CONSULTATIONS AND WORKSHOPS

GEMS/Food
Total Diet Studies

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International Workshop on Total Diet Studies
in cooperation with
the Pan American Health Organization

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1. INTRODUCTION

National authorities have the responsibility and obligation to ensure that toxic chemicals, such as pesticides, heavy metals, environmental contaminants and naturally occurring toxins, are not present in food at levels that may adversely affect the health of consumers. While monitoring for compliance with regulatory standards is essential for consumer protection and facilitation of trade, governments need to assess public health risks arising from the presence of toxic chemicals in food by estimating the actual dietary intake of contaminants for comparison with their corresponding toxicological reference intakes, such as the acceptable daily intake (ADI) or provisional tolerable weekly intake (PTWI).

Thus, estimation of the actual dietary intake of contaminants is essential for risk assessment and can also be used in determining whether there may be a relationship between observed adverse effects in humans and exposure to a particular contaminant. Contaminant exposure assessments are equally critical for making sound decisions in the regulation of chemicals and food safety. The Agreement on the Application of Sanitary and Phytosanitary Measures of the World Trade Organization requires that health and safety requirements related to food must be based on sound scientific risk assessment. Consequently, dietary intake estimates should be given greater emphasis by countries not only in the development of national legislation, but also in the context of the Codex Alimentarius Commission and its standards, guidelines and other recommendations. Finally, such estimates provide assurance that regulatory systems that have been established are effective in protecting the public health.

While there are three basic approaches for dietary intake, the total diet study provides, in general, the most accurate estimates of intakes of contaminants for a country as a whole than either of the other methods. In addition, total diet studies explicitly take into account the kitchen preparation of foods to assess the levels of contaminants in foods as consumed. One of the advantages of total diet studies is that they produce information that is readily understandable for use by regulatory agencies, decision-makers and the public. Consequently, there is a growing interest by countries in conducting total diet studies. Such studies, however, are complex, expensive and technically demanding.

2. THE WORKSHOP

In order to promote the undertaking of reliable and comparable total diet studies by countries, the United States Food and Drug Administration (US FDA) and the World Health Organization (WHO) convened an International Workshop on Total Diet Studies (TDS) at the US FDA Total Diet Study Laboratory located in Kansas City, Missouri, USA from 26 July to 6 August 1999. A list of participants is given in Annex I.

The objectives of the Workshop were to:
- Promote and support TDS in all Member countries;
- Promote reliable and comparable TDS through harmonized approaches and best practices; and
- Promote electronic submission of data on TDS to the WHO Global Environment Monitoring System/Food Contamination Monitoring and Assessment Programme (GEMS/Food).
Divided into two parts, the first week’s workshop included presentations and discussions concerning the planning, implementation and evaluation of TDS. The agenda for the first week is given in Annex II. Practical advice was offered by countries with long experience in TDS, including Australia, Canada, Czech Republic, Japan, New Zealand, Spain, the United Kingdom and the USA.

The intent of the first week was to present a critical assessment of TDS, including important components in the planning, implementation and evaluation of such studies. National experiences in conducting TDS were presented with a view to developing harmonized approaches and to promote consistency and comparability in study results.

During the second week, participants had the opportunity to learn directly through demonstrations and hands-on experience some of the major technical operations in conducting a total diet study, including sample handling, preparation and analysis. Individual consultations were provided concerning various aspects of TDS. The second week was structured to include concurrent lectures in the morning followed by laboratory exercises in the afternoon. The programme for the second week of the Workshop is given in Annex II. Participants completing both the first and second workshops were provided both information on and experience in all aspects of conducting a total diet study.

The conclusions and recommendations resulting from workshop discussions will be used to prepare a document on TDS to compliment the existing WHO publication *Guidelines for the Study of Dietary Intakes of Chemical Contaminants* (WHO, 1985).

3. SUMMARY OF SELECTED PRESENTATIONS

3.1 Welcome and Introduction

W.M. Rogers, Kansas City District Director, US FDA

Mr Rogers welcomed the participants and noted that the Kansas City District Office of FDA was delighted to host this first International Workshop on Total Diet Studies. When the FDA and WHO agreed to cosponsor this Workshop, all the employees in Kansas City District were eager to contribute to its success. He stated that the new Commissioner of the FDA, Dr Jane Henney, supports the concepts outlined in the Workshop objectives and drew attention to her letter welcoming participants to the Workshop. The Mayor of Kansas City Missouri had also sent a personal welcome to each attendee. Mr Rogers stressed that FDA was anxious to share its nearly 40 years of experience in conducting total diet study analyses and looked forward to learning about TDS programmes that are being conducted in other parts of the world.

This first International Workshop on TDS presented a unique opportunity for practicing scientists and programme administrators to establish a TDS network. While all persons involved in TDS face similar challenges in obtaining support for TDS and in conducting their programmes, the good news is, “We’re not alone!” The networks established during the Workshop will serve to strengthen all programmes and advance the acceptance of TDS as the preferred method for monitoring contaminants in the food supply.
3.2 Overview of GEMS/Food
Gerald Moy, GEMS/Food Coordinator, Food Safety Programme, WHO

The Global Environment Monitoring System / Food Contamination Monitoring and Assessment Programme, which is commonly known as GEMS/Food, was established in 1976. GEMS/Food has informed governments, the Codex Alimentarius Commission and other relevant institutions, as well as the public, on levels and trends of contaminants in food, their contribution to total human exposure, and their significance with regard to public health and trade. GEMS/Food is an important health-related component of national and international efforts to provide assurance regarding the safety with respect to chemicals in the food supply and provides the basis - where appropriate - for remedial actions, for standards development, for industry and public education and for resource management. Begun as a project in collaboration with the United Nations Environment Programme (UNEP) and the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization now implements GEMS/Food in cooperation with its network of WHO Collaborating Centres, National Focal Points and Participating Institutions located in nearly 70 countries around the world (see Annex III). In addition, linkages are maintained with the international organizations (such as the FAO/IAEA International Reference Laboratory) and non-governmental organizations (such as IUFoST and IUPAC) as well as other parties interested in food contamination.

To assist countries in conducting studies of dietary intake of contaminants at the national level, GEMS/Food prepared Guidelines for the Study of Dietary Intake of Chemical Contaminants, which describes approaches to carrying out total diet studies, selective studies of individual foodstuffs and duplicate portion studies. Approaches for gathering food consumption data are also discussed. Development of internationally recognized methodology is also carried out by GEMS/Food. In this regard, methods for predicting dietary intake of pesticide residues and contaminants based on the GEMS/Food Regional Diets are being used by the Codex Alimentarius Commission for exposure assessments at the international level. GEMS/Food is also developing a new approach for assessing exposure to acute hazards in the food supply.

3.3 GEMS/Food Database and Operating Programme for Analytical Laboratories (OPAL)
Lawrence Grant, Programme of Management Information System, WHO

Mr Grant described the evolution of the GEMS/Food data management system and the present system. The information system for the GEMS/Food Contamination Monitoring Information System was initially established in 1979 as an information storage, retrieval and reporting tool. The system, as was the style for statistical data collections of that time, employed "batch" processing, and, therefore, was highly dependant on a computer analyst for all operations.

The need was recognized for greater scope and accessibility in data handling, which would reduce operational and maintenance costs by taking advantage of the latest advances in computer technology and software. Development of the enhanced system - the Food Database and Operating Programme for Analytical Laboratories (OPAL) - began in 1997. In developing OPAL, emphasis was given to compatibility of the global
database with existing national databases to facilitate transfer of data and promote data quality. In addition, the development of a model national computer system based on the global database was undertaken for application in countries that have not automated their monitoring data systems. Finally, provision was made for participants to gain easy access to all available data through the World Wide Web (www). The document *GEMS/FOOD Data Collections Including Instructions for the Electronic Submission of Data* describes how data may be transferred electronically from national databases to the global GEMS/Food database.

The OPAL system has two components: OPAL I is for data on contaminants in food commodities, and OPAL II is for results on dietary intakes of contaminants from TDS and related dietary intake assessment methods. The OPAL I Users Manual, which is currently being written, will describe this system. Dissemination of the monitoring results will be performed by the WHO/SIGHT application, which is a www-based navigation tool for statistical databases and documents.

### 3.4 Dietary Intake Studies in Canada

Robert Dabeka, Food Research Division, Bureau of Chemical Safety, Health Protection Branch, Health Canada

Over the past 25 years, the Food Research Division has periodically conducted studies to estimate the dietary intake of toxic chemicals by Canadian infants, children and adults. The surveys included duplicate diet studies, human milk and infant formula surveys, as well as standard total diet or market basket studies. In the total diet studies, foods were collected from different cities, prepared as for consumption in a single location, combined into composites (135 in the latest study), homogenized, and analysed for pesticides, persistent organic pollutants (PCBs, dioxins, dibenzo furans), trace elements and various other chemicals. The concentrations obtained were multiplied by the food intakes for the composites to give estimates of average dietary intakes.

Total diet studies have been conducted as research because of the need to use highly sensitive methods so that intakes are not overestimated. These methods require the use of specialized expertise to control contamination, perform technically demanding preconcentrations, and operate highly technical instruments such as mass spectrometers. In addition, there are frequent changes to methodology to add new chemicals to meet demands. Special emphasis is placed on quality control, which in some cases includes (in addition to recovery studies) running up to seven reagent blanks in every batch, three NIST standard reference materials, varying sample weight, and checking for baseline drift, bias and standard accuracy. The primary weakness of the current total diet study in Canada has been the use of 1972 food consumption data for estimating dietary intakes.

### 3.5 Total Diet Studies in China

Junshi Chen, Deputy Director, National Institute of Nutrition and Food Hygiene, Chinese Academy of Preventive Medicine

Two total diet studies have been conducted in China since 1990. The Chinese TDS included four regional market baskets, including three provinces per region, with 13 composite food groups representing each regional market basket. Intake assessment
was carried out based on the levels of contaminants and nutrients in food composites and the food consumption data for each of the foods in the food composite group. The analytes included a wide spectrum of contaminants (pesticides, heavy metals, aflatoxins and radionuclides) and nutrients (macronutrients, vitamins, minerals, cholesterol, fatty acids and amino acids). The results of the TDS served as important scientific bases for a comprehensive assessment of the safety and nutritional quality of representative diets in China. For example, the results showed that the lead intake of two to seven year-old children was very close to the PTWI with one regional intake exceeding the PTWI. While organochlorine pesticide residues were decreasing, the levels were significantly higher than those reported in developed countries. Several organochlorine pesticides were detected in cereal and vegetable composites, including residues of the highly toxic methamidophos, which indicated a potential problem in agricultural practice.

3.6 Total Diet Studies in the Czech Republic
Jiri Ruprich, National Institute of Public Health, Czech Republic

The Czech Republic is a country with a population of about 10.5 million inhabitants. The environment is relatively polluted, and the transition of the economy is expected to result in deep changes in food consumption. Overproduction of some foods stands in contrast to import of very cheap foods from the EU. One target of the national environment and health policy was defined as evaluation of the health risks of the typical Czech diet. TDS were selected as the method of choice because it is a relatively simple, cost-effective and robust method for population estimates. TDS have been conducted annually since 1994.

The principles recommended by WHO were used for organization of TDS. Household budget survey data are used as a source of food intakes by population. The TDS protocol consists of selecting food groups and items which represents more than 90% of average food intake. Foods are purchased at the market according to shopping lists which are prepared using a standard operating procedure (SOP). Food samples are collected from 12 locations around the country and are then wrapped, stored and transported to one analytical centre. Before analyses all foods are prepared in a central kitchen according to standard recipes. All analytical operations are covered by SOPs. Individual food items are combined to form composite samples before analyses. Each year 552 composite samples are analysed for more than 40 substances, including PCBs, organochlorine pesticides, heavy metals and micronutrients. The analytical quality control and assurance system is an integral part of the TDS. Exposure doses are calculated for the population by multiplying average food intake by percentiles of substance concentrations to determine an average daily dose (non-carcinogenic effects) or a lifetime average daily dose (carcinogenic dose). Evaluation of risks is performed on the basis of comparison of exposure doses with exposure limits (e.g. Acceptable Daily Intake (ADI) or Reference Dose (RFD)) and added risk of attributable tumours (probability) is calculated when feasible.

TDS have been conducted annually since 1994. During that time 10,000 food samples have been collected, more than 50 chemical substances have been studied, and more than 100,000 analytical results are now in the central database. TDS were accepted by state officers as a tool for risk assessment, and is used to focus the national control system and for international comparison.
3.7 Dietary Daily Intake of Dioxins by the Total Diet Studies in Japan
M. Toyoda, National Institutes of Health, Japan

TDS in Japan have been carried out since 1977 for estimating intakes of pesticide residues, PCBs and heavy metals according to guidelines established by the GEMS/Food Programme. TDS for dioxins were started in 1996 under a project supported by the Ministry of Health and Welfare that included seven geographical regions throughout Japan. In each region, 10 district samples were obtained from 10 prefectural or municipal laboratories that collected between 100 and 120 different foods according to their food consumption patterns based on the National Nutrition Survey in Japan. Each food was prepared in the customary manner and categorized into one of 14 food groups for compositing. The 14 food composites were analyzed in one laboratory. Analytical quality assurance was carried out using reference materials (powdered milk and carp). Intake estimates were calculated from the concentration data and the corresponding food consumption data for each composite. The main dietary sources of dioxins were fish and meats. Issues of concern in the TDS include the categorization of foods, harmonization of the limits of quantification, and treatment of non-quantifiable results.

3.8 New Zealand Total Diet Survey: Past, Present and Future
Elizabeth Aitken, Ministry of Health, New Zealand

The Ministry of Health is responsible for conducting the New Zealand Total Diet Survey (NZTDS). The NZTDS is one of the monitoring tools used to assess the safety of the domestic food supply and has been conducted five times over the past 25 years. The 1997/98 NZTDS is currently being completed. Key objectives of the survey are: to estimate the intakes and assess the health implications of dietary exposure to 90 pesticide residues, five heavy metals and three nutrient elements; to provide timely data to stakeholders; to report the data to GEMS/Food; and to contribute data for the New Zealand Food Composition Database (NZFCD).

The 1997/98 NZTDS can be divided into three major phases, each phase taking just over one year to complete. These phases include planning, sampling and analysis, and report writing. The planning phase included developing the specification and food list, identifying a suitable provider group, international review of the proposal and negotiating a contract. The second stage was the pre-testing, sampling and analysis of 114 foods from four regional sites during two seasons, undertaking quality control and releasing ‘raw data’ reports. The third stage involved development of the simulated diets for six age/gender categories, report preparation and external review, and release of the final reports.

The major changes in the NZTDS over the past 25 years have been the significant increase in analytes, changes in food sampling and the diets, and the introduction of written reports. Overall, there has been a decrease in elements and a large increase in the number of pesticide residues included. The number of foods sampled is now 114 and they are prepared ready-to-eat, whereas food samples were previously uncooked and composited by food group. Initially, a diet for a high consuming young male was used and that has now been expanded to include 14-day model diets for six age/gender categories. The NZTDS has moved from published scientific papers only to producing eight written reports.
In the future, key considerations will be the tension between resources versus improved technology and more possible analytes. The major improvements in quality and quantity of food consumption data enable more refined dietary models and the ability to assess risks of specific dietary patterns and high consumers. There is likely to be increased collaboration with other government sectors in New Zealand, Australia and the Pacific region. The Ministry of Health will also be seeking to ensure that future NZTDSs are undertaken, that those data are available to the NZFCD and GEMS. Another important aspect includes strengthening ministry’s the compliance monitoring.

3.9 **Total Diet Study in the Basque Country (Spain)**

Inés Urieta, Health Department Basque Government, Spain

The Basque country is a small region in the north of Spain comprising 7,261 km² in area and a population of 2.2 million. In 1990 the Basque Government initiated a total diet study (market basket approach) as an important part of its monitoring programme for chemical contaminants in the food supply. The main features of the study can be summarized as follows. The average diet of the population was established using the information provided by the Food Survey, which included the adult population (25-60 years of age) using the 24h-recall interview and food frequency questionnaire methods. Then the food list (91 food items) was prepared and the food items were purchased at monthly intervals in different locations of the Basque country. After preparation and cooking, the foods were combined in groups (16 food groups) and analysed for the substances of interest. Finally, the intakes were calculated by a combination of these data with those of consumption, and compared with appropriate reference values and also with data from other countries.

The results obtained between 1990 and 1997/98 show that daily dietary intakes of lead and cadmium are well below tolerable limits and account for less than 16% of the Provisional Tolerable Weekly Intakes (PTWIs). Mercury and arsenic intakes are high in comparison with those of other countries and this is due to very high average fish consumption, i.e. 89 g/day. Nevertheless, arsenic in fish is present mainly as organic arsenic and inorganic arsenic intake is low, accounting for only 4% of the appropriate PTWI. Mercury average intake is 17 µg/day and accounts for 35% of the PTWI. Dietary intakes of pesticide residues (organochlorine, organophosphorus, carbamate and dithiocarbamates) are very low and account for less than 7% of the appropriate ADIs. Average intake of dioxins and dioxin-like PCBs (i.e. Congener Nos. 77, 126, 169, 105 and 108) is 6.5 pg TEQ/kg body weight of which 4.6 are due to PCBs. Estimated intakes of radionuclides (\(^{89}\)Sr, \(^{90}\)Sr, \(^{137}\)Cs, \(^{134}\)Cs) are very low.

There is no indication that dietary intake of aflatoxin M1, sulphites or nitrate threatens the health of the average consumer eating a balanced diet. With regard to nutrients, average intakes of zinc and selenium are adequate but dietary intake of iron is deficient in females.

The results of the TDS from the period 1990-1998 have enabled some priority areas to be identified. In particular, a duplicate portion study on extreme fish consumers has been designed to assess the risk of exposure to mercury, arsenic, PCBs and dioxins. Also, intakes of PUFAs and selenium will be estimated.
3.10 Experiences from the UK Total Diet Study

Steven Wearne, Nutrition Unit, MAFF/DH Joint Safety and Standards Group, United Kingdom

Robust estimates of consumer exposure to food chemicals are needed for regulatory chemical risk assessment. There are two main approaches to food chemical intake assessment:

- If comprehensive records of foods eaten by individuals in a sample population are available, these may be combined with information on the levels of food chemicals of interest in commonly consumed foods. This allows estimation of the total intake of food chemicals by each member of the sample population and the generation of descriptive statistics, such as the mean and range of intakes.

- The construction of a model diet or market basket representing the average diet of the sample population. This model may then be analysed directly for food chemicals of interest. This is the conceptual basis of TDS.

Each of these approaches has its advantages and drawbacks. The method of choice will depend on a number of factors including the availability of other data and the nature of the question to be addressed.

The UK Total Diet Study was established in 1966. Major reviews in 1975 and 1981 have led to the structure of the survey as it is today - 119 specific types of food bought throughout the year and throughout the country, then prepared and grouped into 20 food groups at a single central laboratory using standard practices and subject to rigorous quality control. In order to reflect changes in consumer preferences over this period, the relative quantities of foods in each food group have been revised each year, based on UK National Food Survey data from the preceding three years.

As the TDS approach relies on direct analysis of a composite sample, there is no need to have reliable data on levels of the chemical of interest in individual foods. In recent years the UK Total Diet Study has been used to assess average intakes of fluoride, chromium, dioxins, heavy metals, phytoestrogens and flavonoids. This would not have been possible using the alternative approach due to the incompleteness of food-specific data. The collection of samples for a TDS and analysis of a relatively small number of composite samples is also a relatively inexpensive means of generating a reliable estimate of average exposure to food chemicals. Surveys can therefore be repeated at regular intervals to generate information on trends in food chemical exposure.

However, there are also drawbacks to the TDS approach. Primarily, if you just have a single model diet, you will generate only a single estimate for each food chemical - the average population intake. This may be overcome by mapping the several thousand food codes from national dietary surveys onto the appropriate food groups in the TDS. As the composition of each food group is set so as to model the average national diet, it will be imperfectly matched to the dietary patterns of any particular sub-group or individual. However, if used intelligently, this approach provides a valuable tool to assess intakes of vulnerable population sub-groups.
3.11 Methodology for the U.S. Food and Drug Administration's Measurement of Radionuclides in Foods
Edmond J. Baratta, Winchester Engineering and Analytical Center, US FDA

The US Food and Drug Administration (FDA) is responsible for the wholesomeness of the nation's food supply. The FDA modified its food monitoring programme in January 1973 to include radioactive isotopes. The methodologies used to perform analyses on these food products are taken from the standard-setting professional societies such as the Association of Official Analytical Chemists, International, American Society for Testing Materials and American Public Health Association Standard Methods. In addition, methods not tested by these societies are taken from the literature or from Department of Energy manuals such as the Health and Safety Laboratory and also from Environmental Protection Agency, Public Health Service, and Food and Agricultural Organization manuals. These include the methods for long-lived radionuclides (such as tritium, strontium-90, cesium-137 and plutonium) as well as the short-lived radionuclides (such as iodine-131, radiocesium, radiccierrum and radioruthenium). In addition, they include the naturally occurring radionuclides such as radium and uranium isotopes.

The activity concentrations of gamma-emitters such as radiocesium, iodine-131 and radioruthenium are determined by gamma-ray spectrometry. This is done using intrinsic germanium detectors with the appropriate hardware and software. The alpha and "pure" beta-emitters are determined by various radiochemical methods and techniques.

The results of the TDS samples have shown that the radionuclides present in the food samples do not present a hazard to the public. In addition, the radioactivity in foods has been decreasing since the late 1960s. There was some uptake after the Chernobyl incident, but at the present time this has disappeared. Continued surveillance is recommended.

3.12 Total Diet Studies - Risk Assessment and Pesticide Residues
Richard Vannoort, Institute of Environmental Science and Research (ESR), New Zealand

Dr Vannoort reminded workshop participants that “All substances are poisons; there is none which is not a poison. The right dose differentiates a poison from a remedy (Paracelsus)”. He also pointed out that when considering risk, one needs to consider both the probability and magnitude of a potential adverse effect in relation to a hazard in the food. Too often the focus is on the magnitude of the adverse effect (e.g., AIDS), while the probability of it occurring is often forgotten. Dr Vannoort went on to explain in detail each of the four components of risk assessment, namely hazard identification, hazard characterisation, exposure assessment and risk characterisation. After providing an overview of the different types of pesticides, their modes of action and analysis, Dr Vannoort used the 1990/91 New Zealand Total Diet Survey to illustrate the estimated exposures of pesticide residues found, each as a percent of the Acceptable Daily Intake (ADI). He also showed how the key food groups that contribute to certain pesticide residue intakes could be identified, and the ability of TDS to monitor intake trends over time for pesticide residues (e.g., DDT) and contaminant elements (e.g., lead). In both cases the trends are pleasingly downwards, and both now represent negligible risks to
public health in New Zealand. Dr Vannoort concluded that while TDS can be quite complex, resource intensive and involve exacting science, a developing country can quite easily start a TDS programme by prioritizing where and how scarce resources should be used. Foods could all be combined into food group composites, or possibly even one total diet food composite. If countries have limited analytical capabilities, samples for heavy metals/nutrients analyses could even be sent out of the country. The challenge for all of us is to continue to check the safety of our country’s food supply and the associated risk to the general population by setting up or improving existing total diet studies in addition to other food monitoring and surveillance regimes.

3.13 Estimation of Daily Intake of Food Additives in Japan
Yoshiaki Uyama, Division of Food Chemistry, Environmental Health Bureau, Ministry of Health and Welfare, Japan

An attempt has been made in Japan to estimate daily food additive intake, mainly using concentration determination methods such as the national nutrition survey method, duplicate portion study and market basket method. Daily intake of food additives should be continuously monitored to assure consumer safety in view of the recent increase in the varieties of foods available in the market. It is suggested that the market basket total diet study is a most useful tool for estimation of food additive intake especially under financial, time and human resource limitations. However, estimated daily intake is only determined for the average consumer and depends on various factors, such as the established food consumption values, recovery factors and detection limits. More accurate estimates of daily intake may be made if consideration is given to related information on food additives, such as data from manufacturers on production and use when such information is available. It is also necessary to consider risk assessment and risk management for special subgroups, like children and the elderly, when conducting market basket total diet study.

3.14 Instrumentation for Cadmium, Lead and Nickel Analysis
William R. Mindak, Center for Food Safety and Applied Nutrition, US FDA

An overview of instrumental techniques available for the analysis of cadmium (Cd), lead (Pb) and nickel (Ni) was presented. Techniques discussed included voltammetry, spectroscopy (atomic absorption, atomic emission and mass), neutron activation and classical techniques. Advantages and disadvantages of each technique were discussed and compared including sensitivity, cost, matrix interference, throughput, multi-element capability and complexity of instrumentation. Graphite furnace atomic absorption spectroscopy (GFAAS) was explained in more detail because of its popularity for trace metals analysis. The technique offers high sensitivity at reasonable cost and is used in FDA’s Total Diet Study programme for the determination of Cd, Ni and Pb. Various aspects of GFAAS were discussed including platform versus wall atomization, mechanisms of matrix modification, common matrix modifier chemicals, the necessity for background correction, structured and broad-band background absorption, Zeeman effect and deuterium background correction systems and interference.
3.15 Construction of Food Lists
Katie Egan, Contaminants Branch, Center for Food Safety and Applied Nutrition, US FDA

The purpose of conducting a TDS is to monitor the safety of the food supply and to assess the intake of pesticide residues, food contaminants, and other food constituents. In order to conduct such assessments, it is necessary to determine the foods that constitute the majority of the diet. One approach to determining these foods and constructing a food list for conducting a TDS is to identify “core foods” based on national food consumption data.

There are many types of food consumption data from which a food list can be constructed. Examples include data collected from individuals on the types and amounts of foods consumed, information about household food expenditures and use, and food disappearance data (food balance sheets). In the U.S. TDS, food lists have evolved from 82 foods collected in 1961 to the current number of 260 foods. These food lists were determined from results of surveys of individual consumption patterns conducted by the U.S. Department of Agriculture and the Department of Health and Human Services. For constructing its TDS food list, FDA first determined the amounts of each food reported in the surveys for selected population subgroups. All foods reported in the surveys were then aggregated into approximately 260 groups based on similarity of nutrient content, major ingredients, and food uses. A single food - generally the food consumed in greatest quantity - was selected to represent each of the 260 food groups. In this way, 100% of the diet was accounted for in the TDS. Food lists were evaluated by comparing nutrient intakes estimated from the TDS foods to intakes determined from the detailed food consumption surveys.

In the TDS, each of the 260 foods is analyzed for a range of pesticide residues, contaminants, and elements. From the food consumption survey data, amounts consumed of all foods in a given food group are summed to represent the consumption of that food group. Dietary intakes of all TDS analytes are determined by multiplying their concentrations in each TDS food by the consumption amount of the corresponding food group.

3.16 Experiences on Pesticide Residues in Tanzania
Judicate Ndossi, National Food Control Commission, Tanzania

Tanzania has not incorporated TDS in its Food Safety Programme. However, confined and limited surveys have been conducted on pesticides in Dar es Salaam urban surface waters; in cereals and legumes from Central and Northern Tanzania; in fish from water dams of Mtera and Nyumba ya Mungu in Central and Northern Tanzania, respectively; in marine fish along the shores of the Indian Ocean at Dar es Salaam; and in fish from Lake Victoria.

Results show that the urban surface water in Dar es Salaam had detectable pesticide values (significantly, DDT at 0.2μg/l). Fish from the shallow waters of Dar es Salaam shoreline showed only traces of DDT and PCB (< 0.005 ppm). Fish from the dams had dieldrin (4-36 μg/g). Fish from Lake Victoria had no pesticides detected. Legumes and grain had measurable residues of dieldrin, feritonothion, lindane, malathion and DDT.
A comprehensive TDS is long overdue in Tanzania because of the prevailing poor economic situation. To initiate such an effective programme, the National Food Control Commission of the Ministry of Health is in great need of technical support from the international community.

3.17 Food Consumption Databases and Use in Dietary Assessments of Contaminants: Approaches and Procedures
Barbara J. Petersen, Novigen Sciences, Inc., Washington, USA

Exposure assessments require four types of data: (1) potential levels in each food, (2) frequency of occurrence of the contaminant, (3) absorption factors, and (4) amounts consumed of each food. The most appropriate data to use in each assessment will depend upon the intended application for the exposure assessment (e.g., worst-case versus realistic assessment, typical exposures versus extreme or high consumer exposures). In addition, the biological properties of the contaminants (e.g., acutely toxic versus lifetime toxicity) need to be considered as well as the physical and chemical properties of the contaminant (e.g., stability, solubility, etc.). Finally, available resources are a practical consideration than needs to be taken into account.

There are a number of considerations to be addressed as a part of defining the appropriate exposure assessment procedure(s): relevant regulatory standards; sources of contamination; impact of processing, cooking and storage on contaminant levels; and existing data for contaminant levels and consumption amounts, including the forms (e.g., raw, boiled, etc.) that are eaten.

Several technical issues must be addressed. It is necessary to utilize procedures to match foods for which data on concentrations of the chemical are available to foods for which food consumption data are available. The models must be selected for assessing exposure; options include estimates of average or typical exposure and distributions of exposure. It is possible to refine estimates using probabilistic analyses such as Monte Carlo type assessments.

The selection of the most appropriate model depends upon the availability of data as well as proper application of the models to the data. In most cases, it is critical to conduct sensitivity analyses in order to understand the impact of assumptions and to define additional data needs.

Useful data for identifying the foods with the highest potential contamination include chemical properties (e.g., solubility, heat stability, pH stability), metabolites/degradates of potential concern, differences in levels of raw versus cooked food, home prepared versus commercially processed, and continuous versus periodic contamination.

In selecting food consumption data there are several key considerations. Potential data sources should be evaluated with respect to the following criteria:

- When (how long ago) were the data collected?
- Are current patterns of consumption of the foods of interest similar?
- For which country or countries?
- For which geographical regions?
• For which populations were the food consumption data collected?
• Were all population groups included (e.g., children, vegetarians, subsistence fishermen)?
• Were data collected during all seasons?
• What foods were included?
• Was the quantity consumed estimated for each food?

There are four major types of food consumption surveys. Each type has advantages and disadvantages. Results from these surveys can be adapted to permit exposure assessments. The four major types are (1) food supply surveys (market disappearance), (2) household or community inventories, (3) household food use, and (4) individual food intake surveys.

Inventories are accounts of what foods are available in the household. Food use surveys estimate the quantity of food actually used by households or families. Individual food consumption studies are estimates of food consumption by specific individuals. Individual food consumption survey methodologies include retrospective (24-hour or other short-term recalls, food frequencies, diet histories), prospective (food diaries, food records, or duplicate portions) or a combination of retrospective and prospective.

There are several situations that may require specialized data. These include exposure estimates for contaminants that are present in infrequently consumed foods or where the contaminant is found in only a few foods. If there are differences between food eaten at home versus away from home, data for each source may be needed. Foods that are unique to a specific population may require additional data.

Examples of specific populations include the following: subsistence and recreational fisherman who consume fish that were caught from waters in which the chemical being studied are present at higher than typical levels; vegetarians, whose diets are limited, to varying degrees, to non-animal sources; and infants and young children eating special foods.

Consideration should be given to ensuring that the underlying data and algorithms are valid for the intended purpose. Wherever possible, independent estimates should be derived - at least to provide assurance that the order of magnitude of the results is reasonable. Likewise, the reliability and precision of the estimates should be assessed. Sources of error should be considered and the results should be relevant for the target population.

In conclusion, the following points should be kept in mind:

• Exposure is only as valid as the input information and assumptions.
• Exposure should be relevant to the toxicity of the contaminant.
• It is important to estimate uncertainty and variability.
• It is important to take full advantage of existing data/analyses.
3.18 Uncertainty and Variability in Exposure Assessment
Richard Vannoort, Institute of Environmental Science and Research (ESR),
New Zealand

Dr Vannoort stated that food safety risks are not just risks to public health, but can also
be risks to trade and have political, legal and financial implications. The recent dioxin
and Coca-Cola episodes in Europe were used to illustrate the point. Dr Vannoort went
on to explain the principles of exposure assessment, and also clearly defined and noted
the difference between Limit of Detection (LOD) and Limit of Quantitation (LOQ). He
confronted the problem of what value to assign in the concentration data set for “not
detected” results. With worked examples, he showed the major impact (>30x) on mean
correlation and associated exposure estimates that assigning zero, LOD or LOD/2 to
not detected” values could have. For four different types of compounds (currently used
pesticides, persistent organic compounds, heavy metals, and nutrients) Dr Vannoort
made recommendations as to which “not detected” protocol to use. These options
provided excellent food for thought in this critical area of exposure assessment.
Dr Vannoort concluded his presentation with a succinct but worthwhile explanation of
uncertainty and variability as they relate to consumption and concentration data, both of
which contribute to exposure assessments. His closing point was that exposure
assessments are only estimates and to be meaningful they must be based on the best
available, good quality data. All assumptions/protocols used during the exposure
assessment process need to be clearly documented, as unambiguously as possible.

3.19 How Clean and Green are Infant Foods in New Zealand?
Richard Vannoort, Institute of Environmental Science and Research (ESR),
New Zealand

Dr Vannoort’s presentation provided an interesting change of focus, while still being
very relevant to the Workshop. One problem with total diet studies to date is the lack of
information on food consumption by infants/children which generally means significant
assumptions in exposure assessments of these groups. Dr Vannoort chronicled recent
investigations of 25 commercially available infant formulae products and 30 infant
complementary foods for pesticide residues and selected elements (cadmium, lead, tin,
iodine and fluoride). While a few pesticide residues were detected, concentrations were
extremely low (0.00005–0.022 mg/kg on a ready-to-feed basis). Associated exposure
estimates were all well within WHO Acceptable Daily Intake (ADI) levels. Similar low
results were obtained for cadmium, lead and tin. All survey results were similar to, or
lower than, those encountered in studies in other countries. In comparison with national
and international standards, the pesticide residue and contaminant element levels in the
New Zealand survey were considered highly unlikely to have any adverse health
implications for New Zealand infants.
4. WORKSHOP EVALUATIONS

4.1 Week One

The overall reaction to the first week of the Workshop by 36 responding participants was very positive (i.e., excellent). Participants were generally satisfied with the registration process, programme content and hotel arrangements although a number of recommendations were made.

In terms of improvements, several participants would like to have had earlier notice of the Workshop as well as an advanced copy of the agenda. This comment deserves attention for future workshops given the difficulty some participants have obtaining support to attend meetings such as this.

Most participants noted that the handouts were very useful but suggested that they be provided prior to the session to allow time for review.

Regarding the content of the Workshop, it was suggested that break-out sessions be organized to allow discussion of a broader range of topics such as preparation of food lists, shopping guides, sampling procedures, and calculation of intakes. It was also suggested that a needs assessment session be provided for countries wishing to initiate a TDS.

Another recurring theme among responses was a desire to allow questions immediately after presentations. It was suggested that the availability of more microphones might encourage greater participation in the discussions.

Several responses expressed a desire to convene another workshop in the future (2-3 years).

4.2 Week Two

The second week's participants were also impressed with the quality and depth of the information presented. Because the second week's instruction was tailored to meet the needs of individual participants, comments reflected the specific experiences of each participant. Understandably, some participants expressed being overwhelmed by the volume of information presented; this may be a function of their having attended a two-week workshop. Other participants, however, felt that even more specialized instruction should be offered. Many suggested that this phase of the Workshop should be offered again in the future.

In summary, both weeks were well received. The Workshop was indeed a success.
5. CONCLUSIONS AND RECOMMENDATIONS

On Friday 30 July 1999, a panel discussion was held which included the following persons: Mr Steve Crossley (Moderator), Mrs Elizabeth Aitken, Dr Junshi Chen, Ms Katie Egan, Dr Gerald Moy, Mr Michael Rogers and Dr Jiri Ruprich. The Workshop discussed a number of issues and the following recommendations were agreed:

- **The inclusion and use of water in total diet studies**

(i) The Workshop agreed that drinking water should be included in the total diet study except where resources do not allow, as in some developing countries.

(ii) Where bottled water comprises a significant proportion of the diet, then this should also be included in total diet surveys.

(iii) Where drinking water is used as part of the sample preparation, this should be clearly recorded and taken into account in the interpretation of the analytical results.

(iv) Whether or not drinking water is used in the sample preparation (e.g., boiling of potatoes) should be considered on a case-by-case. Where drinking water is not used, then the use of deionized water is recommended.

- **The handling of data at the limit of quantification (LOQ) in the exposure assessment**

(v) The Workshop agreed that the use of the term “limit of quantification” (LOQ) was desirable rather than “limit of determination” (LOD), since the latter was commonly confused with the “limit of detection” (also abbreviated to LOD).

(vi) The Workshop noted that a large number of different approaches were used internationally in the handling of results at or below the LOQ in the exposure assessments (e.g., residues could be assumed to be at the LOQ, ½ LOQ or zero). The Workshop also recognized that estimated dietary exposure can vary widely depending on the approach adopted.

(vii) The Workshop could not reach a complete consensus, in the time available, on a preferred approach in the handling LOQ results. However, the Workshop agreed to draw the attention of governments to the recommendations of the GEMS/Food-EURO Workshop convened in May 1995, which had made specific recommendations in this area. Refer to the report Reliable Evaluation of Low-Level Contamination of Food available at the WHO website.

(viii) The Workshop recommended that whatever the approach taken in the handling of LOQ results in exposure assessments, it should be clearly recorded in total diet studies.
Dr Robert Dabeka from Canada agreed to prepare a paper to examine the issues and, in particular, his proposal for handling such data.

* Exposure assessments for high percentile consumption

The Workshop agreed that it was desirable for high percentile (e.g., 95%) consumption patterns to be included in total diet exposure assessments. These calculations would be in addition to the use of mean consumption data. These high percentile diets would normally be constructed on an energy intake basis.

* Conducting exposure assessment for different population sub-groups

The Workshop agreed that where specific national or regional consumption data were available for different population sub-groups (e.g., vegetarians, toddlers and infants etc.), exposure assessments should be carried out for these groups. These calculations would be in addition to those carried out for adults or the general population.

The Workshop agreed that duplicate diet studies are a particularly useful alternative for estimating exposure where no national consumption data are available or where an investigation of the exposure of a particular population sub-group is being carried out.

* Choice of analytes for total diet studies

Dr Moy (WHO) provided the Workshop with the United Nations list of analytes and commodities that governments were recommended to monitor in their food supply, which had been developed in cooperation with GEMS/Food (see Annex IV). Three lists are available:
  a) Core list - intended for use by developing countries
  b) Intermediate list - intended for countries with some industrial development
  c) Comprehensive list - intended for use by developed countries

The Workshop strongly endorsed the use of these lists for total diet studies. In addition, the meeting recommended the following analytes be considered for future inclusion in analytes lists as follows:
<table>
<thead>
<tr>
<th>List to which analyte is to be added</th>
<th>Analyte</th>
<th>Commodities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Nitrate and nitrite</td>
<td>Drinking water &amp; meat products</td>
</tr>
<tr>
<td>Core</td>
<td>Inorganic arsenic</td>
<td>Drinking water</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Total arsenic</td>
<td>Food commodities other than drinking water</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Veterinary drug residues</td>
<td>Foods of farm animal origin</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Allergens (especially sulphite)</td>
<td>Not specified</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Dioxin congeners</td>
<td>Foods with high fat content</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Organophosphorous insecticides</td>
<td>Not specified</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Fungicides</td>
<td>Not specified</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Nitrosamines</td>
<td>Not specified</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Aluminum</td>
<td>Not specified</td>
</tr>
<tr>
<td>Comprehensive</td>
<td>Sea food toxins</td>
<td>Fish and shellfish</td>
</tr>
</tbody>
</table>

- **Availability of national consumption data**

  (xv) The Workshop agreed that national consumption data should be used wherever possible. Where these data are not available the meeting recommended that a study should be conducted in order that exposure assessments reflect national consumption patterns.

  (xvi) The Workshop recognized that in developing countries, resources may not be available to conduct a national food consumption study. In these cases, the Workshop agreed that the GEMS Regional Diets, which are based on FAO Food Balance Sheet data, should be used in the exposure assessments.

- **Different approaches in the conduct of total diet studies**

  (xvii) The Workshop noted that there are two different approaches in the conduct of TDS. In the first, a representative food is chosen for each food group (e.g., mandarins for citrus fruit) and the analytical results are used to represent the residue/contaminant concentration for the consumption of the whole group. In the second approach, foods within the groups are composited in the relative proportions in which they are consumed. The composite food group sample is then analysed. The Workshop agreed that the storage of reserve single samples are useful for the second approach because it allows the tracking back to the source of any unusual residues/contaminants that are found.
• *The next International Total Diet Workshop*

(xviii) It was agreed that the next workshop should be held in two years. The WHO would liaise with countries interested in hosting the workshop as well as regional workshops that might be held in the interim to inform other countries about the importance of TDS. The following issues would be discussed:
   a) Progress of total diet studies in developing counties
   b) Results of new total diet studies.
   c) Use of data below the LOQ in total diet exposure assessments.
   d) Choice of analytes for inclusion in total diet studies.

• *Basic total diet study for developing countries*

(xix) The Workshop agreed that in developing countries with fairly limited resources, the compositing of samples across food groups was a cost-effective approach to conducting a total diet study. Although ultimately a single sample representing the entire diet could be derived, the Workshop recommended that some groups be kept apart to facilitate analyses and interpretation of the results.

(xx) An example approach was discussed based on the GEMS/Food African Regional Diet. In this example, foods were compositing to create just four laboratory samples (see Table 1 below). In addition, food groups that account for less than 1% of the diet were excluded as it was anticipated that these foods would not significantly contribute to the overall exposure. The combined consumption value for the four compositing groups would be used in the exposure assessment rather than the consumption values for individual commodities.
Table 1. An example of the use of GEMS/Food Regional Diets in conducting a simple total diet surveys using the African GEMS/Food Regional Diet

<table>
<thead>
<tr>
<th>Composite</th>
<th>Food Group</th>
<th>Consumption (g/day)</th>
<th>Representative food</th>
<th>Consumption (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cereals</td>
<td>318.4</td>
<td>Rice</td>
<td>103.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Maize</td>
<td>106.2</td>
</tr>
<tr>
<td>2</td>
<td>Root</td>
<td>321.3</td>
<td>Cassava</td>
<td>165.5</td>
</tr>
<tr>
<td>1</td>
<td>Pulses</td>
<td>17.8</td>
<td>Pulses</td>
<td>11.9</td>
</tr>
<tr>
<td>2</td>
<td>Sugar &amp; Honey</td>
<td>42.7</td>
<td>Refined sugar</td>
<td>25.5</td>
</tr>
<tr>
<td>3</td>
<td>Nuts &amp; oilseeds</td>
<td>34.2</td>
<td>Nuts (…)</td>
<td>14.8</td>
</tr>
<tr>
<td>3</td>
<td>Veg oils &amp; fats</td>
<td>23.3</td>
<td>Oil of palm kernel</td>
<td>12.4</td>
</tr>
<tr>
<td></td>
<td>Stimulants</td>
<td>0.6</td>
<td>&lt;1% diet</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Spices</td>
<td>1.8</td>
<td>&lt;1% diet</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Vegetables</td>
<td>77.0</td>
<td>Tomato</td>
<td>16.5</td>
</tr>
<tr>
<td>3</td>
<td>Fish &amp; Seafood</td>
<td>36.5</td>
<td>Pelagic marine fish</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>Eggs</td>
<td>3.7</td>
<td>&lt;1% diet</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fruits</td>
<td>94.7</td>
<td>Plantains</td>
<td>41.3</td>
</tr>
<tr>
<td>4</td>
<td>Milk &amp; milk products</td>
<td>42.2</td>
<td>Milks</td>
<td>41.8</td>
</tr>
<tr>
<td>4</td>
<td>Meat &amp; offals</td>
<td>30.4</td>
<td>Mammalian meat</td>
<td>23.8</td>
</tr>
<tr>
<td></td>
<td>Animal oils &amp; fats</td>
<td>0.7</td>
<td>&lt;1% diet</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1038.4</td>
<td>(99.3% of total consumption)</td>
<td>576.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(54.2% of total consumption)</td>
<td></td>
</tr>
</tbody>
</table>
ANNEX I

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ANNEX II

AGENDA for Week One
26-30 July 1999

Monday, 26 July

08:00 - 09:30  Registration

09:30 - 10:30  Introductory Presentations – Ms Monica Maxwell, Kansas City District, FDA, moderator
  • Mr Edward Esparza, Regional Director, SW Region, FDA
  • Dr Gerald Moy, GEMS/Food Coordinator, WHO
  • Mr Claudio Almeida, Regional Adviser on Food Safety, PAHO/WHO
  • Mr Walter Batts, Director, Office of International Affairs, FDA
  • Mr Mike Rogers, District Director, Kansas City District, FDA
  • Dr Arnold Borsetti, Office of the Director, CFSAN, FDA

10:30-10:45  Break

10:45 - 11:15  Overview and Objectives of Workshop - Dr Gerald Moy, WHO
  • Overview of GEMS/Food and the need for a global assessment
  • Objectives of the workshop

11:15 - 12:00  General Presentation and Overview of Total Diet Studies - Dr John Vanderveen, FDA
  • Dietary nutrient, pesticide and contaminant (anthropogenic and natural) survey instrument

12:00-13:15  Lunch

13:15 - 14:30  The GEMS/Food International Databases on Food Contamination - Mr Larry Grant, WHO
  • Geneva-based query-response database
  • OPAL I (Operating Programme for Analytical Laboratories - Commodities)
  • OPAL II (Operating Programme for Analytical Laboratories - Total Diet)

14:30 - 15:00  Break

15:00 - 16:30  Presentations of National Total Diet Studies – Mr Mike Rogers, FDA, moderator
  • Australia - Mr Steve Crossley
  • Canada - Dr Robert Dabeka
  • China - Dr Junshi Chen

17:30-19:30  Reception
Tuesday, 27 July

09:00 - 10:30  Presentations of National Total Diet Studies (continued) -
    Mr Mike Rogers, FDA, moderator
    • Czech Republic - Dr Jiri Ruprich
    • Guatemala - Dr Azucena Zuniga
    • Japan - Dr Masatake Toyoda

10:30 - 10:45  Break

10:45 - 12:00  Presentations of National Total Diet Studies (continued) -
    Mr Mike Rogers, FDA, moderator
    • New Zealand - Ms Elizabeth Aitken
    • Spain - Dr Ines Urieta

12:00 - 13:15  Lunch

13:15 - 14:30  Presentations of National Total Diet Studies (continued) and
    Presentations by Other Countries on Chemical Contaminants in their Food Supply
    • United Kingdom - Dr S. Wearne

14:30 - 15:00  Break

15:00 - 16:30  Presentations by Other Countries on Chemical Contaminants in their Food Supply

Wednesday, 28 July

08:30 - 10:30  Analytical Issues - Dr Marion Clower, FDA, moderator
    • Radionuclides- Mr Edmond Baratta, FDA
    • Pesticides and organic contaminants - Dr Richard Vannoort, New Zealand
    • Dioxins - Mr Doug Hayward, FDA
    • Food additives - Dr Yoshiaki Uyama, Japan

10:30 - 11:00  Break

11:00 - 12:00  Analytical Issues (continued) - Dr Marion Clower, FDA moderator
    • Elemental nutrients - Dr Junshi Chen, China
    • Mycotoxins- Dr Mary Truckess, FDA

12:00 - 13:15  Lunch

13:30 - 17:00  Tour of Laboratories
    • Food and Drug Administration (FDA)
    • Environmental Protection Agency (EPA)
    • Midwest Research Institute (MRI) and Linda Hall Science and Technology Library
Thursday, 29 July

09:00 - 11:00  Food Lists - Mr Michael Rogers and Dr Gerald Moy, WHO, moderator
   • Constructing Food Lists - Ms Katie Egan, FDA
   • Food Lists in the New Zealand Total Diet Study - Ms Elizabeth Aitken

10:30 - 11:00  Break

11:00 - 12:00  Food Lists (continued) - Dr Gerald Moy, WHO, moderator
   • Presentations by other countries

12:00 - 13:15  Lunch

13:15 - 15:00  Food Consumption Databases and Use in Dietary Assessments of Contaminants - Dr Michael Adams, FDA, moderator
   • Food Consumption Databases and Use in Dietary Assessments of Contaminants: Approaches and Procedures - Dr Barbara Petersen, Novigen Sciences, Inc.
   • Exposure assessment - uncertainty and variability - Dr Richard Vannoort, New Zealand

15:00 - 15:20  Break

15:20 - 17:00  Food Consumption Databases and Use in Dietary Assessments of Contaminants (continued) - Dr Michael Adams, moderator
   • Using the US TDS to monitor exposure to dietary contaminants - Dr Elke Jensen, FDA
   • Discussion, questions, moderator’s closing comments

Friday, 30 July

08:30 - 10:30  Wrap-up and Panel Discussion - Mr Steve Crossley, moderator
   • Ms Elizabeth Aitken
   • Dr Junshi Chen
   • Ms Katie Egan
   • Dr Gerald Moy
   • Mr Michael Rogers
   • Dr Jiri Ruprich

10:30 - 10:45  Break

10:45 - 11:30  Closing Remarks and Evaluations - Dr Gerald Moy
AGENDA for Week Two
02-06 August 1999

Monday, August 2 - Thursday, August 5
Each session will begin every morning at 8:00 am and run concurrently until 11:00 am.

ANALYTICAL SESSIONS

SESSION I

A. Analysis of Pesticides and Industrial Chemicals (P&ICs) in Fatty and Non-Fatty Foods

Multiresidue P&IC procedures including solvent and supercritical fluid extractions, fat separation by gel permeation chromatography, water removal by solid phase extraction, florisil column chromatography cleanup and gas chromatography determination, quality assurance measures, and findings will be presented.

- Presentation: Chris Sack, 2 hours
- Laboratory: Chris Sack, 2 hours
  Laboratory Assistants: David Graham
  Joe Kramer

B. Carbamate Analysis

Procedure for the analysis of carbamates including liquid-liquid partitioning, charcoal column cleanup, and HPLC-FL with post-column derivatization determination of N-methyl carbamates in selected nonfatty items, quality assurance measures, and findings will be presented.

- Presentation: Bud Whyte, 45 minutes
- Laboratory: Bud Whyte, 30 minutes
  Laboratory Assistant: Rose Palmer

SESSION 2

A. Analysis of Benzimidazole Fungicides

Procedure for the determination of benomyl and thiabendazole in selected nonfatty items including methanol extraction, acid-base partitioning, and HPLC-FL determination, quality assurance measures, and findings will be presented.

- Presentation: Ron Luchtefeld, 45 minutes
- Laboratory: Sheila Egan, 45 minutes
  Laboratory Assistant: Sanna Ford

B. Analysis of Phenylurea Herbicides

Procedure for the determination of phenylurea, herbicides in selected nonfatty items including methanol extraction, florisil cleanup and HPLC-FL with post-column derivatization, quality assurance measures, and findings will be presented.

- Presentation: Ron Luchtefeld, 45 minutes
- Laboratory: Lucie Mactal, 45 minutes
  Laboratory Assistant: Ron Luchtefeld
C. Analysis of Ethylenethiourea (ETU)

Procedure for the determination of ETU in selected items including methanol/water extraction, column chromatography liquid-liquid partitioning, and HPLC- determination with amperometric detection, quality assurance measures, and findings will be presented.

- Presentation: Sheila Egan, 45 minutes
- Laboratory: Sheila Egan, 45 minutes
  Laboratory Assistant: Sanna Ford

SESSION 3

A. Total Diet Sample Preparation

Afternoon laboratory demonstration will be provided

- Laboratory: Kevin Cline, 45 minutes

B. Analysis of Volatile Organic Compounds (VOCs)

Procedure for the determination of VOCs in selected items including purge and trap extraction, and determination by cryogenic desorption on to GUMS, quality assurance measures, and analytical findings will be presented.

- Presentation: Mary Ellen Fleming-Jones, 45 minutes
- Laboratory: Mary Ellen Fleming-Jones, 45 minutes
  Laboratory Assistant: Paul Smith

C. Analysis of Chlorphenoxy Acids and Pentachlorophenol (CPAs)

Procedure for the determination of CPAs in selected items including solvent extraction, florisil cleanup, methylation by ion-pair alkylation and determination by halogen specific gas chromatography, quality assurance measures, and analytical findings for the determination of CPAs in selected items will be presented.

- Presentation: Jim Daft, 45 minutes
- Laboratory: Jim Daft, 45 minutes

D. Supercritical Fluid Extraction (SFE)

Overview of SFE theory, instrumentation, and application will be presented.

- Presentation: Marvin Hopper, 45 minutes

SESSION 4

A. Analysis of Lead, Cadmium, and Nickel by Graphite Furnace Atomic Absorption Spectroscopy

Procedure for the analysis of lead, cadmium, and nickel including dry ash digestion and GFAAS determination, quality assurance measures, instrumentation, contamination control, and analytical findings will be presented.

- Presentation: Duane Hughes, 1 hour
- Presentation: William Mindak, 1 hour
- Laboratory: Duane Hughes, 2 hours
  Laboratory Assistants: David Foran, LaTonya Mitchell
  Angie Mohrhaus, Joan Nandrea
B. Analysis of Mercury Using Flow Injection Analysis

Procedure for the analysis of mercury in selected items including acid solubilization and flow injection analysis (cold vapor) determination, quality assurance measures, instrumentation, and analytical findings will be presented.
- Presentation: Ron Marts, 30 minutes
- Laboratory: Ron Marts, 30 minutes
  Laboratory Assistant: Mark Parmon

SESSION 5

A. Analysis of Elemental Minerals by Inductively Coupled Argon Plasma (ICAP)

Procedure for the analysis of minerals including ternary acid digestion and ICAP determination of selected minerals, quality assurance measures, instrumentation, contamination control and analytical findings will be presented.
- Presentation: Ron Marts, 2 hours
- Laboratory: Ron Marts, 2 hours
  Laboratory Assistant: Harold Watson

B. Analysis of Arsenic and Selenium

Procedure for the analysis of arsenic and selenium including determination by flow injection analysis (hydride evolution), quality assurance measures, instrumentation, contamination control, and analytical findings will be presented.
- Presentation: Barbara Rogolsky, 45 minutes
- Laboratory: Barbara Rogolsky, 45 minutes
  Laboratory Assistants: LaTonya Mitchell Harold Watson

Friday, August 6

08:00 – 09:00   Emerging Techniques for the Determination of Chemical Contaminants -Dr. Adeboye Adejare
09:00 - 09:45   Next Steps - Mike Rogers
09:45 - 10:00   BREAK
10:00 - 11:00   Panel Discussion
11:00 - 11:30   Presentation of certificates
ANNEX III

LIST OF INSTITUTIONS PARTICIPATING
IN THE GEMS/FOOD PROGRAMME

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PI: Participating Institution

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# Annex IV

## United Nations List of Priority Foods and Contaminants

### Core List

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>aldrin, dieldrin, DDT complex (p,p'- and o,p'-DDT, p,p'-TDE and p,p'-DDE),</td>
<td>whole milk, butter, animal fats and oils, fish,</td>
</tr>
<tr>
<td>endosulfan (α and β), endosulfan sulfate, endrin, hexachlorocyclohexane (</td>
<td>cereals*, human milk</td>
</tr>
<tr>
<td>and β) and hexachlorobenzene, heptachlor, heptachlor epoxide and polychlorinated biphenyls</td>
<td></td>
</tr>
<tr>
<td>lead</td>
<td>milk, canned/fresh meat, kidney, cereals*,</td>
</tr>
<tr>
<td></td>
<td>canned/fresh fruit, fruit juice, spices, infant</td>
</tr>
<tr>
<td></td>
<td>food, canned beverages, wine, drinking water</td>
</tr>
<tr>
<td>cadmium</td>
<td>kidney, molluscs, crustaceans, cereals*</td>
</tr>
<tr>
<td>mercury</td>
<td>fish</td>
</tr>
<tr>
<td>aflatoxins</td>
<td>milk, maize, groundnuts, other nuts, dried figs</td>
</tr>
<tr>
<td>diazinon, fenitrothion, malathion, parathion, methyl parathion, methyl</td>
<td>cereals*, vegetables, drinking water</td>
</tr>
<tr>
<td>pirimiphos</td>
<td></td>
</tr>
</tbody>
</table>

* Or other staple foods
### INTERMEDIATE LIST

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>aldrin, dieldrin, DDT complex (p,p'- and o,p'-DDT, p,p'-TDE and p,p'-DD)</td>
<td>whole milk, dried milk, butter, eggs, animal fats and oils, fish, cereals*, vegetable fats and oils, human milk, total diet, drinking water</td>
</tr>
<tr>
<td>endosulfan ( and β), endosulfan sulfate, endrin, hexachlorocyclohexane ( and β, and ), hexachlorobenzene, heptachlor, heptachlor epoxide and polychlorinated biphenyls (congeners No. 28, 52, 101, 118, 138, 153 and 180)</td>
<td>milk, canned/fresh meat, kidney, fish, molluscs, crustaceans, cereals*, pulses, legumes, canned/fresh fruit, fruit juice, spices, infant food, canned beverages, wine, total diet, drinking water</td>
</tr>
<tr>
<td>lead</td>
<td>kidney, molluscs, crustaceans, cereals* flour, vegetables, total diet</td>
</tr>
<tr>
<td>cadmium</td>
<td>fish, fish products, total diet</td>
</tr>
<tr>
<td>mercury</td>
<td>milk, milk products, maize, cereals*, groundnuts, other nuts, spices, dried figs, total diet</td>
</tr>
<tr>
<td>aflatoxins</td>
<td>cereals*, vegetables, fruit, total diet, drinking water</td>
</tr>
<tr>
<td>diazinon, fenitrothion, malathion, parathion, methyl parathion, methy pirimiphos, chlorpyrifos</td>
<td>cereals*, vegetables, milk, drinking water</td>
</tr>
<tr>
<td>radionuclides (Cs-137, Sr-90, I-131, Pu-239)</td>
<td>vegetables, drinking water</td>
</tr>
<tr>
<td>nitrate/nitrite</td>
<td></td>
</tr>
</tbody>
</table>

* Or other staple foods
<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Food</th>
</tr>
</thead>
<tbody>
<tr>
<td>aldrin, dieldrin, DDT complex (p,p'- and o,p'-DDT, p, p'-TDE and p,p'-DD),</td>
<td>whole milk, dried milk, butter, eggs, animal</td>
</tr>
<tr>
<td>endosulfan ( and β), endosulfan sulfate, endrin, hexachlorocyclo- hexane (</td>
<td>fats and oils, fish, cereals*, vegetable fats</td>
</tr>
<tr>
<td>and β and ), hexachlorobenzene, heptachlor, heptachlor epoxide and</td>
<td>and oils, human milk, total diet, drinking</td>
</tr>
<tr>
<td>polychlorinated biphenyls (congeners No. 28, 52, 101, 118, 138, 153 and 180),</td>
<td>water</td>
</tr>
<tr>
<td>dioxins (PCDDs and PCDFs)</td>
<td></td>
</tr>
<tr>
<td>lead</td>
<td>milk, canned/fresh meat, kidney, fish, molluscs,</td>
</tr>
<tr>
<td></td>
<td>crustaceans, cereals*, pulses, legumes, canned/</td>
</tr>
<tr>
<td></td>
<td>fresh fruit, fruit juice, spices, infant food,</td>
</tr>
<tr>
<td></td>
<td>total diet, drinking water</td>
</tr>
<tr>
<td>cadmium</td>
<td>kidney, molluscs, crustaceans, cereals*,</td>
</tr>
<tr>
<td></td>
<td>vegetables, total diet</td>
</tr>
<tr>
<td>mercury</td>
<td>fish, fish products, mushrooms, total diet</td>
</tr>
<tr>
<td>aflatoxins</td>
<td>milk, milk products, eggs, maize, cereals*,</td>
</tr>
<tr>
<td></td>
<td>groundnuts, other nuts, spices, dried figs,</td>
</tr>
<tr>
<td></td>
<td>total diet</td>
</tr>
<tr>
<td>ochratoxin A</td>
<td>wheat, cereals, meat (pork)</td>
</tr>
<tr>
<td>patulin</td>
<td>apples, apple juice, other pomme fruit and</td>
</tr>
<tr>
<td></td>
<td>juice</td>
</tr>
<tr>
<td>fumonisin s</td>
<td>maize</td>
</tr>
<tr>
<td>diazinon, fenitrothion, malathion, parathion, methyl parathion, methyl</td>
<td>cereals*, vegetables, fruit, total diet, drinking</td>
</tr>
<tr>
<td>pirimiphos, chlorpyrifos</td>
<td>water</td>
</tr>
<tr>
<td>dithiocarbamates</td>
<td>cereals*, vegetables, fruit, total diet, drinking</td>
</tr>
<tr>
<td></td>
<td>water</td>
</tr>
<tr>
<td>radionuclides (Cs-137, Sr-90, I-131, Pu-239)</td>
<td>cereals*, vegetables, milk, drinking water</td>
</tr>
<tr>
<td>nitrate/nitrite</td>
<td>vegetables, drinking water</td>
</tr>
</tbody>
</table>

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