respectively, were collected from major crop growing provinces and analyzed for organophosphate and organochlorine compounds by gas chromatographic methods and for N-methyl carbamate residues by HPLC-post column derivatization. No N-methyl-carbamate compounds were detected in any crops except in one sample of mung beans. DDT the most common insecticide, was frequently found in all 3 crops. BHC, endosulfan, toxaphene, fenitrothion, endrin, dieldrin and some other compounds were also detected, but the very low levels of all residues found indicated that the crops were safe for consumption. No other residues except trace amounts of DDT were found in supplementary food mixture samples.

5.2 Study design and criteria for assessing appropriate technology

The Expert Group reviewed and identified the high-risk circumstances and situations in Thailand for groups of chemicals in connection with a study of appropriate technology. The following groups of chemical were reviewed:

1. Pesticides
2. Heavy Metals
3. Natural toxins
4. Veterinary residues: hormones, antibiotic
5. Chemicals misused in food: borax, dye, sod. dithionite
6. Toxic chemicals migrating from containers

The expert group, composed of experienced scientists from various institutions in related fields, was appointed to undertake the project. After wide discussion in meetings it was agreed that the following activities would be performed :-

1. Design questionnaires to survey the types of study of chemical contamination , methods of analysis, references and instruments used at each institution involved.
2. Set criteria for assessing appropriate technology
3. Review the questionnaires and make recommendations according to the set criteria.

Questionnaires were sent to 44-concerned government agencies, which included 2 research institutions, 19 regulatory institutions, and 23 academic institutions, and 41 questionnaires were returned. They revealed that there were many kinds of chemical contamination of interest to identify qualitatively and/or quantitatively.

Target groups of chemical contaminants can be divided as follows:

- Pesticide,heavy metal residues in fresh agricultural commodities
- Pesticide, heavy metal residues in aquatic products
- Pesticides in environment
- Toxins in aquatic products and agricultural commodities
- Misused of chemicals in food eg. borax, sodium dithionite,dye
- Toxic chemicals migrating from food containers
- Natural Toxins
- Veterinary residues in agricultural commodities
- Miscellaneous

Pesticide residue is the category of greatest interest, being mentioned by 23 agencies. About half of these carry out analysis of pesticide residues in food commodities.

At present, agencies responsible for the analysis of chemical contaminants mostly select the methods used according to the facilities and equipment available in their laboratories. The procedures of analysis may be adapted and modified from analytical references in order to suit their facilities, as well as requirement of the countries which import the products. The methods used can be summarized as follows:

1. Chemical contamination in the environment

1.1 Ambient air

CO : Non-dispersive infrared detection
Pararosaniline/Fluorescence

SO_2 : Non-dispersive infrared detection
Chemiluminescence

NO_2 : Pararosaniline/Fluorescence
TGS
ANSA method

dust, mist: Gravimetric - High volume

O_3 : Chemiluminescence

SO_2, NO_2, O_3, CO: WHO, Selected methods
ASTM Standard part 26
APHA, Methods of Air Sampling and Analysis

Pb : Wet ashing, atomic absorption spectrometric method

particulate matter: Atomic absorption spectrometric method

heavy metals: Color chemical reactions
NIOSH
NAA

hydrocarbons: Gas Liquid Chromatography (FID)

suspended particulates: Gravimetric method

silica: NIOSH

pesticide residues, organic solvent: NIOSH method

1.2 Water: ground water, inland water, marine water

pesticide residues: - Extraction - GC (ECD)

- GC methods for the determination of organochlorine pesticides (Standard methods for the examination of water and waste water, APHA, AWWA, WPCF)
- Color development
- PAM. US. EPA
- GTZ
- JICA

arsenic: - Standard methods for the Examination of water and wastewater 16th ed. 1985

- simple test kit developed by the Environmental Health Division

heavy metals: - Digestion - AAS

- Extraction - AAS
- Simple test kit for water analysis,developed by the Environmental Health Division
- NIOSH - AAS

1.3 soil and sediments

pesticide residues: Extraction - GC (ECD), HPLC

- TLC

Spectrophotometer

heavy metals: - Extraction - AAS

- Methods of Soil Analysis, American Society of Agronomy, Inc., Madison, Wisconsin, USA

herbicide residues : PAM. US. EPA
- J.AOAC
- Residue Review
- J. Analyst
- J.Weeds
- and other specific methods from Pesticide manufacturers

arsenic: Standard methods for the examination of water and wastewater, 16th ed. 1985

aflatoxin: - Environmental Carcinogen Selected Methods of Analysis Vol. 5
- Japanese Standard Methods Manual,1978

tetrodotoxin: Food Hygiene Inspection Manual 1978, Food Hygiene Association, Tokyo, pp. 232-240

formalin: - AOAC 1975

phytotoxin: Microbial Toxins Vol. VIII

antibiotic

chloramphenicol: Wal J., Peleram J. and Bories G. High Performance liquid chromatographic determination of chloramphenicol in milk, J. Assoc, Off. Anal. Chem. 63 (5): 1980

sulfonamide: - Spectrophotometry : Tishler et. al (1968)
- Indirect AAS

hormones (DES): AOAC

growth regulator

(i.e. morantel residue) : J.AOAC 1986

borax: - AOAC 1984
- Tumeric testing paper method
- Ignition method

dye: - Manual of Food Quality Control

- Colors for Food, Drug, and Cosmetics, Reprinted from Encyclopedia of Industrial Chemical Analysis, Vol.10, 1970

sod. dithionite: - Modified Rankine Method

- Chemical reaction, color developing

nitrate and nitrite: - Colorimetry. (Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology, 1980)

2. Chemical contaminant in fresh agricultural commodities and food

pesticide residues:
- Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives, by Gunter Zweig
- J.AOAC (Vol 64, No. 3, 1981)
- Pesticide Analytical Manual US.EPA Vol. I-IV
- J. Analyst, Luke Ma et, al
- Neutron Activation Analysis
- J.Agric. Food Chem.
- J.Environ Contam. Tox.

heavy metals:
- Dry ashing solvent extraction, AOAC (1980-1984)
- Manual of Food Quality Control
- HPB - FC - 5
- Neutron Activation Analysis
- Food Chemical Codex
- Clinical Analysis by AAS varian Techtron 1976
- Colorimetry
- Polarography
- Techniques and Instrumentation in Analytical Chemistry Vol. 5

3. Chemical contaminant in animal feed

heavy metals: - Wet digestion with HNO_3, $HClO_4$ and AOAC 1984

toxins: - CB method from AOAC 1984

- HPLC condition and derivatization modified from J. AOAC 1981, Vol.64,No.6

antibiotics: - Official Journal of the European Communities

growth regulator: - Analytical Abstract 1986, Vol. 48

4. Detection of Chemicals and/or pesticides in blood, plasma, and urine (in farmers or workers)

organophosphate and carbamate pesticide

in plasma: - colorimetry

- spectrophotometry

heavy metals (Pb)

in urine: - Test kit that use UV-light passing through coproporphyrin extraction substance

in urine, blood: - NIOSH
Clinical Chemistry (Weekul Weeranuwat and Kanoknart Chupanya)
Wako reagent

Occupational health and sanitation in factory (heat, light, ray, sound, vibration, atmospheric pressure and chemicals eg. smoke, dust, vapor): - NIOSH method
(globe thermometer, LUX meter, scintillation, survey meter, sound level meter, vibration meter, barometer)

5. Migrated toxic chemicals from food container

- UDC 678.01 : 642
- AOAC Official Methods of Analysis 1984
- Extraction in the Notification of Ministry of Public Health No. 19 (B.E. 2516) and Pb analysis by AAS
- Techniques and instrumentation in Analytical Chemistry Vol 5. (Elsever)

Since there is no single recommended method to identify chemical contaminants and available methods range form rather simple to highly complex using modern sophisticated equipment, the techniques listed above have been adapted and modified to suit most available facilities.

The criteria for assessing appropriate technology were established on the basis of the Gold Standard of Disease Diagnosis (13,14,15).

(a) Simple: Method basic and readily applicable for verifying the identity of chemical contaminants using a limited range of readily available reagents

(b) Practical: Especially where well equipped laboratories are not available

(c) Rapid: Quick verification of the identity in various cases of sample delivery

(d) Reliable: Scientifically taken or modified from analytical references

(e) Economical: Not requiring sophisticated laboratory procedures (such as a lot of solvent, reagent and/or laborabory instruments)

(f) Sensitivity: High ratio of response to change in quantity or concentration

(g) Accuracy: Closeness of results to the "true" magnitude concerned

6. Summary and Recommendations for Appropriate Technology

6.1 Recommendations for appropriate technology

Each expert was assigned to make recommendations for appropriate technology under his or her particular specialty, using the criteria developed. Data from all experts are tabulated in the table below.

Chemical contaminants	Instrument used and recommended method	Limits of determination and other remarks
I. Chemicals		
1. Borax	a) Tumeric paper b) Titration	
2. Heavy metals(Cd, Ni, Hg, Cu, Zn etc.)	Digestion and AAS (AOAC 1984)	0.001-0.01 ug/g
3. Pesticide residues		
3.1 Insecticide residues		
(a) Organophosphorus compounds	TLC (AOAC and Pesticide Analytical Manual Vol I.)	0.1-1.0 ug/g
(b) Organochlorine compounds	TLC	0.5-1.0 ug/g
(c) Carbamates	TLC	0.005-1.0 ug/g
(d) Pyrethroids	GLC (ECD)	0.001-0.01 ug/g
(e) Insect Growth regulator	GLC (ECD)	0.001-0.01 ug/g
3.2 Fungicide residues	TLC	0.1-1.0 ug/g

Chemical contaminants	Instrument used and recommended method	Limits of determination and other remarks
3.3 Herbicide residue	Spectrophotometer	0.05-0.1 ug/g
4. Dye	a) TLC (Manual of Food Quality control) b) Spectrophotometer (AOAC 1984)	
5. Migrating toxic chemical (Pb, Sb, Mn, Cd)	a) AAS (AOAC 1984) b) Ion meter	For regional level For district level
VCM	GLC (FID)	For regional level
6. Sodium dithionite	Titration (Modified Rankine Method)	meets all criteria
7. Benzoic acid	UV-Vis Spectrophotometry	meets all criteria
8. Nitrate, Nitrite	UV-Vis Spectrophotometry	meets all criteria
9. Sodium bisulfite	Titration	meets all criteria
II Biologicals		
1. Antibiotic	TLC and Spectrophotometry	
1.1 Chloramphenicol	Spectrophotometry (Tishler et.al 1968)	
1.2 Sulfonamide	UV-Spectrophotometry	
2. Morantal residue	TLC	
3. Marihuana	Spectrophotometry	
4. Other alkaloids	Chemical test for alkaloids	
5. Aflatoxin	a) Minicolumn-UV-Vis Spect. (Minicolumn method) b) BGYF method	field survey and primary screening only

Chemical contaminants	Instrument used and recommended method	Limits of determination and other remarks
6. Tetrodotoxin	Extraction and a) Bioassay (Food Hygiene Inspection Manual 1978, Food Hygiene Association, Tokyo) b) TLC	For regional level
7. Hormones (DES)	TLC (AOAC)	
8. Air pollutants (SO_2, NO_2, CO, O_3)	Gas analyzer	For district level

Regional level: provincial level, regional medical science center level

District level: including tambon level

6.2 Problems encountered

The chemical contaminants were divided by the experts into two groups, one chemical and the another biological. Apart from the test-kits developed by government and commercial agencies, the data showed that only a few meet all of the required criteria other than those for sodium dithionite, benzoic acid, nitrate, nitrite, sodium bisulfite, borax, and aflatoxin. Some methods for example those recommended for heavy metals, require digestion and use of AAS which is rather sophisticated equipment. In addition, for detection of pesticide residues, TLC was the recommended method. However, TLC recognizes only groups of pesticides and not individual compounds, and hence is more appropriate for screening purposes. In addition, the detection limits are not low enough to be useful for standard residue levels for enforcement proposes.

6.3 Discussion and future directions

Currently, all developing nations are faced with rapid population growth, which brings the problems of poor nutrition and food supply. Improving production of food with adequate nutritional content is a high priority in developing countries. However, not only must food be available in sufficient quantity, but it must be safe for consumption and not endanger the health of the population through infection or intoxication. Modern technology has led to the creation of chemicals, e.g., pesticides,food additives, food flavoring etc. Although growth of food industry has been marked by production of foods of greater convenience for consumers, eg. precooked food and canned food, traditional food habits in different parts of the country may still leave people at risk. For example, northern Thais are fond of eating fermented pork which may carry trichinella larvae.

The causes of food contamination, whether unintentional or intentional, can be categorized into two groups: naturally occuring, hazards and man-made toxicants. Among naturally occurring toxicants, mycotoxin is a serious problem and a cause of morbidity and mortality. The high humidity of the tropics nurtures the growth of certain groups of molds which are capable of producing toxins in some agricultural products, particularly grains, cottonseed meal, legumes and other foods. These molds can produce the powerful carcinogen "aflatoxin" which is capable of producing fatal liver cancer. Microbial contamination causes most food-borne illnesses such as staphylococcal food poisoning, salmonellosis, typhoid and acute diarrhoea. It is estimated that in recent years 80 to 90% of the outbreaks of food-borne illnesses may be attributed to contamination of food by pathogenic bacteria due to ignorance of hygienic practices. In addition, plant toxicants in edible plants and poisonous plants which resemble them (mushrooms, some wild green plants) are important causes of illness in many areas of Thailand.

The two man-made toxicants are pesticides and food additives. The application of pesticide chemicals has grown rapidly in order to provide higher agricultural yields. Yet, there remains the problem of chemical residues in foods that are bioconcentrated through the food chain and ultimately reach humans. Health risks due to pesticide use is directly related to their misuse or mishandling by farmers and users, while chemical additives may cause problems because of ignorance of hygienic practices. There is also concern about misusing of both permitted and non-permitted chemical additives which leads to serious problems of food contamination and safety of these additives.

Reports of food-borne illnesses during 1982-1988 have revealed that acute diarrhoea and food poisoning are major problems.

Reported cases of poisoning and deaths by year, in Thailand

1984 - 1988

Disease	1984		1985		1986		1987		1988	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
1. Food poisoning	36961	30	39782	40	44937	34	52060	34	55338	34
2. Drug poisoning	328	3	326	1	479	8	695	21	629	8
3. Mushroom poisoning	140	3	256	4	193	2	314	4	382	6
4. Cassava poisoning	3	-	1	-	2	-	11	-	10	-
5. Accidental poisoning by petroleum product	3	-	7	-	6	-	10	-	5	-
6. Accidental poisoning by other poison	41	-	44	-	22	4	70	-	65	-
7. Poisoning by other noxious foodstuffs	-	-	14	-	7	1	8	-	26	-
8. Suicide by liquid substance poisoning and drugs	186	7	220	8	757	32	1241	73	2247	122

SOURCE Annual Epidemiological Surveillance Report, Div. of Epidemiology, Office of the Permanent Secretary for Public Health, Ministry of Public Health.

To ensure public safety, food handling, processing and food products must be monitored systematically to prevent health hazards and fraudulent practices.

Recently new legislation, the Pesticide Monitoring Improvement Act of 1988, was enacted in the United States because of deep public concerns over the use of pesticides in agricultural products exported to the U.S.(16). The legislation emphasizes development of a detailed long-range plan and timetable for research that is necessary for the development and validation of

(a) new and improved analytical methods capable of detecting at one time the presence of multiple pesticide residues in food, and

(b) rapid pesticide analytical methods.

Although pesticide residue levels found in the past were generally low, continual surveillance is needed to ensure the safe use of these compounds. Thus, method of detection of pesticide residues recommended by the expert group should be tested at the provincial level in the future. This issue is of wide concern all over the world, in both exporting and importing countries.

Aflatoxin is known as a potent hepatocarcinogen in experimental animals and may cause human health problems. Various foods and foodstuffs have been known to be contaminated with aflatoxin, among them all kinds of edible nuts, peanuts, cereals,dairy products, meat, meat products and also spices. With the evidence that aflatoxin may be responsible for some human diseases, many scientists are attempting to improve the technology for determination of aflatoxin contamination in food. It is suggested that the minicolumn method is most suitable for field survey and primary screening as it can give results within two hours with an accuracy of lower than 10 ppb. It is also commercially available as the OXOID Toxin detection kit, a product of Microtest Research Ltd for Oxoid Ltd., which is a rapid semi-quantitative screening method for the extraction and detection of total aflatoxin (aflatoxins B_1, B_2, G_1, and G_2).

Substances migrating into food from food-contact materials are also of great concern in our country. Although many such materials are made of polymer systems which are usually inert, non-toxic, and do not migrate to food, "monomers" are inevitably present in the polymeric materials as residual reactants, intermediates, manufacturing aids, solvents, and plastic additives, as well as the products of side reactions and chemical degradation. These monomers may migrate into food and may be toxic, e.g. vinyl chloride monomers (VCM) which are known to be human carcinogens (17). Besides those migrating substances which we now analyse (e.g. VCM, Pb, Sb, Mn, Cd), others are also of interest; for example styrene, bis (2-ethylhexyl) phthalate, and acrylonitrile. There is evidence indicating that styrene might be mutagenic and its intermediate metabolite, styrene oxide (epoxide), is strongly mutagenic. Acrylonitrile has been found to be teratogenic in hamsters and rats, and carcinogenic in rats when administered orally or inhaled. Epidemiological studies of workers exposed to acrylonitrile suggest that it may also be a human carcinogen. Bis (2-ethylhexyl) phthalate is considered to be a liver carcinogen in rats and mice, although it appears not to be mutagenic, but its principal metabolite, monoethylhexylphthalate, has been found to be mutagenic in a number of systems (18).

The objective of this project is to promote consumer protection against health hazards by monitoring food and food products using appropriate technology for faster enforcement by authorities under Food Act. B.E. 2522. Since now, the capabilities for analysis at regional level are only for simple contaminants i.e. preservative, color, food additive, aflatoxin, and some heavy metal in water (Pb, Fe, As). In order to expand their capabilities, the central authorities have to modify method or develop technique to suit their facilities, of which we are now interested are antibiotic and aluminum residue analysis. However, a key factor for success in keeping potential hazards to

the minimum is to rely not only on statutory measures but promote cooperation between the business and public sectors. Since industry is responsible for insuring the quality and safety of products, it must undertake the task of securing the necessary toxicological and scientific data base, technological support and analytical procedures and provide such information to meet governmental requlatory reguirements. Industry should have the sense of responsibility to keep an unsafe product out of the market. Thus, self regulatory initiatives by business must constitute part of an effective system of consumer protection.

Lastly, to promote strategies for the solution of food safety problems, public awareness must be increased. One way to increase public awareness is through education and campaigns using all possible means to get attention of consumers,and convince them not to be influenced by the deceptive advertising of unscrupulous food producers and vendors, and to promote proper understanding of safe consumption of food. One of the constraints limiting the achievement of this goal is food habits which varies from country to country and are affected by cultural religions and beliefs which are difficult to alter. To succeed in this activity will require an atmosphere of trust and cooperation among various people, in order to narrow the gap in attaining the goal of health for all by the year 2000.

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ANNEX

Method for assessing contamination of chemical in various group Annex 8.1

Data from governmental agencies

Agencies	Analysis	Target	Method of Analysis	Instrument used
1. Environmental Health Division, The Bangkok Metropolitan Administration	carbonmonoxide	ambient air (for awareness around heavy traffic-jam area)	Non-dispersive infrared detection	CO Gas Analyzer
2. Merchandise Division, Department of Internal Trade	nil	-	-	
3. The Royal Irrigation Department	nil	-	-	
4. Thailand Tobacco Monopoly, Ministry of Finance	Pesticide residue	Tobacco leaves	Analytical Methods for Pesticides, Plant Growth Regulators, and Food Additives Vol 1 by Gunter Zweig	GC

Agencies	Analysis	Target	Method of Analysis	Instrument used
5. Plant Protection Service Division, Department of Agricultural Extension	Pesticide residue	Fresh agricultural commodities (vegetable, fruit)	Assoc. Anal. Chem (Vol. 64, No. 3, 1981)	GC
6. Agricultural Chemistry Division, Department of Agriculture	Heavy metal	Agricultural products (pineapple canned, Baby-corn-canned, cereal, defatted soy flour)	- AOAC 1984 - Manual of Food Quality Control - HPB - FC - 5	AAS AAS - hydried-generator
	Toxin	cereal	AOAC 1984	Densitometer HPLC
	Chemical abuse - Borax - dye	Food (preserved fruit) Food (Refreshment, Candy)	AOAC 1984 Manual of Food Quality Control	Spectrophotometer TLC
	Migrated toxic chemical	plastic container for food	UDC 678.01 : 642	GC AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
7. Office of the National Environment Board	Pesticide residue	fresh water	Extraction - GC (7.1)	GC - ECD
		sediment	Extraction - GC (7.2)	GC - ECD
		fish, mollusk	Extraction - GC (7.3)	GC - ECD
	Heavy metal	Inland water (fresh water)	Digestion - AAS (7.1)	AAS
		marine water	Extraction - AAS (7.1)	AAS
		sediment	Extraction - AAS (7.4)	AAS
		fish, mollusk	Digestion - AAS (7.4)	AAS
	other contaminant		Non-Dispersive Infrared detection	Beckman CO Analyzer Model 866
	SO_2	atmosphere	Chemiluminescence	Beckman NO_x Analyzer Model 952A
	NO_2	atmosphere	Pararosaniline/	Beckman Fluorescent
	CO	atmosphere	Fluorescence	SO_2 Analyzer Model 953 and Horiba AP - 300
	dust, mist	atmosphere	Gravimetric - High Volume	GMN High Volume Air Sampler Model GMWL-2000H

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Ozone	atmosphere	Chemiluminescence	Ozone - Analyzer Beckman Model 950 A/Monitor Labs
	Pb	atmosphere	Wet Ashing - Atomic Absorption	Perkins - Elmer Atomic Absorption
	Hydrocarbon	atmosphere	Flame Ionization	Beckman HC Analyzer Shimadzu Gas Chromatograph
8. Ground Water Division, Department of Mineral Resources	Heavy metal	ground water	Analytical methods for Atomic Absorption Spectrophotometer Perkin - Elmer model 5000	AAS
9. Feed Quality Control Division,	Pesticide residue	Animal Nutrition (Feed)	Transfer to Department of Agriculture	
Department of Fisheries	Heavy metal	Animal Nutrition (Feed)	Wet digestion with HNO_3 $HCLO_4$ and AOAC 1984	AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Toxin	Animal Nutrition (Feed)	CB method from AOAC 1984 HPLC condition and derivatization modified from J. AOAC 1981, V. 64 No. 6	TLC HPLC
	Antibiotic	Animal Nutrition (Feed)	Official Journal of the European Communities	Laminar flow etc.
	Growth regulator	Animal Nutrition (Feed)	Analytical Abstract 1986 Vol. 48	HPLC etc.
10. Agricultural Toxic Substances Division, Department of Agriculture	Pesticide residue	Fresh agricultural commodities (vegetable, fruit, field crops, oil crops, meat, milk, egg, feed, fat & oil)	Pesticide Analytical Manual, Vol. I - IV US. EPA Manual GTZ Publication	GLC HPLC Spectrophotometer TLC
	Pesticide residue	water, soil, sediment	"----------	"----------
	Heavy metal	cereal	J.AOAC 1980 - 1984	Atomic Absorption Spectrophotometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
11. Environmental Health Division, Department of Health	Pesticide residue	river water	Gas Chromatographic methods for the determination of organochlorine pesticide (Standard methods for the Examination of Water and Waste Water APHA. AWWA WPCF)	Gas Chromatographic Instrument
	Heavy metal	- river water, drinking water, rain water, ground water	1. Laboratory level - Atomic Absorption - Spectrometry (Standard Methods for the Examination of Water and Waste Water APHA, AWWA, WPCF) 2. Field level - Appropriate Technology	1. Atomic Absorption Spectrometer 2. Simple kit for water analysis, developed by Environmental Health Division

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Other contaminant	Atmosphere-Ambient air around industrial, commercial and residential area	1. Particulate Metals - Atomic Absorption Spectrometric Method 2. Nitrogen dioxide - TGS - ANSA Method 3. Sulfur dioxide - Peroxide Absorption/Titration 4. Suspended particulate - Gravimetric Method	
12. Occupational Health Division, Department of Health	Pesticide residue (organo-phosphate pesticide only)	The farmers who use pesticide, atmosphere, raw material	Tumbon level - color chemical reaction District level - Color comparation Province level - Color develop	Comparator Spectronic - 20 Spectrophotometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
			Regional Medical Sciences Center (Department of Medical Sciences)	
			- EPA (Central part level) (Laboratory center)	GC
			- EPA	GC
		Water, Soil	Province level	
			- Color develop	Spectrophotometer
			Regional Medical Science Center level	
			- EPA	GC
			Central Part level	
			- EPA	GC
	Heavy metal	Atmosphere	Tumbon level	
			- Color Chemical Reaction	Comparator
			District Level	
			- Color develop	Spectronic - 20

Agencies	Analysis	Target	Method of Analysis	Instrument used
			Province level	
			- NIOSH	Spectrophotometer
			Regional Medical Science	
			Center level	
			- NIOSH	Atomic Absorption
				Spectrophotometer
			Central Part level	
			(Laboratory center)	
			- NIOSH	AAS
		Raw material, water	Province level	
			- NIOSH	Spectrophotometer
			Regional Medical Science	
			Center level	
			- NIOSH	AAS
			Central Part level	
			- NIOSH	AAS
	Silica	Workers who expose to	Tumbon level	
		silica	- Color Chemical	Comparator
		- Ambient air	reaction	

Agencies	Analysis	Target	Method of Analysis	Instrument used
			District level	
			- Color Chemical reaction	Spectronic 20
		atmosphere, raw material	Province level	
			- NIOSH	Spectrophotometer
			Regional Medical Science Center level	
			- NIOSH	Spectrophotometer
			Central Part level	
			- NIOSH	Spectrophotometer
	Pesticide residue (organophosphate and carbamate pesticide only)	Farmers who use pesticide - plasma	Color change of indicator developed by cholinesterase activity	Village-Tumbon level - Testing paper District level - Tintometer Province level - Spectrophotometer Regional Medical Science Centre level - HPLC

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Heavy metal (Pb)	Workers who expose to lead - urine	Test kit that use UV. light passing through coproporphyrin extraction substance	Village-tumbon level - Test kit that black light is used Province level - UV - lamp test kit
		- urine, blood	NIOSH	Province level - Spectrophotometer Regional Medical Science Center level - AAS
13. Office of Food Sanitation Programme, Department of Health	Borax dye	mono-sodium glutamate, pickle tea	- Turmeric Testing paper - ignition solubilizing test by using cold water	- Turmeric paper - aluminium spoon cold water
14. Food Analysis Division, Department of Medical Science	Pesticide residue	vegetable,fruit, cereal, dried nut,fat and oil meat, egg, milk	- Pesticide Analytical Manual Vol. I - Luke method	GC GC

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Pesticide residue	Fish (fresh water), marine animal, salted fish, dried fish	Pesticide Analytical Manual Vol. I-IV	GC
	Heavy metal	plant, vegetable, fruit, meat,milk, egg, fresh water animal, marine animal	14.4	AAS Mercury Analyzer
	Aflatoxin	cereal, flour, nut	Environmental Carcinogens	Densitometer
	Ergot alkaloid	nuts,nut of fat and oil plant, vegetable fat and oil, meat, milk, egg, spice, raw material for animal feed,salted fish, dried fish, mollusk	Selected Methods of Analysis volume 5-Some Mycotoxins AOAC Chapter 26 Natural poisons	HPLC
	Borax	plant, vegetable, fruit, meat,aquatic animal, flour, chemical	14.5	Spectrophotometer
	Sodium dithionite	jaggery, pickle, shrimp paste, dried shrimp, other food	Modified Rankine Method (14.5)	Titration

Agencies	Analysis	Target	Method of Analysis	Instrument used
	dye	coloring agent used food eg. toffee, lozenge, candy, pickle, shrimp paste, dried shrimp, sausage etc.	Colors for Food, Drug and Cosmetics, Reprinted from Encyclopedia of Industrial Chemical Analysis V.10 Copyright 1970	Spectrophotometer
	Formalin	Hen egg, fish, vegetable fruit and etc.	AOAC 1975, 357-358	Spectrophotometer
	Phytotoxin	seasoning food, mushroom (yellow)	Microbial Toxins Vol. VIII	HPLC TLC
	Migration toxic chemical	plastic bottle, plastic cantainer, plastic sheet plastic pipe (PVC)	14.6 - 14.7 14.6 - 14.7	GC AAS
	Antibiotic (Chloramphenicol)	chicken meat, liver	Wal J., Peleram J. and Bories G. High Performance Liquid Chromatographic Determination of	

Agencies	Analysis	Target	Method of Analysis	Instrument used
			Chloramphenicol in Milk J. Assoc, off.Anal.Chem 63 (5) : 1980, 1044-1048	
	Hormones (DES)	chicken meat	AOAC	TLC HPLC
	Growth regulator (Morantel Residue)	Beef, milk	J. AOAC 1986 Vol. 69 No. 4 pp 646 - 651	TLC GLC (ECD)
15. Fishery Technological Development Division, Department of Fisheries	Heavy metal (Hg, Cd)	Tuna, Corper shell, shrimp, cuttlefish	- AOAC methods (1980) - Digestion in Decomposition Vessel	- Mercury analyzer - AAS
	Natural toxin (Tetrodotoxin)	cuttlefish	Food Hygiene Inspection Manual 1978, Food Hygiene Association Tokyo, pp. 232-240	Bioassay (guinea pig)
16. Biological Science Division, Department of Science Service	Heavy metal	vegetable, fruit	AOAC (1984)	Atomic Absorption Spectrometer
	Aflatoxin	corn, peanut	AOAC (1984) 26.032 - 26.036	Densitometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
		agar powder	Japanese Standard Methods of Food Analysis	Spectrophotometer
	Migrating toxic chemical eg. VCM, Pb	plastic bottle for drinking water	AOAC (1984)	Atomic Absorption Spectrometer
		Utensil : dipping tube (plastic) chopstick	AOAC (1984)	Atomic Absorption Spectrometer
	Other toxic contaminant	ambient air (Industrial factory)	Methods of Air Sampling and analysis PHA Intersociety Committee	Depend on various kind of pollutant
		Water (Industrial factory)	Standard Methods for the Examination of Water and Waste water 16th Edition 1985	- AA Spectrophotometer - UV - Vis - Spectrophotometer - Oxygen meter - S.C.T. Meter - oil Content Meter

Agencies	Analysis	Target	Method of Analysis	Instrument used
17. Office of Atomic Energy for Peace	Pesticide residue (Trace, toxic element of pesticide residue eg. As, Hg, Br, Co, Zn)	Vegetable, fruit, rice, meat, fish, mollusk, shrimp, crab, cuttlefish, freshwater and sea	Neutron Activation Analysis (NAA) i.e. INAA and RNAA (attach No. 6.1.1)	- Research Reactor - Freeze-drying apparatus - Gamma Spectroscopy and Data Acquistion
	Heavy metal (As, Cd, Hg, Se, Mn, Cr, Br, Co, Zn, Fe, V, Sb, Mo)	vegetable, fruit, rice, meat aquatic animal and drinking water	- INAA and RNAA - AAS	- Research Reactor - Freeze-drying Apparatus - Gamma Spectroscopy and Data Acquistion and AAS
	W, Pb, Methyl-Mercury, Cd, Zn, Cu, Mn, Cr, Co	fish To develop assay technique	attach No. 6.1.2 - AAS, INAA	GC
	Migrating toxic chemical (Mn)	Blood, hair nail (workers in dry-battery factory) neat	AAS (attach No. 6.1.3)	AA - 6 Model
	Growth regulator (As)		Neutron Activation Analysis	- Research Reactor - Gamma Spectrophotometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Other Toxic contaminant (As, Cd,Cu,Hg,Se,Br, Co,Zn)	suspended substance in ambient air (dust,mist) soil, fertilizer	NAA	- Research Reactor - Gamma Spectrophotometer
18. Medical Department,Royal Thai Army	Pesticide residue	plant,meat,milk product		Capillary GC HPLC
	Toxin eg. aflatoxin, Trichothecene	rice,corn,vegetable plant		Capillary GC
19. Plant Pathology and Microbiology Division, Department of Agriculture	Toxin eg. aflatoxin	corn,peanut,sorghum etc.	AOAC Official Method of Analysis 1984 (modified)	TLC HPLC
20. Poison Center, Faculty of Medicine Siriraj Hospital	Heavy metal (As, Pb, Cd)	vegetable fruit, fish sauce, salt	AAS	AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Borax	cookedmeat ball (beef-chicken,fish), artificial meat	1. Chemical reaction, color developing 2. Spectro 3. Atomic Absorption	
	Sodium dithionite	ginger (fresh) bamboo shoot (pickled), sugar, shrimp paste, fruit (pickled), sugar cooked food	Chemical reaction, color developing	
	Migrating toxic chemicals			
	Pb, Sb	Food canned	AAS	AAS
	Pb	Tooth-brush	AAS	
	Other Toxic contaminant	ambient air	1. AAS	
	(Pb, Trilene)	ambient air (around factory)	2. Cnemical reaction color developing and color comparative by Spectro.	

Attach

Method of analysis and Reference

No. 6.1.1

Method of Analysis

- Neutron Activation Analysis i.e. Instrumental Neutron Activation Analysis Element assayed are Br, Co, Zn, Fe, V, Mn and Radiochemical Neutron Activation Analysis by Combustion technique assay for Hg, Se and Ion exchange for As, Cd, Cu assay
- For water assay, the sample has to be preconcentrated with active carbon firstly, and then assay for various elements by using neutron activation
- Atomic Absorption Spectroscopy is used for Pb assay.

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No. 6,1,3 Using Atomic Absorption Spectrometry technique by chemical extraction of Mn H.T. Delves, G. Shepherd, P. Vinter, Analyst, 96 (1971) 260.

Data from Ministry of University Affairs

Agencies	Analysis	Target	Method of Analysis	Instrument used
1. Faculty of Science, Chulalongkorn University	Pesticide residues	Fresh agricultural commodities	AOAC methodology for anal. Toxicology	GC. UV-Vis. Spect. HPTLC
	Pesticide residues	aquatic animals and water resources	AOAC methodology for anal. Toxicology and EPA manual	UV-Vis. Spect. HPTLC GC
	Heavy metals	Fresh agricultural commodities	EPA manual	AAS ICPS
	Heavy metals	aquatic animals and water resources	-	and UV-Vis. Spect.
	Pesticides	ambient air (storage and/or spray area)	AOAC methodology for anal. Toxicology	GC
	dye	Food	-	UV-Vis. Spect. Chromatography HPTLC

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Hydrocarbons	Water, Sediment and Biota	UV Fluorescence Gas Chromatographic method IOC	Spectrofluorometer GC (FID)
2. Department of Pharmacology, Faculty of Pharmaceutical Science, Chulalongkorn University	Pesticide residues	Fresh agricultural commodities (vegetable, fruit, food)	- Pesticide Analytical Manual Vol. I	GC
	Pesticide residues	aquatic animals and water resources		
		- sediment from Gulf of Thailand	Mestres (1975)	GC
		- water (paraquat)	Baselt (1984)	Spectrophotometer
		- Exposure Pads for farmers (endosulfan)	AOAC (1982)	GLC
		- Exposure Pads for farmers (dimethoate)	EPA (1977)	GLC

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Heavy metals (Cd, Pb, Ni)	Fresh agricultural commodities (Tobacco - in Chieng - mai market, cigarette produced by Thailand Tobacco Monopoly)	Dry ashing solvent extraction AOAC (1984)	AAS
	Borax	Food (meat-ball,pickle)	Colorimetry (Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology, 1980)	Spectrophotometer
	Nitrate and Nitrite	Food (salted-meat, sausage, Chinese-sausage etc.)	Colorimetry (Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology, 1980)	Spectrophotometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Migrating Toxic chemicals	Food Containers (Zinc coated on plastic on ceramic dish)	- Extraction in the Notification of Ministry of Public Health No.19 (B.E. 2516) and - Pb analysis by AAS	AAS
	antibiotic (sulfonamide)	Fresh agricultural commodities (duck's egg hen's egg, plasma)	- Tishler et. al (1968) J.Agr. Food Chem. (1968)	Spectrophotometer Pye Unicam SP-18000
	PCB's level	Sediments (Gulf of Thailand)	Mestres' (1975)	GLC GLC-Ms
3. Department of Sanitary Engineering, Faculty of Engineering, Chulalongkorn University	TSP	Atmosphere	WHO, Selected Methods	Hi-vol Sampler
	SO_2	Atmosphere	ASTM Standard Part 26	Gas Sampler
	NO_2	Atmosphere	APHA, Methods of Air Sampling and Analysis	Spectrometer
	O_3	Atmosphere		Gas Analyzer
	CO	Atmosphere		AAS
	HC	Atmosphere		GC (FID)
	Heavy metals	Atmosphere		AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
4. Faculty of Veterinary Medicine, Kasetsart University	Pesticide residues	Fresh agricultural products (beef, pork, chicken and milk)	- Analysis of pesticide residues, 1977 - U.S. Environmental Protection agency	GC
	Pesticide residues	smoked catfish	U.S. Environmental Protection agency	GC
	antibiotics	Blood-plasma in cow, buffalo, fish, pig and poultry	Microbilolgical Method	-
5. Faculty of Fisheries, Kasetsart University	Antibiotics	Fish and water	Antibiotic assay Bennett et al. 1966 Applied Microbiology 14 : 170 - 177	Micro-incubation plate
6. Environmental Toxicology and Occupational Health Laboratory	Pesticide residues	water	EPA and JICA Method	GC (ECD)
	Heavy metals	Natural water, waste water, blood, urine, workers' hair	NIOSH Method	AAS (Atomic Absorption Spectrophotometer)

Agencies	Analysis	Target	Method of Analysis	Instrument used
Center, Faculty of Public Health, Mahidol University	Pesticide residues	samples of respiration air,	NIOSH Method	GC & other necessary
		ambient air (around industrial factory)	NIOSH Method	GC (ECD)
	Heavy metals	ambient air (quality analysis)	NIOSH Method	AAS
	Heavy metals	soil (quality analysis)	NIOSH Method	AAS
	Clinical Chemistry eg. CBS, Cholesterol Sugar, Viral Hepatitis, Kidney and liver function	Workers' blood; urine	Clinical Chemistry (Weekul Weeranuwat and Kanoknart Chupanya) and Wako reagent	Centrifuge and Spectrophotometer
	Occupational health and sanitation in	Workers	NIOSH Method	Globe Thermometer, LUX Meter

Agencies	Analysis	Target	Method of Analysis	Instrument used
	factory (heat, light, ray, sound, vibration, atmospheric pressure and chemicals eg. smoke, dust, vapor)			Scintillation/Survey Meter/Sound Level Meter/ Vibration Meter/Baro Meter
7. Environmental Science Project, Faculty of Forestry, Kasetsart University	Pesticide residues	water resources	Standard Methods	GLC
	Heavy metals	water resources	Standard Methods	AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
8. Srinakharinwirot University, Bangsaen Campus	Heavy metals	marine animals	Wet ashing with hydrogen peroxide/nitric acid (FAO/SIDA, 1983)	- Atomic Absorption Spectrophotometer
9. Department of Chemistry, Faculty of Science, Srinakharinwirot University, Prasanmit Campus	Heavy metals	seaweed, agar	Food Chemical Codex	- UV-Vis. Spectrophotometer - AAS
	Borax	seaweed, agar	AOAC (1984)	- UV-Vis. Spectrophotometer
	Standard for agar	agar	FCC US. Pharmacopaeia AOAC (1984) IS 5707 - 1970	- UV-Vis. Spectrophotometer
	Migrating toxic chemicals	canned food	AOAC Official Methods of Analysis 1984	- AAS - Ion meter

Agencies	Analysis	Target	Method of Analysis	Instrument used
10. Faculty of Science, Kasetsart University	Pesticide residues	Water and soil from every region part of Thailand	Gas-liquid chromatography AOAC APHA-AWWA-WPCF Anal. Chem. The Analyst Bull. Environ, Contamin, anal. Toxicol	GLC (ECD)
	Heavy metals	Canned fruit	electrochemistry spectrophotometry AOAC Anal. Chem The Analyst Bull. Environ. Contamin. and Toxicol.	ISE analyzer/UV-Vis. spectrophotometer/ AAS
	Pesticide residues	marine fish	gas-liq. chro. and extraction	GC-ECD
	Heavy metals	marine fish	Acid digestion	AAS
	Heavy metals	canal water	electrochemistry AOAC, Anal. Chem.	ISE for Pb

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Other toxic contaminants (Quantitative Analysis of humic acid)	Slush of Makkhasan marsh	IR UV Fluorescence	IR UV Fluorescence
11. Faculty of Science, Mahidol University	Aflatoxin	corn	Thin layer chromatographic method: AOAC official Method of Analysis, 1984	TLC
	Heavy metals	canned food	AAS method. AOAC (1985)	AAS.
12. Department of Biochemistry, Faculty of Medicine, Chieng Mai University	Aflatoxin	Fresh agricultural commodities (corn, peanut, rice, milk)	Extraction and analysis by thin layer chromatography	TLC
	Natural toxins - Mutagen contaminated in consumed food	Herbal medicinal plant and spice used for cooking (plant, vegetable)	Mutagenicity assay	- Salmonella - Microsome test - HPLC

Agencies	Analysis	Target	Method of Analysis	Instrument used
	- Cell capture by chemicals	Lectin (plant, vegetable, plant seed and aquatic animals)	Hemoagglutination assay	L/A plate
13. Faculty of agriculture, Chiang Mai University	Heavy metals (analysis for phosphorus quantity in form of P_2O_5)	Milk product	AOAC 1984	Spectrophotometer
	dye		AOAC 1984	Spectrophotometer
14. Department of Chemical Pharmacy, Faculty of Pharmacy, Chiang Mai University	Pesticide residues (analyse for Organo-chlorine and Organo-phosphorus)	Fresh agricultural commodities (vegetable and fruit)	TLC Spectrophotometer GC HPLC	TLC Spectrophotometer GC HPLC
	Heavy metals	Agricultural products (canned food, rice)	AAS	AAS
	Heavy metals (eg.Pb,Hg,Cu,Zn)	Aquatic animal (fish)	AAS	AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Aflatoxin	dried corn, peanut	TLC Minicolumn method	TLC
	Chemical abuses			
	- Borax	Food (pickle)	Titration	Thermometric Titration
	- dye	Food (Chinese-sausage, jelly,semi-processed noodle)	Paper chromatography Chemical analysis, determining by Spectrophotometry	Spectrophotometer
	Migrating toxic chemicals	canned food	AAS	AAS
	antibiotic	chicken - meat	TLC/Spectrophotometry	Spectrophotometer
15. Faculty of Natural Resources,Prince of Song Khla University	Heavy metals	soil	Standard Methods for the Examination of water and wastewater 15 ed. America Public Health Association ; USA :1981 (ATHA)	AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
16. Faculty of Medicine, Prince of Song Khla University	Pesticide residues	river and canal water mine lake	GC method Ref : - APHA Acrwa-Wpef 1985. Std. method for the Exam. of water and wastewater. 16 th. ed. - NEB Rec. Std. of water and wastewater Anal NEB. PUB. 1987 - 009	GC (ECD) GC
	Heavy metals	fish, shrimp, cuttlefish, river, canal, mine, lake	1. Std. method for the Examination of water and wastewater 16th ed. 1985 2. Clinical Analysis by AAS varian techtron 1976	AAS Varian : AA 1475 AAS.
	Arsenic	soil, water	Std. method for the Examination of water and wastewater 16th Ed 1985	Arsine generator Spectrophotometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
17. Department of Chemistry, Chiang Mai University	Pesticide residues	vegetable, fruit, meat, eg. pork	TLC	Clean up kit and TLC
	Pesticide residues	water in Ang-Kaew reservoir, Chiang Mai University, Mae Ping and In-ta Non	GLC	GC (ECD)
	Heavy metals	vegetable, fruit, milk, meat	1. AAS 2. Colorimetry 3. Polorography	1. AAS 2. Colorimeter 3. Polarography
	Heavy metals	fish	Atomic Absorption Spectrophotometry	AAS
	Borax	cooked beef-ball, pork-ball and chicken-ball	1. Thermometric Titration 2. Potentiometric Titration 3. Colorimetry	1. Titrate kit 2. pH meter (mv and pH recorder) 3. Spectrometer
	dye	soft drink	Polarography	Polarograph
	Boric acid	body talc	Colorimetry	Spectrophotometer

Agencies	Analysis	Target	Method of Analysis	Instrument used
	SO_2	soft drink	Colorimetry	Spectrophotometer
	Benzoic acid	canned food	UV Spectrophotometry	Spectrophotometer
	Migrating toxic chemical	plastic bag	AAS	AAS
	Pb.Cd.Zn,Cu	spoon	AAS	AAS
	antibiotic			
	- Sulfa	chicken and pork	1. Spectrophotometry 2. Indirect AAS	1. Spectrophotometry 2. AAS
	- Chloramphenicol	cow - milk	Spectrofluorimetry	Spectrofluorimeter
	Heavy metal	dust in ambient air	AAS	AAS
		lime		
		soil		
		sediment		
		road surface		
18. Department of Environmental Engineering, Asian Institute of Technology	Pestidide residues	water	GC (Ref. 1)	GC
	Heavy metals	water	- AAS - others that indicated in Ref. 1	- AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Other toxic contaminants	ambient air (NO_2, SO_2, O_3, HC,.....etc.)	Those indicatied in Ref.2 or those indicated by ONEB	
		Soil (heavy metal)	Ref. 3	
	Ref. 1. APHA, AWWA and WPCF (1985), Standard Methods for the Examination of Water and Wastewater, 16th Edition APHA, Washington D.C., USA. 2. APHA (1977), Methods of Air Sampling and Analysis, 2nd Edition, Washington, American Public Health Association 3. Black, C.A., Evans, D.D. White, J.L., Ensminger, L.E. Clark, F.E., and Dinaver, R.C. (1986) Methods of Soil Analysis, American Society of Agronomy, Inc., Madison, Wisconsin, USA.			
19. Department of Chemistry, Faculty of Science, Prince of Song Khla University	Pesticide residues	vegetable, water in the university	Modified EPA and other standard method	Extractor (Separatory funnel) - GC with ECD
	Heavy metals	Modified milk	Standard method and AOAC method	- Spectrophotometer - AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
		Rain water and Song Khla Lake's water (outside part)	Developed and Modified EPA and Standard Methods	- Polarograph - AAS - Spectrophotometer
	Herbicide residues (paraquat)	soil	Developed and applied ICI-Laboratory and other standard method	- Spectrophotometer - Column L.C.
	Other toxic contaminant (assay SO_2, NO_x CO and heavy metal in ambient air eg.Pb,Cd,Zn, Cu)	Ambient air around Song Khla Province	Various standard method	- Palarograph - Spectrophotometer - AAS
	Suggestion : More attention should be paid on method of analysis and sampling technique and also date interpretation so as to achieve the accurately precised analysis result.			
20. Faculty of Pharmacy,Khon Kaen University	Pesticide residues	vegetable fruit,fish, ponds in up-country	Methodology for Analytical Toxicology	GLC TLC

Agencies	Analysis	Target	Method of Analysis	Instrument used
	Heavy metals(eg. Pb, As)	cereal, meat, milk, fish, ponds in up-country	Techniques and Instrumentation in Analytical chemistry Vol.5	AAS
	Hallucinogen contamination eg. Marihuana	Cooked meat-ball,noodle	Clark's Isolation and Identification of Drugs	Spectrophotometer
	Natural Toxin eg. Cyanide, some toxic alkaloid	Consumed plant in up-country eg. cassava, toxic mushroom	Methodology for Analytical Toxicology	Conway Microdiffusion dishes, Spectrophotometer,GLC
	Migrating toxic chemical	Food canned Packed sheet for food Toys	Techniques and instrumentation in Analytical Chemistry Vol. 5 (Elsever)	AAS

Agencies	Analysis	Target	Method of Analysis	Instrument used
21. Institute of Environmental Research, Chulalongkorn University	Heavy metals	Natural water, waste water, sea water, ground water, soil sediment	* 1. Standard Methods 2. Soil Analysis * Using Wet digestion/dry ashing/filtering/solvent extract, depended on the element type and sample nature Ref. 1) APHA, AWWA, WPCF, Standard Methods for the Examination of Waste and Wastewater, American Public Health Asssociation, Washington D.C., USA. 1985 2) ASA and SSSA, Methods of Soil Analysis, American Society of Agronomy and Soil Science Society of America, Wisconsin, USA, 1982.	AAS

Annex 8.2

Method for assessing contamination of specific group in food

Agencies	Analysis	Target	Method of analysis	Instrument used
1. Faculty of Science, Chulalongkorn University	Pesticide residues	Fresh agricultural commodities and aquatic animal	AOAC methodology for anal. toxicology	GC UV - vis. spect. HPTLC
	Heavy metals	Fresh agricultural commodities and aquatic animal	AOAC methodology for anal. toxicology EPA manual	AAS ICPS & UV - vis spect
	dyes	Food	AOAC methodology for anal. toxicology and EPA manual	GC
	Hydrocarbons	Mussel & Oyster	IOC	GC (FID)
2. Department of Pharmacology, Faculty of Pharmaceutical Science, Chulalongkorn University	Pesticide residues	vegetable, fruit, some kinds of food	- Pesticide Analytical Manual Vol. I	GC
	Heavy metals(Cd, Pb, Ni in tobacco leaves)	Tobacco in Chiang Mai market, Cigarette by the Thailand Tobacco Monopoly	Dry ashing solvent extraction AOAC (1984)	AAS
	Borax	cooked meat-ball, pickle	Colorimetry (Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology, 1980)	Spectrophotometer

Agencies	Analysis	Target	Method of analysis	Instrument used
	Antibiotic (sulfonamide)	duck's egg, hen's egg, chicken meat, plasma	Tishler ed. al (1968) J. Agr. Food Chem. (1968)	Spectrophotometer Pye Unicam SP-1800
3. Faculty of Veterinary Science, Kasetsart University	Pesticide residues	red meat, beef, pork, liver, chicken, milk	- Analysis of Pesticide Residues, 1977 - U.S. Environmental Protection agency	GC
	Pesticide residues	smoked catfish	- Analysis of Pesticide Residues, 1977 - U.S. Environmental Protection agency	GC
	antibiotics	Blood plasma in cow, buffalo, pig, poultry and fish	Microbiological Method	-
4. Faculty of Fisheries, Kasetsart University	antibiotics	fish and water	Antibiotic assay, Bennett et al. 1966 Applied Microbiology 14 : 170 - 177	Micro-incubation plate

Agencies	Analysis	Target	Method of analysis	Instrument used
5. Environmental Toxicology and Occupational Health Laboratory Center, Faculty of Public Health Mahidol University	Pesticide residues	water	EPA and JICA method	GC (ECD)
	Heavy metals	Natural water, waste water, blood, urine, workers'hair	NIOSH Method	AAS
6. Srinakharinwirot University, Bangsaen Campus	Heavy metals	marine animal	Wet ashing with hydrogen peroxide/nitric acide (FAO/SIDA, 1983)	AAS
7. Department of Chemistry, Faculty of Science, Srinakharinwirot University, Prasanmit Campus	Heavy metals	seaweed, agar	Food Chemical Codex	- UV - Vis Spectrophotometer - AAS
	Borax	seaweed agar	AOAC (1984)	- UV - Vis Spectrophotometer
	Standard for agar	agar	FCC US. Pharmacopoeia AOAC (1984) IS 5707-1970	- UV-Vis Spectrophotometer

Agencies	Analysis	Target	Method of analysis	Instrument used
	Migrating Toxic chemicals	canned food	AOAC Official Methods or Analysis 1984	- AAS - Ion meter
8. Faculty of Science, Kasetsart University	Heavy metals	Vairous kind of canned fruit	electrochemistry spectrophotometry AOAC Anal. Chem. The Analyst Bull. Environ. Contamin. and Toxicol	ISE analyzer, UV -Vis spectrophotometer AAS
	Heavy metals	marine fish	gas-liq. chro. and extraction	GC (ECD)
9. Faculty of Science, Mahidol University	Aflatoxin	Corn	Thin layer chromatographic method : AOAC official method of analysis, 1984	TLC
	Heavy metals	canned fruit		AAS
10. Plant Protection Service Division, Department of Agricultural Extension	Pesticide residues	vegetable, fruit	Assoc. Anal. Chem. (Vol. 64, No. 3, 1981)	GC

Agencies	Analysis	Target	Method of analysis	Instrument used
11. Department of Biochemistry, Faculty of Medicine, Chiang Mai University	Aflatoxin	Corn, nut, rice, milk product	Extraction and analysis by thin layer chromatography	TLC
	Mutagen contaminated in consumed food	Herbal medicinal plant and spice used for cooking (plant, vegetable)	Mutagenicity assay	- Salmonella - Microsome Test - HPLC
	cell capture by lectin containing food	Lectin (plant, vegetable, plant seed and aquatic animals)	Hemog-glutination assay	L/A plate
12. Faculty of Agriculture, Chiang Mai University	Heavy metals (quantitative analysis for phosphorus in form of P_2O_5)	milk product	AOAC 1984	Spectrophotometer
	dye	modified food	AOAC 1984	Spectrophotometer
13. Department of Pharmaceutical Chemistry, Faculty of Pharmacy, Chiang Mai University	Pesticide residues (Quantitative analysis for organochlorine and organophosphorus)	various kind of vegetable and fruit	-	TLC Spectrophotometer GC HPLC

Agencies	Analysis	Target	Method of analysis	Instrument used
	Heavy metals (Pb, Hg, Cu, Zn)	canned fruit, various kind of rice, fish,	AAS	AAS
	Aflatoxin	dried corn, peanut	TLC Minicolumn method	
	Borax	salted fruit, pickle	Titration	Thermometric Titration
	dyes	Chinese sausage, jelly, semi-processed noodle	- Paper chromatography - Chemical analysis by Spectrophotometry	spectrophotometer
	migrating toxic chemicals	canned food	AAS	AAS
	antibiotics	chicken - meat	TLC Spectrophotometry	Spectrophotometry
14. Agricultural Chemistry Division, Department of Agriculture	Heavy metals	Canned pineapple, Canned baby-corn, defatted soy flour	- AOAC 1984 - Manual of Food Quality Control - HPB - FC - 5	AAS AAS-hydried-generator
	Toxin	cereal	AOAC 1984	Densitometer HPLC

Agencies	Analysis	Target	Method of analysis	Instrument used
	Borax	preserved fruit	AOAC 1984	Spectrophotometer
	dye	soft drink, candy	Manual of Food Quality Control	TLC
	migrating toxic chemicals	plastic container and utensils for food	UDC 629.113 : 612.43.048	GC AAS
15. Office of the National Environment Board	Pesticide residue	fish, mollusk	Extraction - GC (15.2)	GC (ECD)
	Heavy metals	fish, mollusk	Digestion - AAS (15.4)	AAS
16. Feed Quality Control Division, Department of Livestock Development	Heavy metals	animal feed	Wet Digestion with HNO_3 and $HCLO_4$, AOAC 1984	AAS
	Toxins	animal feed	CB method from AOAC 1984 HPLC condition and derivatization modified from J. AOAC 1981, V. 64 No. 6	TLC HPLC
	antibiotics	animal feed	Official Journal of the European Communities	Laminar Flow etc.
	Growth regulator	animal feed	Analytical Abstract 1986 Vol. 48	HPLC etc.

Agencies	Analysis	Target	Method of analysis	Instrument used
17. Faculty of Medicine, Prince of Songkhla University	Heavy metals	fish, shrimp, cuttle-fish	Std. method for the Examination of water and waste water 16th ed. 1985	AAS Varian : AA 1475 AAS
18. Office of Food Sanitation Programme, Department of Health	Borax	mono-sodium glutamate, pickle	- Turmeric testing paper - ignition	Turmeric paper Aluminium spoon
	dyes	tea	Solubilizing test by using cold water	
19. Department of Chemistry, Faculty of Science, Chiang Mai University	Pesticide residues	vegetable, fruit, meat	TLC GLC	TLC GLC
	Heavy metals	vegetable, fruit, milk product, meat	-	AAS Colorimetry Polarography
	Heavy metals	Various kind of fish	Atomic Absorption Spectrophotometry	AAS

Agencies	Analysis	Target	Method of analysis	Instrument used
	Borax	cooked meat-ball (beef, pork and chicken)	1. Thermometric titration 2. Potentiometric titration	1. Titration set 2. pH meter (mV and pH can be recorded)
			3. Colorimetry	3. Spectrometer
	dyes	Sweetened drink, carbonated beverage	Polarography	Polarograph
	SO_2	Beverage	Colorimetry	Spectrophotometer
	Benzoic acid	Food canned, (fruit)	UV. Spectrophotometry	Spectrophotometer
	antibiotic			
	- Sulfa	chicken and pork	Spectrophotometry	Spectrophotometer
	- Chloramphenicol	milk product (cow)	Indirect AAS	AAS
			Spectrofluorimetry	Spectrofluorimeter
20. Food Analysis Division, Department of Medical Science	Pesticide residues	vegetable, fruit, cereal, dried nut, fat and oil, meat, egg, milk	- Pesticide Analytical Manual Vol. I - Luke' MA et. al	GC
	Pesticide residues	Fish (fresh water), marine animal, salted fish, dried fish	- Pesticide Analytical Manual Vol. I	GC

Agencies	Analysis	Target	Method of analysis	Instrument used
	Heavy metal	plant, vegetable, fruit, meat, milk, egg, fresh water animal, marine animal	20.4	AAS Mercury Analyzer
	Toxins eg. Aflatoxin, Ergot alkaloid	cereal, flour, nut, nut of fat and oil plant, vegetable fat and oil, meat, milk, egg, spice, raw material for animal feed, salted fish, dried fish, mollusk,	- Environmental Carcinogens Selected Methods of Analysis volume 5 - Some Mycotoxins and AOAC chapter 26 Natural Poisons	- Densitometer - HPLC
	Borax	plant, vegetable, fruit, meat, aquatic animal, flour, chemical	20.5	Spectrophotometer
	Sodium dithionite (SO_2 residue)	jaggery, pickle, shrimp paste, dried shrimp, other food	Modified Rankine Method	Titration

Agencies	Analysis	Target	Method of analysis	Instrument used
	dyes	coloring agent used in food eg. toffee, lozenge,candy, pickle, shrimp paste, dried shrimp, sausage etc.	Color for food, Drug and Cosmetic Reprinted From Encyclopedia of Industrial Chemical Analysis V. 10, Copyright 1970	Spectrophotometer
	Formalin	Hen egg, fish, vegetable, fruit, and etc.	AOAC 1975, 357-358	Spectrophotometer
	Phytotoxin	seasoning food, mush-room (yellow)	Microbial Toxins V. VIII	HPLC TLC IR
	antibiotics (chloramphenicol)	chicken, meat, liver	Wal J., Peleram J. and Bories G. High Performance Liquid Chromatographic Determination of Chloram-phenicol in Milk J. Assoc. off. Anal. Chem. 63 (5) : 1980, 1044-1048	HPLC
	Hormones (DES residue)	chicken meat	AOAC	TLC HPLC

Agencies	Analysis	Target	Method of analysis	Instrument used
	Growth regulator (Morantel residue in cow milk product)	beef, milk	J. AOAC 1986 Vol. 69 No. 4 p. 646 - 651	TLC GLC (ECD)
21. Division of Toxicology Department of Medical Science	Pesticides	- Environmental samples - Household products - Biological specimens	- Laboratory Method - Standard Method for the examination of Water and Wastewater APHA. AWWA WPCF	GC
	Heavy metals	- Environmental samples - Household products - Biological specimen	- Laboratory method - Standard methods for the examination of water and wastewater - AOAC	AAS

Agencies	Analysis	Target	Method of analysis	Instrument used
22. Fishery Technological Development Division, Department of Fisheries	Heavy metal (Hg, Cd)	Tuna, Carper shell, shrimp, cuttlefish	- AOAC methods (1980) - Digestion in Pressure Decomposition Vessel	- Mercury Analyzer - AAS
	Natural toxins	cuttlefish	Food Hygiene Inspection Manual 1978, Food Hygiene Association Tokyo, pp. 232 - 240	Bioassay (guinea pig)
23. Agricultural Toxic Substances Division, Department of Agriculture	Pesticide residues	Fresh agricultusal commodities (vegetable, fruit, field crops, oil crops, meat, milk egg, feed, fat & oil)	Pesticide Analytical Manual, Vol. I-IV US. EPA Manual GTZ Publication	GLC HPLC Spectrophotometer TLC

Annex 8.3

Institutions

1. Ministry of Agriculture and Cooperatives.
   - 1.1 Department of Agriculture
     - Agricultural Toxic Substances Division
     - Agricultural Chemistry Division
     - Plant Pathology and Microbiology Division
   - 1.2 Departmemt of Livestock Development
   - 1.3 Department of Fisheries
   - 1.4 The Royal Irrigation Department
   - 1.5 Department of Agricultural Extension
     - Plant Protection Service Division
2. Ministry of Public Health
   - 2.1 Department of Medical Sciences
   - 2.2 Department of Health
     - Environmental Health Division
     - Division of Occupational Health
3. Ministry of Industry
   - 3.1 Department of Mineral Resources
     - Ground Water Division
4. Ministry of Science Technology and Energy
   - 4.1 Thailand Institute of Scientific and Technological Research
   - 4.2 Office of the National Environmental Board
   - 4.3 Department of Science Service
5. Ministry of Defence
   - Royal Thai Army
   - 5.1 Chemical Department
   - 5.2 Armed Forces Research Institute of Medical Sciences

6. Ministry of University Affairs

6.1 Chulalongkorn University

- Faculty of Pharmaceutical Sciences
- Faculty of Science
- Faculty of Veterinary Science
- Faculty of Engineering
- The Institute of Environmental Research

6.2 Mahidol University

- Faculty of Sciences
- Faculty of Public Health

6.3 Kasetsart University

- Faculty of Sciences
- Faculty of Agriculture
- Faculty of Fisheries
- Faculty of Forestry
- Faculty of Veterinary Medicine

6.4 Srinakharinwiroj University

- Prasarnmit Campus
- Bangsaen Campus

6.5 Prince of Songkhla University

6.6 Chieng Mai University

6.7 Khon Kaen University

7. Ministry of Finance

- The Customs Department

8. Ministry of Commerce

Department of Internal Trade

- Merchandise Division

9. The Bangkok Metropolitan Administration
   - Environmental Health Division
10. Asian Institute of Technology (AIT)
11. The Electricity Generating Authority of Thailand
12. Thailand Tobacco Monopoly
13. National Cancer Institute

Annex 8.4

Conclusion of methods of analysis for food contaminants, used at present

chemical contaminants	Method of analysis	Instrument used	No.of agencies used the method
Borax	1. Turmeric paper Test	Turmeric paper	1
	2. Ignition	aluminium spoon	2
	3. Titration	Thermometric Titration	1
	4. Colorimetry (Analytical Procedures for Therapeutic Drug Monitoring and Emergency Toxicology 1980)	Spectrophotometer	1
	5. AOAC 1984 FCC US Pharmacopia	UV Vis Spectrophotometer Ion Chromatography	2
	6. Color develop-chemical reaction	AAS	1
Heavy metals	1. AOAC (1984)	AAS ICPS UV-Vis Spect. ISE analyzer	10
	2. Wet ashing with H_2O_2/nitric acide (FAO/SIDA, 1983)	- AAS	2

chemical contaminants	Method of analysis	Instrument used	No.of agencies used the method
	3. Food Chemical Codex	- UV-Vis Spect. AAS	1
	4. Manual of Food quality Control	- AAS - hydried generator	1
	5. HPB - FC - 5		
	6. Std. method for the Examination of water and waste 16th ed. 1985	AAS Varian : AAS 1475 AAS	1
	7. Colorimetry		1
	8. Polarography		1
	9. AOAC (1980)	Mercury analyzer	1
	10. Digestion in Pressure Decomposition Vessel	AAS	1
Pesticide residues	1. AOAC	GC (ECD) UV-Vis Spect. HPLC	1
	2. Pesticide Analytical Manual Vol. I	GC (ECD)	1

chemical contaminants	Method of analysis	Instrument used	No.of agencies used the method
	3. - Analysis of Pesticide Residues, 1977 - US. EPA	GC	2
	- JICA method	GC (ECD)	1
	4. J. AOAC	GC (ECD)	1
		TLC	2
		HPLC	2
dyes	1. AOAC and EPA manual	GC	1
	2. AOAC 1984	Spectrophotometer	3
	3. Manual of Food Quality Control	TLC	1
	4. solubilize in cold water	cold water	1
antibiotics	1. Tishler et.al(1968)	Spectrophotometer	1
	2. J.Agr.Food Chem. (1968)	Pye Unicam SP - 1800	1
	3. Microbiological Method	Micro-incubation plate	2
	4. Official Journal of the European Communities	Laminar Flow etc.	1
	5. J.Assoc.Off.Anal. Chem. 63.(5) : 1980	HPLC	1

chemical contaminants	Method of analysis	Instrument used	No.of agencies used the method
Migrating Toxic Chemicals	1. AOAC 1984	- AAS - Ion meter	3
	2. UDC 629.113 : 621.43.048	GC	1
Aflatoxin	1. AOAC 1984	- TLC	6
		- HPLC	3
	2. Minicolumn method	- Minicolumn - UV. Vis Spect.	1
Sodium dithionite	1. Modified Rankine Method	Titration	1
Standard agar product	Food Chemical Codex	UV-Vis Spect.	1
	US. Pharmacopoeia	Ion Chromatography	
	AOAC (1984)		
	IS 5707 - 1970		
Mutagen in consumed food	Mutagenicity assay	- Salmonella - Microsome Test - HPLC	1
Cell capture by lectin in food.	Hemog - glutination assay	L/A plate	1
Growth regulator	1. Analytical Abstract 1986 Vol. 48	HPLC	1

chemical contaminants	Method of analysis	Instrument used	No.of agencies used the method
	2. J. AOAC Vol. 69 No.4	GLC (ECD)	1
Formalin	AOAC 1975	Spectrophotometer	1
Phytotoxin	Microbial Toxins Vol. VIII	- HPLC - TLC - IR	1
Hormones (DES)	AOAC	- TLC - HPLC	1
Tetrodotoxin	Food Hygiene Inspection Manual 1978, Food Hygiene Association Tokyo.	Bioassay	1
Hydrocarbons	IOC Method	GC (FID)	1

Annex 8.5 **List of experts**

Expert group on Appropriate technology for identifying chemical contamination in different conditions

Names of Experts :

1. Prof. Dr. Pakdee Pothisiri — Expert and Chairman
   Deputy Secretary - General
   Food and Drug Administration

2. Mr. Montri Rumakom — Expert
   Deputy Director - General
   Department of Agriculture

3. Mrs. Nuansri Tayaputch — Expert
   Deputy Director,
   Agricultural Toxic Substances Division
   Department of Agriculture

4. Dr. Palarp Sinhaseni — Expert
   Associate Professor, Department of Pharmacology
   Faculty of Pharmaceutical Science
   Chulalongkorn University

5. Dr. Gullaya Wattayakorn — Expert
   Associate Professor, Department of Marine Science
   Faculty of Science
   Chulalongkorn University

6.	Dr. Sunibhond Pummangura Associate Professor Head Department of Pharmaceutical Chemistry Faculty of Pharmaceutical Science Chulalongkorn Universitv	Expert
7.	Dr. Sumol Pavittranon Medical Scientist Toxicology Division Department of Medical Sciences	Expert
8.	Dr. Chalong Konantakieti Food and Drug Technical Officer Technical Division Food and Drug Administration	Expert and Secretary
9.	Miss Pornpit Sinkavuth Food and Drug Technical Officer Technical Division Food and Drug Administration	Expert and Assistant Secretary

Questionnaire Annex 8.6

Name of institution .....

The institution is responsible for the following analysis :

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
1. Pesticide residue	*Fresh agricultural commodities					
	aquatic animal and water resources					

* Fresh agricultural commodities mean products at farm e.g. vegetable, fruit, meat, milk and milk product etc.

** Detail can be described in page 100.

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
2. Heavy metal	*Fresh agricultural commodities					
	aquatic animal and water resources					
3. Toxin e.g. Aflatoxin	*Fresh agricultural commodities					
	aquatic animal					

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
4. Pesticide	ambient air (storage and/or sprayed area)					
5. Chemical abuse 5.1 Borax	food					
5.2 Sodium dithionite	food					
5.3 dye	food					

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
5.4 miscellaneous						
6. Natural toxin e.g. plant or animal resource						
7. Migrating chemical substance e.g. VCM, lead etc.	Food package and/or containers					
	Utensil					

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
8. Chemicals for animal used 8.1 antibiotic	*Fresh agricultural commodities (meat, egg)					
8.2 hormones	*Fresh agricultural commodities (meat, egg)					
8.3 Growth regulator	*Fresh agricultural commodities (meat, egg)					

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
9. Other toxic contaminants	atmospheric air					
	soil					

Suggestions.....

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Method of analysis and Reference

Example

Name of institution : Food analysis division, Department of Medical Science

The institution is responsible for the following analysis

Chemical contaminant	Product target	analytical sample	sampling by (agency)	**Method of analysis and reference	Instrument used	Analysis purpose
Pesticide	fresh agricultural commodities	vegetable	Technical Division, Food and Drug Administration	Pesticide Analytical Manual Vol. 1	HPLC	To serve the objective of the Notification of Ministry of Public Health no.71 (B.E.2525)

ABBREVIATIONS USED

In this report the following abbreviations have been used :

For techniques :

AA	atomic absorption
AAS	atomic absorption spectrophotometry
ANSI method	American National Standard Institute method
ASTM std.	American Society for Testing Materials Standard
BGYF method	Bright Greenish Yellow Fluorescence method
CB method	Coomes and Sanders, Broadbent et al method
GC	Gas chromatography
GC (ECD)	Gas chromatography with electron-capture detection
GC (FID)	Gas chromatography with flame-ionisation detection
GLC	Gas-Liquid chromatography
GLC (ECD)	Gas -Liquid chromatography with electron-capture detection
GLC-MS	Gas-Liquid chromatography-Mass Spectrometry
Hi-vol sampler	High-volume sampler
HPLC	High Performance Liquid Chromatography
HPTLC	High Performance Thin Layer Chromatography
ICPS	Inductive Couple Plasma Spectrophotometry
IR	Infra-red spectrophotometry
ISE analyzer	ION Selective Electrode analyzer
INAA	Instrumental Neutron Activation Analysis
NAA	Neutron Activation Analysis
RNAA	Radio chemical Neutron Activiation Analysis
TLC	Thin layer Chromatography

UV-Vis Spect	Ultra-violet Visible Spectrophotometer
For substance :	
DES	Diethylstilbestrol

For Institutes :

APHA	American Public Health Association
ASA	American Society of Agronomy
AWWA, WPCF	American Waterworks Association and Water Pollution Control Federation
FAO	Food and Agriculture Organisation of the United Nations
JICA	Japan Institute Co-operation Association
NIOSH	National Institute of Occupational Safety and Health
SSSA	Soil Science Society of America
US. EPA	The United States of America, Environmental Protection Agency
WHO	World Health Organisation
IOC	Intergevernmental Oceanographic Commission

For Manuals :

PAM	:	Pesticide Analytical Manual, US Department of Health and Human Services, Washington D.C.
AOAC	:	Handbook of the Association of Official Analytical Chemists, Washington D.C.
GTZ Publication	:	DEUTSCHE GESELLSCHAFT FUR TECHNISCHE ZUSAMMENARBEIT (GTZ) GmbH Publication
FCC	:	Food Chemical Codex

Date Due		

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