Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Food Safety and Control Newsletter

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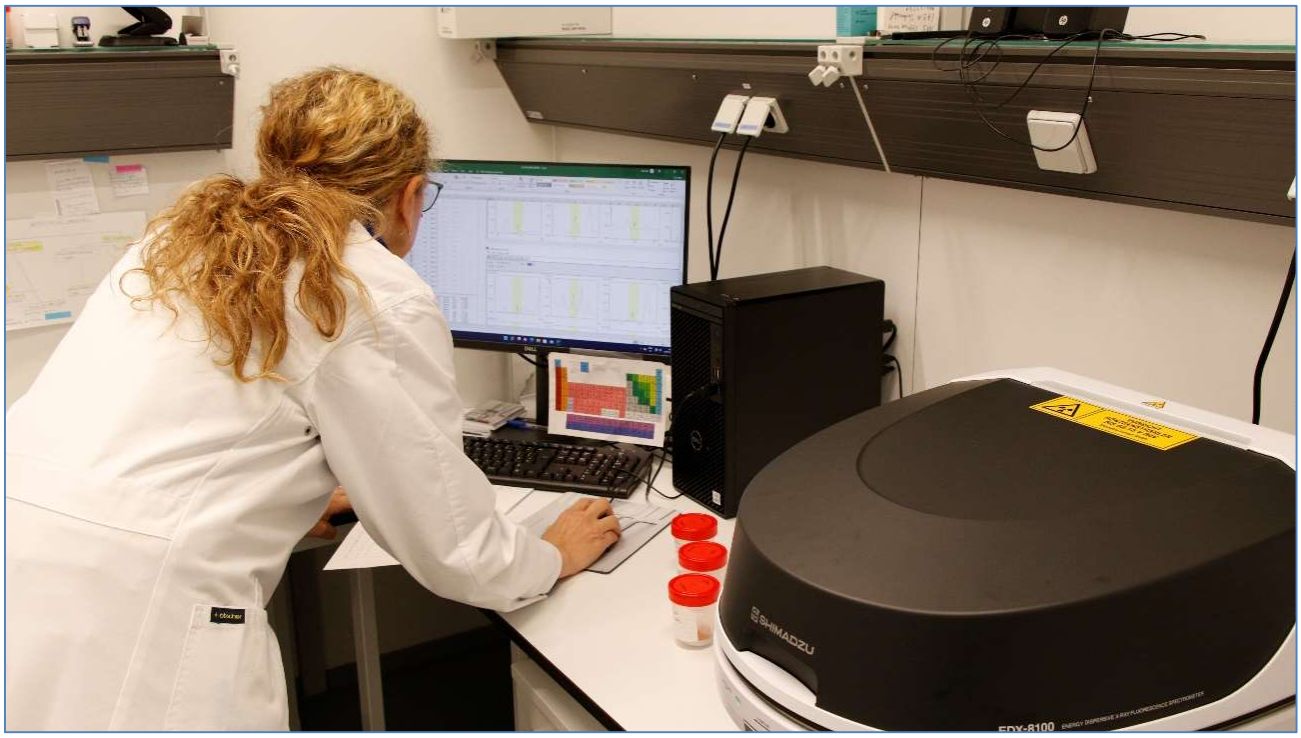
To Our Readers



Research on food authenticity using energy dispersive X ray fluorescence in the Food safety and Control Laboratory.

Greetings to all our readers and very best wishes for a happy and successful 2023! The second half of 2022 has been a very busy period as our subprogramme has striven to maintain and increase outputs in the face of global economic difficulties and disruption, even as we, hopefully, recover from the COVID-19 pandemic and deal with other issues, such as the various effects of climate change on food safety and control.

One major change in our situation is the retirement at the end of October of Mr Qu Liang, who provided strong leadership as the Director of the Joint FAO/IAEA Centre since 2005. We proffer our sincere thanks to Mr Liang for his direction and support over that period, and our best wishes for happiness and fulfilment in the future. From 1 November until further notice, Mr Thanawat Tiensin, who recently took up the position of Director of the Animal Production and Health Division of FAO, Rome, will also act as Officer in Charge of the Joint FAO/IAEA Centre, with Ms Dongxin Feng taking care of day-to-day management of the Centre in Vienna. We welcome Ms Feng and Mr Tiensin to their new roles and look forward to working closely with them pending the appointment of a new Director.

The Food Safety and Control subprogramme continues to play an active role in technology and knowledge transfer,

and this has been demonstrated in the past six months through a number of training courses and workshops, both through the Technical Cooperation Programme and through extra-budgetary funding. These events encompassed various aspects of food safety and quality, including methods of sampling and analysis for residues, contaminants and adulterants in food, risk assessment, proficiency testing, profiling techniques for food authenticity, statistical treatment of results and factors related to the adoption of X ray and electron-beam technologies for food irradiation. Knowledge and information has also been disseminated through a number of international conferences and symposia, including the African Food Safety Workshop, the 8th International Forum on Food Authenticity Technology and Industrial Development in China, the 2nd International Conference on Applications of Radiation Science and Technology, the 14th Rapid Methods Europe Conference and a side event, 'Revealing Secrets Using Nuclear Techniques', at the 66th IAEA General Conference. Overall, in 2022 the training and awareness building activities of the subprogramme have reached well over 1000 people.

Applied and adaptive research continues on several fronts in the Food Safety and Control Laboratory (FSCL). Analytical methods for the control of chemical residues and contaminants and for the verification of food authenticity and geographic origin to underpin regulatory control systems remain major focuses, with an emphasis on rapid methods that can be used to support food control systems in crises or emergencies. A consultancy meeting was held in September to elaborate a new coordinated research project proposal on 'rapid screening for safe food', which will be submitted for potential extrabudgetary funding. In this issue of the newsletter, updates are given on methodology developed for the discrimination of organic and conventionally produced strawberries to protect consumers and industry from fraud, and for the geographical discrimination of palm oils to support sustainable palm oil production. An update is provided on a method for the analysis of residues of neonicotinoid pesticides in honey. These pesticides are implicated in the global decline of bee populations, and their control is vital to food production and to maintain biodiversity in different ecosystems. The validation of a method for the determination of several pesticides and their metabolites in biobed samples is also reported, as is work on methodology for the screening and confirmation of mycotoxins in corn flour and tortillas.

Meanwhile, our coordinated research programme is proceeding much as planned. One project, CRP D52040, 'Field-deployable Analytical Methods to Assess the Authenticity, Safety and Quality of Food' was completed, and two projects have had their end-dates extended from 2022 to 2023 to allow for delays in implementing the workplans due to COVID-19. Research coordination meetings for four projects are reported within these pages.

There are a number of staff changes to report in the Food Safety and Control subprogramme since the previous issue of this newsletter.

Ms Kyoko Narikawa, who has provided exceptional service and support as a team assistant in the Food and Environmental Protection/Food Safety and Control Section since 2013, retired from her post on 30 November 2022. Kyoko is a friend, as well as a respected colleague, to all she has served with now and in the past in the subprogramme. Her commitment, diligence and meticulous attention to detail have contributed significantly to our outputs over the years, and she will be missed. We wish Kyoko happiness and fulfilment in the future, and hope for many visits for coffee in the Vienna International Centre with her old colleagues!

Ms Sonia Veliyath also left the Section at the end of November. Sonia worked with us on a six month consultancy to develop eLearnimg courses from the wealth of material developed for virtual training events over the period of the COVID-19 pandemic. Sonia worked very effectively with the FSC team and external experts and the results of her work are available online on the IAEA NUCLEUS platform. We thank Sonia for her excellent work and wish her all the best for the future.

There are also a number of changes to staff, consultants, interns and fellows in the FSCL. We are sorry to lose Mr Shuichi Nakaya, Ms Aminata Faustmann and our intern, Mr Vamsi Golla, as well as Ms Colette Samantha Eusey-Cuello, Mr Enrique Mejias and Ms Nur Hafizati binti Abdul Halim, who completed fellowships during this period. We welcome the return of Ms Joanna Malgorzata Mletzko, who has re-joined FSCL as a team assistant, Mr An Li who joins as a cost-free expert and Ms Beatriz Pérez-Fernández, who started a one year consultancy in July 2022. These are all detailed within this issue; suffice to say here that we greatly appreciate the contributions of all to our outputs, and our best wishes go to all those who have left FSC in the past six months.

Once again, wishing you and your families all the best for the year ahead.

Andrew Cannavan

Section Head,
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Feature Article

Food Irradiation
The Rise of the Machine

Carl Blackburn, Andrew Cannavan

Irradiating food is a chemical-free way to improve food safety, maintain food quality and extend the useful shelf life of foods. Ionizing radiation is gentle on food, but not on microbes or pests. It does not raise food temperature noticeably and so its controlled application does not compromise nutritional quality and has minimal impact on the taste, texture, and appearance of food. In conventional food irradiation the beams are energetic and penetrating, so pre-packaged foods can be irradiated, and the wrapping protects the food from the risk of adventitious contamination after treatment. The irradiation of at least one type of food commodity is allowed in about 70 countries, and more than 160 irradiation facilities in some 50 countries treat food as part of their everyday business activities. Commercial irradiation centres deliver a certified dosage of ionizing radiation within a predefined dose range to various products, for example for the medical, pharmaceutical and food industries.

A good example of the utility of food irradiation is with dried foods such as spices, where many microbes, including foodborne pathogenic organisms can survive in the desiccated state, e.g., *Salmonella spp., B. cereus* and *C. perfringens*. Although contamination levels might be low, adding dried spices to food provides water and a rich environment in which these organisms can rapidly multiply and thrive. Ionizing radiation destroys the microbes but has minimal effect on the components within the spice responsible for their sensory, quality and wellness attributes. Irradiation can also be used to slow down maturation and prevent foods like garlic, ginger, onions, and potatoes from sprouting. It can also stop pests from developing and reproducing and so is used as a phytosanitary treatment to enable trade across quarantine boundaries. For example, it ensures that economically significant pests like fruit flies and weevils cannot spread to new territories through trade in fresh fruits and vegetables.

At present almost all irradiated food products come from specialist facilities that use gamma rays from cobalt-60, a radioactive isotope that emits high energy photons with energies of 1.17 and 1.33 mega-electron volts (MeV). Gamma ray irradiation accounts for approximately 90% of commercial food irradiation facilities, the remainder using machine source irradiation, where electricity is used to produce high energy electron beams (up to 10 MeV) and/or X rays (typically up to 5 MeV). About 5% of food irradiation service providers have invested in electron beam and X ray machine source capacity in addition to their cobalt-60 irradiation units. This diversity of technology has become important as the demand for radioactive cobalt sources continues to grow. Its production has a lead time of several years and it is becoming increasingly expensive, making electron beam and even X ray irradiation attractive alternatives. There are also practical advantages to machine source irradiation. In contrast to gamma irradiation, machine sources can be turned off. Therefore, they avoid the procurement, transport, storage, disposal, and security issues associated with radioisotopes.

The International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization of the United Nations (FAO) have helped member countries to establish and expand conventional gamma source food irradiation services to reduce food loss and facilitate export trade for various commodities, including dried spices, fresh and frozen seafood and fruits such as mango, dragon fruit, and litchis. Viet Nam, for example, has secured fresh fruit exports to the United States of America worth US $20 million annually and is expanding trade with Australia. Member States are also supported in their efforts to develop novel and practical machine source food irradiation applications through coordinated research, for example the recently completed project, ‘Development of electron beam and X ray applications for food irradiation’. New advances in the field include the development of tools to simulate the food irradiation process and rapidly ascertain optimum treatment parameters. Institutions in China and Viet Nam have designed and built new devices that are helping commercial high energy electron beam irradiation centres to model and calculate dose distributions for different food loading configurations so that the optimum settings can be pre-assessed for rapidly testing at a facility, thereby reducing beam down-time and improving productivity. Experts at Tsinghua University, China, have taken the concept further and worked with the technology company, Nuctech, to develop a commercial product. These and similar tools in development elsewhere aim to facilitate good practice and enhance productivity at gamma, X ray and electron beam irradiation facilities.

Soft Beam Technology

An interesting trend in developing irradiation technologies is related to the ability to tune beam energy from machine source devices. For example, using low energy beams (soft electrons or soft X rays) with energies measured in kilo-electron volts (keV) makes it possible to use relatively compact irradiation lamps that can be housed safely in cabinets or other devices for use directly in food production lines. Soft electrons can be effective even though they cannot pass through the whole bulk of a food, for instance, where microorganisms are found chiefly on or near food surfaces, such as with whole shell-eggs (Figure 1), whole cuts of meat and poultry, and whole dried seeds (herbs and spices). Soft X rays can also be used where the beam needs to pass through small batches of a food.

This technology is promising as a method of surface and near surface microbiological decontamination. The food engineering company, Bühler, for example, has developed a free flow system to pass dried ingredients through a soft electron beam (<300 keV) to ensure that microbiological contamination can be maintained within acceptable levels. An example of soft X ray development for small batch irradiation is where a cabinet type irradiator, generally used to sterilize medical instruments, was investigated as a means of processing food by researchers at the Advanced Radiation Technology Institute of the Korea Atomic Energy Research Institute. This low energy (160 keV) X ray technology, readily available in hospitals, was shown to be capable of ensuring that fresh cut vegetables can be made suitable for consumption by immune-compromised patients.

A new IAEA coordinated research project on innovating radiation processing of food with low energy beams from machine sources aims to address technical challenges and promote the future promise of new soft beam technology. Countries involved in technical cooperation projects in Africa and in the Asia and Pacific Regions have already expressed an interest and a desire for soft beam irradiation to be realized as a commercially viable technology worldwide.

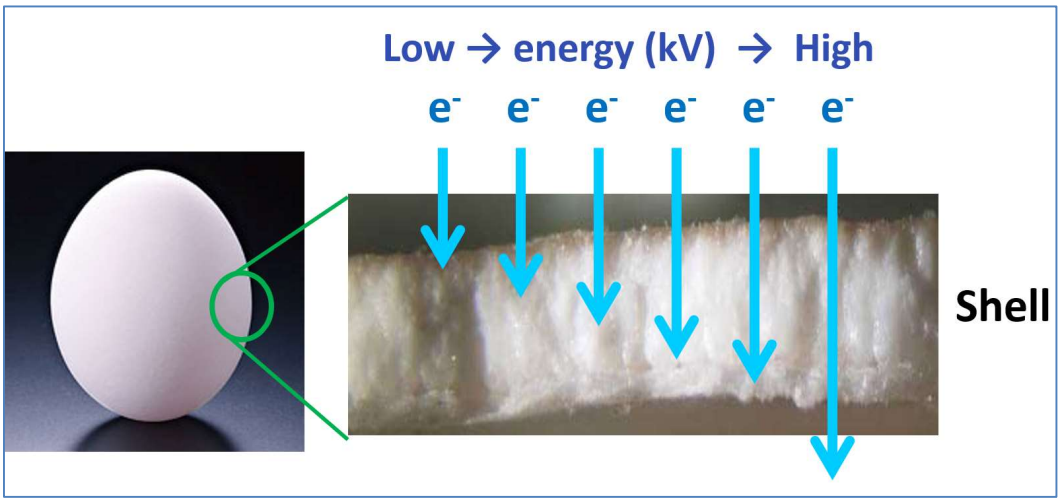


FIG. 1. Concept of using soft electrons with increasing energies to penetrate the shell to an appropriate depth to destroy Salmonella on the surface of whole eggs (Noriaki Kataoka, Tokyo Metropolitan Industrial Technology Research Institute, Japan).

Forthcoming Events

Research Coordination Meetings and Training Courses

Final Research Coordination Meeting on Integrated Radiometric and Complementary Techniques for Mixed Contaminants and Residues in Foods (D52041-CR-4), Vienna, Austria, 8–12 May 2023.

Latin American and Caribbean Analytical Network (RALACA) Workshop on Rapid Screening for Safe Food, Panama City, Panama, 25–26 May 2023.

First Research Coordination Meeting on Rapid Screening for Safe Food (D52045-CR-1), Seibersdorf, Austria, 5–9 June 2023.

Second Research Coordination Meeting on Novel Irradiation Technology for Phytosanitary Treatment of Food Commodities and Promotion of Trade (D61026-CR-2), Strasbourg, France, 3–7 July 2023.

Third Research Coordination Meeting on Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices (D52043-CR-3), Ohrid, North Macedonia, 21–25 August 2023.

Virtual Second Research Coordination Meeting on Nuclear Techniques to Support Risk Assessment of Biotoxins and Pathogen Detection in Food and Related Matrices (D52044- CR-2), 2–6 October 2023

Latin American Risk Assessment Symposium, Lima, Perú, October 2023 (TBC)

International Meetings/Conferences

Codex Committee on Residues of Veterinary Drugs in Foods (CCRVDF26), Portland, Oregon, United States of America, 13– 17 February 2023.

Codex Committee on Contaminants in Foods (CCCF16), Netherlands (TBC), 17–21 April 2023

Latin American Pesticide Residue Workshop (LAPRW2023), Panama City, Panama, 21–24 May 2023

Virtual Codex Committee on Pesticide Residues (CCPR54), China, 26 June – 01 July 2023.

Codex Alimentarius Commission (CAC46), TBD

Past Events

Participation in the 53rd Session of the Codex Committee on Pesticide Residues and Supporting Initiatives to Establish Maximum Residue Limits in 'Minor Crops'

James Sasanya

The Joint FAO/IAEA Centre was represented by Mr James Sasanya at the 53rd CCPR session hosted virtually by China, 4–8 and 13 July 2022. Mr Sasanya addressed over 250 delegates under Agenda item 4b 'Matters of Interest Arising from Other International Organizations', drawing their attention to recent and ongoing activities of the Joint FAO/IAEA Centre that are relevant to the CCPR. He highlighted coordinated research and technical cooperation projects; the Joint Centre's work on capacity building, including supervised field trials and matters related to stability and purity of certified reference material addressed under the session's Agenda item 15, 'Discussion paper on monitoring the purity and stability of certified reference material of multi-class pesticides during prolonged storage'. He also reported the Joint Centre's work on supporting food safety networks and enhancing active participation of developing countries in Codex matters. Research involving the use of radio-labelled material, the results of which could support the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) evaluations and the process of elaborating prioritized Codex MRLs, including dual use compounds, as well as work on analytical methods for testing and monitoring a mixture of chemical hazards including pesticide residues were also presented.

Delegations, referring to their written comments in conference room documents (CRD) such as CRD 22 (Uganda's comments) and CRD 23 (Uruguay's comments), and others through verbal remarks in plenary, appreciated the Joint FAO/IAEA Centre for its support and cooperation in strengthening food safety capacities in their countries, including laboratory capacities and the development of laboratory networks. They asked for continued support and collaboration with the Joint FAO/IAEA Centre.

The CCPR (Chair) and the Codex Secretariat also sought technical input from the Joint Centre on the 'Discussion paper on monitoring the purity and stability of certified reference material of multi-class pesticides during prolonged storage'. Mr Sasanya and the Head of the FSCL, Ms Christina Vlachou, provided feedback and suggestions that were well received. Further, following the meeting the JMPR and the Codex Secretariat requested the Joint Centre to share data arising from a supervised field trial on selected pesticides in okra and analysis of the residues. This information was provided to JMPR and was included in discussions held on 13–22 September 2022. The JMPR summary report of October 2022 considered inclusion of the results submitted by the Joint FAO/IAEA Centre and Uganda, in the database of information previously reported by the JMPR, and according to the procedure described in the 2018 JMPR Report. Whether this contributes to a decision on maximum residue limitss or not, it indicates the importance and relevance of the Joint Centre's work to Codex and its Member States.

The 53rd session of the Codex Committee on Pesticide residues, 2022.

Joining Hands to Enable Food Safety in Africa: Agency-Supported African Food Safety Workshop Brings Together Stakeholders with Solutions

James Sasanya

The Joint FAO/IAEA Centre organized the African Food safety Workshop with the National Metrology Institute of South Africa (NMISA). The workshop was held in Johannesburg, South Africa, from 27 June to 1 July 2022. Over 280 participants from 43 countries attended and addressed a wide range of topics related to food safety, chemical and microbiological hazards as well as matters related to food fraud. The proceedings included 46 oral and 77 poster presentations. Besides overseeing the event as scientific secretary, Mr James Sasanya delivered three presentations on: the Africa Food Safety Network (AFoSaN) - food safety cross-cutting collaborations and capacity building; the burden of disease from drug-resistant infections - monitoring and evaluation of fresh produce; and risk analysis, a cornerstone for effective food safety systems.

The workshop participants recommended that as stakeholders strive to strengthen food safety control systems in Africa, they should continue utilizing existing capabilities resulting in visible socio-economic change that the general public can associate with; and that there is a need to continue biennial African food safety workshops, to further enhance networking (AFoSaN) and promote knowledge generation and sharing. In this regard Egypt expressed an interest in hosting the next workshop in 2024. There was a call to

strengthen capabilities and mechanisms for setting food safety standards, including maximum residue limits; to embrace a One-Health approach to addressing continental food safety issues; and to promote laboratory excellence leading to more ISO accreditations and supporting local institutions involved in the production of reference materials as well as implementing proficiency test and interlaboratory schemes. The workshop also recommended continued education and training on food safety, and strengthening food safety R&D, especially leading to generation of reliable data for standards and improving risk analysis. An additional call was made to address equipment access and maintenance challenges; coordinating and enhancing AFoSaN by facilitating regular meetings, especially for the various committees; assisting stakeholders with resource mobilisation for routine food safety monitoring; addressing food trade rejections and generating information on the burden of food borne diseases. Stakeholders were also urged to enhance the role of metrology and promote its active involvement in food safety on the continent. The wide scope of food safety stakeholders was also encouraged to work closely in each country, establishing systems that interact.

Participants at the African Food Safety Workshop 2022, Johannesburg, South Africa.

Revision of IAEA Specific Safety Guide SSG-8: Radiation Safety of Gamma, Electron and X ray Irradiation Facilities

Carl Blackburn

The IAEA Safety Standards are among the key publications of the organization. Under the auspices of its Statute, the IAEA may establish or adopt safety standards for the protection of health and to minimize the danger to life and property. A meeting was held to review Specific Safety Guide SSG-8 that relates to the safety of gamma, electron, and X ray irradiation facilities. It provides practical recommendations on the safe design and operation of irradiators. The publication is written to give guidance that can be used by operators, designers, and regulatory bodies. Radiation processing is important as it serves many different sectors including the food, medical and industrial sectors. This specific guidance is needed because ionizing radiation can be harmful unless it is properly controlled. The latest version of SSG-8 was published in 2010 and is available online: https://www.iaea.org/publications/8401/radiation-safety-of-gamma-electron-and-x-ray-irradiation-facilities.

Although the publication remains current, reviews like this are necessary to check that the safety standard in question continues to be useful, promotes internationally accepted good practices and fully reflects current IAEA general safety recommendations.

A panel of experts met at the IAEA headquarters from 15 to 19 August 2022, led by Mr Haridasan Pappinisseri, a Radiation Projection Specialist of the IAEA Division of Radiation, Transport and Waste Safety. Mr Carl Blackburn, The Food Irradiation Specialist of the Food Safety and Control section was invited to participate along with international experts from Argentina, France, Serbia and the USA. Practices at operational irradiation facilities were considered and the contents of safety guide SSG-8 were reviewed, including a detailed check against the provisions of the higher-level IAEA general safety requirements. This is the first step of a lengthy and detailed process of consultations to justify the need for such a guide and account for any necessary revisions. The initial detailed review included experts responsible for operating commercial scale irradiation facilities. It is envisaged that the process will result in a revised publication in several years from now.

Second International Conference on Applications of Radiation Science and Technology (ICARST-2022)

Carl Blackburn

The ICARST-2022, which was rescheduled to enable in-person participation as much as possible, was held at the IAEA headquarters in Vienna, from 22 to 26 August 2022. As well as the many that were able to watch proceedings via a live internet feed, some 800 radiation scientists, technologists, entrepreneurs, and policymakers from 90 countries, came to participate and exchange information on the many uses of radiation in sectors as diverse as food, agriculture, industry, engineering and medicine.

Food irradiation highlights included a presentation from Mr Vikram Kalia on trends in the radiation processing of foods in India. Mr. Philippe Dethier also provided an excellent presentation on electron beam and X ray systems for food irradiation that highlighted a new generation of irradiators from Mevex, part of the STERIS company. A series of speakers from Argentina, Tunisia, Egypt, Sri Lanka and Serbia gave presentations on the use of ionising radiation for microbial control in different products. Mr Suresh Pillai, the Director of the IAEA Collaborating Centre at Texas A&M University, United States of America, chaired a session of radiation processing applications in food and agriculture that highlighted research

in the following fields: to improve bioactive compound extraction from olive wastes using gamma irradiation (Portugal); a feasibility study on using high energy X rays for the phytosanitary treatment of mangoes (IAEA Collaborating Centre, Aerial, in France); FCV-F9 virus elimination in fresh product using combined treatments with gamma irradiation (Canada); a concept for a mobile irradiator to contribute to food security (India); and effects of gamma irradiation on fatty acids and biological activities of garlic (Tunisia). Many posters at the conference also highlighted the breadth and depth of research activities in the food and agriculture area.

An article on food and phytosanitary irradiation was also produced for the May edition of the IAEA's flagship publication "IAEA Bulletin" and published to coincide with the conference.

Mr Vikram Kalia, Director of MICROTOL Pvt Ltd, presents at ICARST.

Virtual Training Course on the Use of Rapid Profiling/Fingerprinting Techniques to Determine Food Origin and Verify Food Authenticity

Alina Mihailova, Simon Kelly

A virtual training course on 'the Use of Profiling/Fingerprinting Techniques to Determine Food Origin and Verify Food Authenticity' was held from 22 August to 2 September 2022 under the Peaceful Uses Initiative (PUI) project 'Enhancing Capacity in Member States for Rapid Response to Food Safety Incidents and Emergencies', which is funded by the Japanese Government. The objective of the training was to enhance the capabilities of laboratory personnel in Member State institutions in the application of rapid, untargeted screening methods, enabling Member States to respond to food safety-related incidents and emergencies and to improve their food control systems.

The course covered the following techniques:

- Infrared spectroscopy, including Fourier transform infrared (FT-IR) and Fourier transform near-infrared (FT-NIR);
- Benchtop nuclear magnetic resonance (NMR) spectroscopy;
- Gas chromatography - ion mobility spectrometry (GC-IMS);
- Multi-spectral imaging (MSI);
- Spectral data processing and chemometrics to enable interpretation of the data.

The virtual training employed pre-recorded lectures, video presentations of laboratory procedures (sample preparation, instrumental analysis, data processing, chemometrics) and 'live' online question-and-answer sessions. In addition, examples of standard operating procedures and method protocols were provided to course participants to foster adoption of the demonstrated methods in their own laboratories. Course materials were made available to participants via the NUCLEUS SharePoint site.

The course was attended by 111 scientists from institutes in 33 countries: Bangladesh, Belarus, Côte D'Ivoire, Ecuador, Egypt, Greece, India, Indonesia, Iraq, Jordan, Kuwait, Lebanon, Libya, Malaysia, Mauritius, Mongolia, Morocco, Myanmar, Oman, Pakistan, Qatar, Saudi Arabia, South Africa, Sri Lanka, Tajikistan, Tanzania, Togo, Tunisia, United Arab Emirates, Uganda, Uruguay, Viet Nam and Zimbabwe.

In addition to the FSCL staff, this training was delivered by external experts from the United Kingdom (Ms Kate Kemsley, Quadram Institute) and Belgium (Mr Vincent Baeten, Mr Juan-Antonio Fernandez Pierna, Walloon Agricultural Research Centre), and contributors from Bruker Optics (Germany), Bruker BioSpin (Germany), Magritek (UK), Perkin Elmer (UK, Belgium), Videometer (Denmark), G.A.S. Dortmund (Germany), Metrohm (United States of America), and Imprint Analytics (Austria).

Ms Alina Mihailova moderating the Q&A session on infrared spectroscopy techniques and chemometrics.

The virtual training course was very well received. Of the participants who completed an anonymous online feedback questionnaire, 94.3% rated the course as 'very good' or 'excellent' and indicated that the information provided during the course would be implemented in their activities or laboratory work at their home institution. The content of the training course can be accessed by registered IAEA NUCLEUS account holders here: https://nucleus.iaea.org/sites/nafa-projects/tranining-profiling-fingerprinting/SitePages/Home.aspx.

66th IAEA General Conference Side Event 'Revealing Secrets Using Nuclear Techniques'

Alina Mihailova, Simon Kelly

The 66th Annual Regular Session of the IAEA General Conference was held from 26 to 30 September 2022 at the Vienna International Centre in Vienna, Austria, and was attended by high-ranking officials and representatives from IAEA Member States. The Department of Technical Cooperation (TC), Division for Europe, organized a side event entitled 'Revealing Secrets Using Nuclear Techniques', which was held on the 26th September 2022. The side event gave attendees an opportunity to learn about non-destructive nuclear techniques and stable isotope analysis and their diverse applications, including the investigation of the composition, origin and authenticity of paintings and historical artefacts, the detection of food fraud, as well as the verification of the authenticity and origin of food products and timber.

The opening address was given by Ms Melissa Denecke, Director of the Division of Physical and Chemical Sciences. The event was moderated by Ms Emina Alic, a Programme Management Officer in the TC Division for Europe. The speakers included Mr Matthew Grima (Heritage Malta), Ms Lucile Beck (Alternative Energies and Atomic Energy Commission, France), Ms Lidija Strojnik (Josef Stefan Institute, Slovenia), Ms Alina Mihailova (IAEA) and Ms Federica Camin (IAEA).

Ms Lidija Strojnik gave an overview of stable isotopes and demonstrated several success stories of the applications of stable isotope analysis to verify the authenticity and geographical origin of local Slovenian milk and truffles. This research work has been supported by the Joint FAO/IAEA Centre's Food Safety and Control Laboratory (FSCL) though the CRPs D52038, 'Accessible Technologies for the Verification of Origin of Dairy Products' and D52042, 'Implementation of Nuclear Techniques for Authentication of Foods with High-Value Labelling Claims'.

The side event also showed the applications of novel compound-specific stable isotope approaches for the verification of food authenticity developed in the FSCL. One of the case studies, performed together with IAEA Isotope Hydrology Laboratory, demonstrated the application of stable oxygen and nitrogen isotope analysis of plant-derived nitrate by a titanium (Ti(III)) reduction method for the discrimination between organic and conventional strawberries. Another case study showed the application of a novel hydrogen stable isotope method for the detection of pineapple juice adulteration with cane sugar.

The side event attracted a lot of interest from the attendees on the issues related to food fraud and food authenticity, which were discussed during the Q&A session and after the event.

Ms Alina Mihailova giving a presentation on the compound-specific stable isotope approaches for the verification of food authenticity developed in the Food Safety and Control Laboratory.

14th Rapid Methods Europe Conference

Alina Mihailova

The Rapid Methods Europe (RME) conferences are dedicated to innovations and breakthroughs in rapid analysis and diagnostics across the agri-food, water, animal health, healthcare, and forensic sectors. The conference series aims to further strengthen academia-industry relations and disseminate advanced research towards practical applications.

The 14th in the series of RME conferences was held in Amsterdam, the Netherlands, from 3 to 5 October 2022. The opening address was given by Dr Aart van Amerongen from BioSensing & Diagnostics at Wageningen University, the Netherlands. The programme included sessions on food and feed integrity, plant diagnostics, environmental quality, human health, animal health and forensics. There were several workshops on the development of DNA/RNA-based, immuno-based and spectroscopy-based methods as well as proficiency testing.

Ms Alina Mihailova gave an oral presentation at the Food and Feed Integrity Session entitled, 'Benchtop and portable spectroscopy techniques for food authenticity screening'. The presentation gave an overview of the latest applications of the rapid screening techniques, such as infrared spectroscopy and multispectral imaging, used at the FAO/IAEA Food Safety and Control Laboratory for research related to the verification of food authenticity and origin. The presentation was well received and attracted considerable interest in the R&D activities of the FSCL. Other presenters in the Food and Feed Integrity Session also demonstrated the potential of infrared spectroscopy, ion mobility spectrometry and other rapid screening techniques for food authenticity and food safety testing. New developments, current limitations, and future needs in the area of untargeted spectroscopic screening and related data processing and chemometric approaches, as well as the

importance of the integration of rapid screening techniques and AI, were also discussed.

Ms Alina Mihailova giving a presentation on benchtop and portable spectroscopy techniques for food authenticity screening.

8th International Forum on Food Authenticity Technology and Industrial Development & Annual Meeting of the Chinese National Center of International Research on Food Authenticity Technology

Simon Kelly

The eighth International Forum on Food Authenticity Technology and Industry Development was held as an on-line event on 11 and 12 November 2022. The forum was organized by the Chinese National Centre of International Research on Food Authenticity Technology. Over 13,000 people attended through on-line participation. The forum was designed to address the requirement for the development of new methods and techniques to verify the quality, authenticity, and safety of food. Dr Liang Qu (recently retired Director of the FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture) gave an introductory speech. He welcomed the participants and described the historical formation of the partnership between the FAO and IAEA and its important work in the areas plant health, animal production, insect pest control, soil and water management and its applied and adaptive research in the area of food authenticity and traceability over the past 13 years. Another 27 Chinese researchers and industrialists, plus seven international researchers, gave presentations.

Mr Simon Kelly gave an invited presentation in the *'Analysis on the development of stable isotope and metabolomic research in the field of traceability of agricultural products'* session, on 'Organic Food Authentication: Is it really organic? What do Isotopic techniques have to offer?'. This is of particular importance to Chinese researchers at the moment because China is currently the fourth largest consumer of organic food, by value, globally and this is predicted to continue to increase. In 2018, China's organic agriculture acreage ranked third in the world, accounting for 4.5% of the total land-area of global organic agriculture and 50% in Asia.

Mr Kelly presented the theoretical basis underpinning the use of nitrogen isotope analysis to distinguish between conventional plants that have been cultivated with synthetic nitrogen fertilisers and organic plants fertilised with mammalian manures. He showed how this approach had successfully been applied to develop a test for organic tomatoes, published in the Journal of Agricultural and Food Chemistry. He then explained the limitations of the technique and consequently presented the use of oxygen-18 isotope analysis of nitrate extracted from plant material as a further development of the technique that improved the detection of mislabelled conventional produce and helped overcome the confounding factor of leguminous crop-rotations in organic cultivation systems. Mr Kelly finished by summarising the advantages and disadvantages of several different analytical techniques to differentiate between organically and conventionally cultivated crops.

Mr Liang Qu (former Director of the FAO/Joint Centre) giving a keynote lecture at the 2022 International Forum on Food Authenticity Technology and Industry Development.

Mr Kelly then participated in a 30-minute live question and answer session with Dr. Enrico Valli, Dr. Ivan Smajlovic, Dr. Carsten Fauhl-Hassek and Professor Saskia van Ruth. Participants at the forum asked two questions related to Mr Kelly's presentation. The first was regarding determination of authentic organic food cut-off points from databases. Mr Kelly explained that establishing a robust database of authentic samples is one of the most important conditions if a stable isotope method is to be used as an officially acknowledged procedure for organically cultivated plant quality control. The second question was regarding whether stable nitrogen isotope analysis was being used by organic certification bodies to confirm if synthetic nitrogen fertilisers had been used in organic food production. Mr Kelly spoke of his experiences in the United Kingdom where some food retailers were routinely using the technique to gather 'intelligence' on suppliers of organic food. He explained that he was aware of some European certification bodies who had discussed using it in the past, but that he could not unequivocally confirm if it was currently being used. Mr Kelly concluded by stating that, in his opinion, the technology is best used in conjunction with inspection and certification systems and that this would be the optimum *modus operandi* rather than relying completely on certification, or completely on end product testing.

Coordinated Research Projects

CRP Reference Number	Ongoing CRPs	Project Officer
D52040	Field-deployable Analytical Methods to Assess the Authenticity, Safety and Quality of Food	S. Kelly
D52041	Integrated Radiometric and Complementary Techniques for Mixed Contaminants and Residues in Foods	J.J. Sasanya
D52042	Implementation of Nuclear Techniques for Authentication of Foods with High-Value Labelling Claims (INTACT Food)	S. Kelly
D52043	Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices	J.J. Sasanya
D52044	Nuclear Techniques to Support Risk Assessment of Biotoxins and Pathogen Detection in Food and Related Matrices	J.J. Sasanya
D61025	Innovating Radiation Processing of Food with Low Energy Beams from Machine Sources	C.M. Blackburn
D61026	Novel Irradiation Technology for Phytosanitary Treatment of Food Commodities and Promotion of Trade	C.M. Blackburn

Final RCM of CRP D52040, 'Field-Deployable Analytical Methods to Assess the Authenticity, Safety and Quality of Food'

Simon Kelly

The Joint FAO/IAEA Centre held the fourth and final research coordination meeting (RCM) for the coordinated research project (CRP) to utilize and adapt bench-top, portable and hand-held nuclear and molecular spectroscopic technologies for food authenticity screening, as an on-line event,13–21 June 2022. The meeting participants comprised seven research contract holders from China, India, Malaysia, Morocco, the Russian Federation, Sri Lanka and Uganda; six research agreement holders from Austria, Belgium, Sweden, the United Kingdom, the United Kingdom and the United States of America; and three observers representing Barilla G.R. F.lli SpA (Italy), the Institute of Chemical Physics RAS (Russian Federation) and the University of Cape Coast (Ghana). In addition, there was one attendee in an individual capacity from the Walloon Agricultural Research Centre (Belgium).

The scientific secretary, Mr Simon Kelly, reintroduced the background, scope and objectives of the CRP to the participants. He presented a summary of the expected outcomes of the project and the main aims of the final RCM, which included contributions to the meeting report; the requirements for the project technical document (TECDOC); an output table to demonstrate the success of the project; lessons learned and possibilities for collaboration beyond the life of the project. On the basis of the research contract holders' presentations and follow-up discussions, the contributions to the TECDOC were reformulated, when necessary, to take account of advice from the meeting. The agreement holders and observers presented updates their research that was of relevance to the project, including opportunities for funding, training and collaboration.

Despite the challenges of the Covid-19 pandemic, and the detrimental effects of lock-down periods on access to laboratories and the opportunities for authentic sample collection, the key objectives had been met and the project had reached a successful conclusion. It was agreed that there has been a measurable increase in capacity for this technology in the participating Member States. There has also been a demonstrable engagement with relevant stakeholders in the food industry and regulatory bodies that raised the profile of the project, its participants and its outputs. Major achievements include: 1) the establishment of the IAEA shared spectral data library upload tool, through a technical contract with the Walloon Agricultural Research Centre (Belgium), as a repository for spectra from authentic vegetable oil and milk powder samples gathered through the various rapid screening techniques (near infrared, mid infrared, Raman, nuclear magnetic resonance); 2) the distribution of sealed calibration units of vegetable oil and milk powder to ensure inter-comparability of spectra between different laboratories and equipment 3) the finalization of the chemometrics add-in for excel (CAFE) software and eLearning package covering principal component analysis, principal component regression, partial least squares analysis, one-class soft independent modelling by class analogy and partial least squares discriminant analysis for two, three or more classes; 4) significant scientific output as evidenced by 16 research articles

published in peer-reviewed journals over the 5-year lifespan of the project.

The consortium's final recommendations focused on the firm commitment from the Walloon Agricultural Research Centre to continue to support the shared spectral library beyond the lifetime of the project and for the IAEA to maintain the CAFE software and accompanying training modules through their eLearning platform (CLP4NET). The RCM provided a forum for the incubation of ideas for further research and development. It is anticipated that these ideas will lead to further collaborations and cooperation between Member States using portable nuclear and complementary technologies for rapid food safety and authenticity screening in the future.

Some of the D52040 RCM participants using Microsoft Teams.

First RCM of CRP D52044, 'Nuclear Techniques to Support Risk Assessment of Biotoxins and Pathogen Detection in Food and Related Matrices'

James Sasanya

The first research coordination meeting (RCM) for the CRP, 'Nuclear Techniques to Support Risk Assessment of Biotoxins and Pathogen Detection in Food and Related Matrices' was held in Vienna, Austria, from 22 to 26 August 2022, with 16 participants from Argentina, Bangladesh, China, Indonesia, Morocco, Pakistan, Philippines, South Africa, Tunisia, Uganda, and the USA as well staff of the IAEA attending. This new 5-year CRP has a One Health perspective. It brings together a wide range of researchers, including toxicologists, microbiologists, chemists, and veterinary public health specialists with knowledge of epidemiology and risk assessment and focuses on nuclear, isotopic and related techniques, and generation of data on biotoxins such as cyanotoxins in fresh/inland water and associated food matrices along the food chain. It also involves work on biomarkers of these toxins; some targeted mycotoxins; toxins from pathogens; and pathogens of zoonotic and nonzoonotic nature associated or potentially associated with outbreaks of illness, as well as national or international emergencies and concerns. The project is therefore of great significance to initiatives such as ZODIAC.

The CRP includes studies that are novel for foodborne pathogen detection by, for instance, combining isotope labelling technique with matrix-assisted laser desorption ionization time of flight mass spectrometry (MALDI-ToF MS). This is totally different from previous or current conventional methods based on the simple fingerprint comparison. This method is dependent on the quantification of isotopic peaks of specific biomarkers to accurately differentiate bacteria. Through data independent acquisition, quantitative proteomics and statistical analysis, a series of biomarkers for different species can be identified and expressed using stable isotope labelling with amino acid in cell culture (SILAC) medium to get the heavy labelling form. This novel technique has significant potential for the detection of foodborne pathogens in the future.

The meeting was well organized and demonstrated that there is a lot in common among the Member States involved in the CRP, and that participants can collaborate on a range of common topics related to biotoxins and food pathogens. Some participants (from China) could attend only virtually. While virtual meetings can help where travel is restricted, there are limitations, including disruption of remote participants' attention and transmission challenges, among others. Face-to-face meetings are therefore irreplaceable.

The CRP participants appreciate research funds provided and that these have helped some investigators to obtain extrabudgetary funding, e.g. in the Philippines, where the CSI received a grant of € 209 000 from the National Agency, Department of Science and Technology. Nevertheless, additional funding opportunities are needed. This would, for instance, support a range of inter-laboratory activities including method validation, comparisons, proficiency testing etc.

Participants at the first Research Coordination Meeting for CRP D52044 in Vienna.

A number of activities, such as synthesis of labelled material, implementation of isotopic techniques including SILAC, DNA probe labelling etc., and database creation were identified as urgent areas of need that could be

addressed by technical contracts. The meeting also addressed the need to plan for increased visibility of the project and its findings as well as sustainability or continuity. Morocco expressed willingness to host the next RCM in October 2023, if conducted in-person.

Consultants' Meeting on Rapid Screening for Safe Food

Britt Maestroni

A consultant's meeting was organized from 26 to 30 September 2022 at the Food Safety and Control Laboratory in Seibersdorf, Austria. The meeting was attended in person by seven experts and virtually by additional four participants. Six observers from the private industry participated partially; one of the private companies allowed participation in person for two representatives for the entire duration of the meeting. Three staff members of the Food Safety and Control Laboratory (FSCL) participated.

The purpose of the consultant's meeting was to:

- produce recommendations on the scope and objectives of a new coordinated research project (CRP) on 'Rapid Screening for Safe Food';
- design a project document including the activities needed to achieve the CRP objectives to be able to submit the project proposal to donors' funding;
- advise on the development of nuclear and related analytical techniques for rapid food safety testing
- establish the pre-requisites for laboratories for participation in the CRP;
- elaborate annexes to the meeting report to include references to current regulatory frameworks for sampling of commodities, analytical techniques/ methodologies for rapid screening;
- prepare a list of suggested laboratories/ countries/experts in different analytical areas;
- advise the FAO/IAEA Joint Centre on possible sources for extra-budgetary funding;
- prepare a report of the meeting, including recommendations to the Agency.

After the introductory remarks and administrative communications, a draft CRP proposal was presented by the technical officer to the meeting participants. The draft document was introduced as a starting point for brainstorming and discussions at the consultants' meeting. Following the CRP framework setting, experts' presentations were provided by representatives of the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) on analytics in the context of development projects and the new WHO global food safety strategy with a focus on laboratory related objectives.

The presentations of the second day of the meeting focused on the following topics: challenges in low and middle income countries for rapid screening of mycotoxins; an overview of the state of the art and current research needs for mycotoxins; solutions based on artificial intelligence for food safety; rapid screening by sound wave and Raman spectroscopy to ensure food integrity; point of use biosensing strategies based on nanomaterials for food contaminants; portable sensors for quality and safety of cocoa, rice and palm oil, rapid and cost effective determination of food adulteration and contamination. Day two ended with a demonstration of the use of screen-printed carbon electrodes for the determination of aflatoxins in pistachio and heavy metals in turmeric teas by FSCL technical staff.

Day three was mainly dedicated to the experience gained by the private sector in rapid and portable screening. The mycotoxins issue was discussed in terms of the industrial food safety management using deoxynivalenol as an example. Databases and chemical informatics tools were also discussed as essential tools. Rapid food safety testing using surface enhanced Raman spectroscopy was discussed and demonstrated in a demo session using portable devices. Direct mass spectrometry for rapid testing for food integrity was presented as a possible approach for rapid testing. A representative from the Walloon Agriculture Research Centre provided an overview of potential future ideas for research development and collaboration.

The other sessions of the meeting comprised structured discussion sessions about the different sections of the CRP proposal and recommendations to the Joint FAO/IAEA Centre.

The consultants successfully achieved the meeting objectives and also advised on important points that need to be considered in the evaluation of proposals by potential research contract holders. These prerequisites are:

- Regular, relevant R&D expertise in the agri-food value chain area
- Substantiated interest in data sharing
- Relevant scientific publishing track record
- Willingness to collaborate with project partners
- Commitment to transfer knowledge to a wider group of relevant stakeholders (other labs and networks, universities, authorities)
- Access to relevant operational laboratory equipment
- Long-term availability, management of retention/sustainability of knowledge
- Commitment to participate in regular online meetings
- Ability and flexibility to regularly communicate about the project
- Established QA/QC system in the laboratory
- Versatility in types of analyses/commodities and, potentially, availability of a contingency plan for crises situations

The experts prepared a set of recommendations to the Agency which included:

- IAEA should be very proactive when it comes to communication of the current activities and identification of stakeholders.
- IAEA should increase the collaboration with the private sector as much as possible, particularly to leverage in-kind contributions from instrument manufactures, e.g. loan equipment to demonstrate its utility within the scope of this CRP proposal

The experts noted that the meeting was very enriching from a technical perspective, it was focussed, the selection of participants was very good, there was an adequate balance in terms of expertise to discuss the different aspects of the proposal, between analytical scientists, regulatory experts and private industry. The meeting was timely and very innovative in terms of the subject topic. One expert noted that this CRP proposal will provide sub-Sharan countries with an improved food safety agenda and impetus to new preventative measures for food safety.

The CRP document on rapid screening for safe food is currently being internally reviewed by IAEA and, when funding is ensured, the research project will be published on the IAEA Research Contract Section webpages and will be open for submission of research proposals by the member states.

Innovating Radiation Processing of Food with Low Energy Beams from Machine Sources (D61025)

Carl Blackburn

The second research coordination meeting (RCM) of coordinated research project (CRP) D61025 on innovating radiation processing of food with low energy beams from machine sources was held from 10 to14 October 2022 at the IAEA Headquarters in Vienna. The overall objective of the CRP is to promote the innovation of in-line and in-house radiation processing of foods using low energy beams. This is being achieved by research to produce data and increase know how in the use of low energy beams of ionizing radiation for different types of food treatments. Publication of such fundamental information is necessary to prepare a solid technical and scientific foundation for the expansion of soft electrons and soft X ray technologies (kilo-electron volt electron beams and X rays) for food uses.

At the second RCM, updates and newly generated research outputs were presented by representatives of twenty-one organizations from eighteen countries (Argentina, Canada, China, France, Ghana, the Islamic Republic of Iran, Japan, Republic of Korea, Pakistan, Philippines, Poland, Portugal, Switzerland, Syria, Tunisia, Turkey, Viet Nam, and USA). Although two research groups in China and one in Turkey could not be present in person at the meeting, their representatives were able to provide information by video-link. Research contracts for institutes in Syria, Tunisia and Turkey were initiated after the first research coordination meeting in September 2021 and these new research participants were made particularly welcome at the opening session.

The RCM was successful in reviewing the research achievements of CRP D61025 obtained so far. Progress towards the CRP research objectives were assessed, workplans and collaborations were tweaked to address any necessary modifications.

In many instances, the irradiation of food using low energy beams may be sufficient to eliminate pathogens, insects, and spoilage organisms. A deeper understanding of the science, technology, and the processes associated with soft beams and associated equipment can facilitate their use in the food industry for in-house (in-line/end of line) solutions for phytosanitary measures as well as food safety and quality challenges. Some of the challenges being researched include efficacy, microbiology, process control, and optimization. Targeting microorganisms residing on or near food surfaces (e.g., whole shell-eggs, raw whole cuts of meat and poultry, fresh vegetables, dried herbs and spices) with soft electrons or using soft X rays for phytosanitary applications are economically attractive options because they will enable treatments to take place in food factory or packing house and avoid the additional logistics needed in conventional irradiation that uses mega-electron volt energy irradiation with gamma rays , electron beams and X rays, where treatments must be shielded in specialist irradiation facilities. The food needs to be transportation to these specialist irradiation service centres.

Participants at the second Research Coordination Meeting of CRP D61025.

Third RCM of CRP D52042, 'Implementation of Nuclear Techniques for Authentication of Foods with High-Value Labelling Claims'

Simon Kelly

The Joint FAO/IAEA Division held the third meeting of the five year coordinated research project (CRP D52042) as a hybrid, event from 31 October to 4 November 2022. The main objective of the CRP is to conduct applied and adaptive research to elaborate stable isotope and other nuclear or complementary methods to verify the authenticity and provenance of premium foods with added-value labelling claims, such as Geographical Indications, organic food, religious/ethical compliance or natural rather than synthetic food components. The in-person participants comprised twelve research contract holders (from Argentina, Chile, Costa Rica, India, Indonesia, Jamaica, Malaysia, Morocco, Myanmar, Slovenia, Thailand and Uruguay), seven research agreement holders (from Denmark, Germany, Italy, Japan, New Zealand, Spain and USA) and two observers representing the University of Cordoba (Argentina), and the National Institute of Standards and Technology (NIST, USA). The four on-line participants comprised three research contract holders, one from Brazil and two from China, and one research agreement holder from China.

The third RCM commenced with a welcoming address from the Food Safety and Control (FSC) Section Head, Mr Andrew Cannavan, and the FSC Laboratory Head, Ms Christina Vlachou. This was followed by brief introductions from the meeting participants and appointment of the chairperson, Mr Russell Frew. The scientific secretary, Mr Simon Kelly, then gave a presentation providing a brief reminder of the objectives of the project and an overview of the administrative aspects of the project. This included the expansion of the project for its final stages with new partners, funded by the U.S. State Department through the Peaceful Uses Initiative (PUI), with the additional objective of developing an authenticity laboratory network (FALNET), and the food commodities being studied, including those in the new research projects. The research contract holders presented their project progress with questions and answers and comments from the research agreement holders and other meeting participants. The agreement holders' technical presentations were on a range of topics of relevance to the contract holders. These presentations reinforced understanding of the principles of food authentication using stable isotope and trace element (SITE) fingerprinting, and screening techniques such as near infrared spectroscopy, as well as providing case studies of how the data generated can be applied in 'real-world' food authentication situations. Group sessions in the 'World Café' format were held to evaluate and refine the contract holders' final phase proposed workplans. The focus of the next 12–18 months of the project is to maintain the momentum. Harmonised methods are in place, which use appropriate reference materials to ensure data quality. In this final phase, the methods will be used to generate and collate data that will facilitate one of the key objectives of the CRP, which is to populate the shared database created by NIST with high-quality data from samples of known provenance, thus enabling Member States to protect and promote food products with added-value labelling claims.

After the RCM, a meeting of the Latin American and Caribbean (LAC) participants was held to discuss the supplementary funding received from the U.S. State Department. This funding was provided to support an additional five research contract holders from LAC within CRP D52042, support the formation of a food authenticity laboratory network in the LAC region, and to facilitate the construction of an open-access database for comparison of SITE data derived from authentic food samples. It was anticipated by the meeting participants that although the laboratory network would be initiated in LAC, it would grow to include and/or network with other countries and other regions.

In-person participants in the third Research Coordination Meeting of CRP D52042. (Online participants from Brazil and China also took part in the meeting via Microsoft Teams).

Technical Cooperation Projects

Country/Region	Project No.	Title	Technical Officer
Burundi	BDI5003	Strengthening National Capacities for Monitoring and Testing Veterinary Drug Residues in Food	J.J. Sasanya
Burundi	BDI5004	Enhancing Control of Chemical Residues and Related Contaminants in Food	J.J. Sasanya
Benin	BEN5013	Expanding Analytical Capabilities for Systematic Control of Veterinary Drug Residues and Related Contaminants in Foodstuff	J.J. Sasanya
Bangladesh	BGD5032	Building Capacity in Improving Food Safety Using Nuclear and Other Complementary Analytical Techniques	S.D. Kelly
Bangladesh	BGD5034	Enhancing Competence in Nuclear and Complementary Capabilities for Testing/Monitoring Veterinary Drug Residues and Other Contaminants in Foods	J.J. Sasanya A. M.V. M. Rodriguez y Baena
Bahrain	BAH5002	Establishing a National Quality Control Standard for Foodstuffs and Fishery Products	J.J. Sasanya
Bosnia and Herzegovina	BOH5003	Using Nuclear Technology in Enhancing Science Based Safety, Quality and Control Systems in Feed and Food Chains	A. Cannavan
Botswana	BOT5020	Enhancing Capabilities for a Holistic Approach to Testing Food Hazards in Poultry Production and Products	J.J. Sasanya
Botswana	BOT5023	Enhancing Control of Food Hazards in Poultry Production and Products	J.J. Sasanya
Belize	BZE5011	Strengthening Laboratory Capabilities to Monitor Contaminants in Fisheries Products	B.M. Maestroni
Cameroon	CMR5025	Improving Laboratory Testing Capabilities to Enhance the Safety and Competitiveness of Agricultural Products - Phase I	J.J. Sasanya
Chile	CHI0021	Building General Capacity for Nuclear Science and Technology Applications in Key Sectors	S.D. Kelly J.J. Sasanya
Chile	CHI5053	National Reference System for Verification of Authenticity and Determination of Origin of Food using Nuclear Isotopic Techniques	S.D. Kelly
Costa Rica	COS5037	Strengthening Capabilities to Analyse and Monitor Toxic Metals in Animal Products	J.J. Sasanya
Cuba	CUB5022	Promoting Food Safety through the Mitigation of Contaminants in Fruits for Human Consumption	C.M. Blackburn J.J. Sasanya
Djibouti	DJI5001	Developing Nuclear/Isotopic and Complementary Food Safety Testing Capabilities	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Dominica	DMI5002	Enhancing Capacity to Monitor Agrochemical Residues in Foods and Related Matrices	J.J. Sasanya
Dominica	DMI5003	Strengthening a Nuclear Isotopic Laboratory and Complimentary Field Food Safety Surveillance Capabilities	J.J. Sasanya
Dominican Republic	DOM5005	Strengthening National Capabilities to Ensure Food Authenticity	S.D. Kelly
Ecuador	ECU5030	Reducing Post-Harvest Losses of Native Potatoes and other Fresh Foods by Irradiation	C.M. Blackburn
Ecuador	ECU5033	Strengthening Laboratory Capacities for Monitoring Residues of Neonicotinoid Pesticides in Honey Bees and Honey	B.M. Maestroni
Eritrea	ERI5012	Developing Analytical Capabilities for Food Safety	J.J. Sasanya
Eritrea	ERI5014	Enhancing Food Safety Analytical and Monitoring Capabilities	J.J. Sasanya
Fiji	FIJ5002	Increasing Trade and Export Capacities of Selected Value Chains within the Agro-Food Sector through the Adoption of an Appropriate Quality Infrastructure	C.M. Blackburn
Fiji	FIJ5005	Establishing a Food Safety Laboratory for Analysis of Pesticide Residues in Fresh Fruits, Vegetables and Root Crops — Phase II	B.M. Maestroni
Georgia	GEO5001	Enhancing National Programmes for Testing and Monitoring Food Contaminants and Residues	J.J. Sasanya
Haiti	HAI5009	Strengthening Laboratory Capacity to Test and Monitor Food Contaminants	J.J. Sasanya
Honduras	HON0003	Improving National Capabilities in the Use of Nuclear Technologies for the Promotion of Sustainable Development Goals	Mr P.D.M. Brisset Ms T. Jevremovic Ms I.T.Bertral J.J. Sasanya
Indonesia	INS5045	Strengthening Food Security Through Improvement of Food Safety for Exports Using Gamma Irradiators and Electron Beams	C.M. Blackburn B. S. Han
Iran, Islamic Republic of	IRA1011	Building Capacity for the Development of Stable Isotope Techniques in Medicine, the Environment, Agriculture, and Sciences	S. D. Kelly U.D. Sarvana Kumar O. Kracht J.A. Miller
Cote d'Ivoire	IVC5042	Improving Testing and Monitoring of Food Hazards Using Nuclear and Isotopic Techniques	J.J. Sasanya
Cambodia	KAM5004	Strengthening National Capability for Food and Feed Safety	J.J. Sasanya
Kazakhstan	KAZ5005	Building Capacities in Effectively Irradiating Food	C.M. Blackburn

Country/Region	Project No.	Title	Technical Officer
Kenya	KEN9007	Establishing a National Standard Laboratory for Individual Monitoring, Radioanalysis, and Calibration of Neutron and Surface Contamination Services	C.M. Blackburn J.J. Sasanya
Kyrgyzstan	KIG5001	Establishing Effective Testing and Systematic Monitoring of Residues and Food Contaminants and of Transboundary Animal Diseases	J.J. Sasanya I. Naletoski
Lebanon	LEB1001	Strengthening the Nuclear and Complementary Analytical Techniques of the Lebanese Atomic Energy Commission to Meet Forensic Needs for Materials Investigation and Characterization	S. D. Kelly
Lebanon	LEB1010	Establishing an Isotopic Ratio Mass Spectrometry Laboratory Dedicated to Authentication and Provenance for Supporting the National Fraud Repression Scheme	S. D. Kelly M. Groening
Lebanon	LEB5016	Strengthening Capacity for Exposure Assessment of Residues and Contaminants in the National Diet	J.J. Sasanya
Lebanon	LEB5017	Strengthening Technical Capabilities by Introducing Metal Speciation Techniques to Support Health and Environmental Safety	S. D. Kelly
Lesotho	LES5011	Strengthening Nuclear and Related Food Safety Laboratory Capabilities to Control Veterinary Drug Residues and Related Contaminants	J.J. Sasanya
Madagascar	MAG5028	Developing Food Safety Laboratory Capabilities	J.J. Sasanya
North Macedonia	MAK5009	Enhancing National Capacities to Standardize Nuclear Based and Related Techniques for Food Safety and Detection of Irradiated Food	A. Cannavan B. S. Han A. Mihailova C.I. Horak
Malaysia	MAL5032	Strengthening National Capacity in Improving the Production of Rice and Fodder Crops and Authenticity of Local Honey Using Nuclear and Related Technologies	A. Mihailova S.D. Kelly J. J. Adu-Gyamfi E. Fulajtar C. Zorrilla
Mauritius	MAR5027	Building Capacity to Analyse Veterinary Drug Residues and Related Chemical Contaminants in Animal Products	J.J. Sasanya
Mauritania	MAU5008	Strengthening Laboratory Capacity to Analyse and Monitor Residues and Contaminants in Foods	J.J. Sasanya
Marshall Islands	MHL5002	Building Core Capacities to Control Contaminants and Other Residues in Food — Phase I	J.J. Sasanya
Mali	MLI5032	Improving Laboratory and Monitoring Capabilities for Contaminants in Cereals and Nuts	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Mongolia	MON5024	Enhancing Food Safety Analytical Capabilities for Veterinary Drug Residues and Related Contaminants Using Isotopic Techniques	J.J. Sasanya
Mozambique	MOZ5010	Strengthening Confirmatory Analytical Capabilities for Veterinary Drug Residues and Related Contaminants in Animal Products	J.J. Sasanya
Mozambique	MOZ5012	Enhancing Food Safety Testing and Monitoring of Hazards Using Nuclear and Related Techniques	J.J. Sasanya
Namibia	NAM5018	Strengthening Animal Health and Food Safety Control Systems	J.J. Sasanya
Namibia	NAM5019	Enhancing National Capacity for Contaminant and Adulteration Monitoring of Marine and Other Food Products for Consumer Protection	J.J. Sasanya A. Mihailova M. H. T. Metian
Nepal	NEP5007	Supporting Analysis of Pesticide Residues in Agricultural Products	B.M. Maestroni
Niger	NER5023	Strengthening Capacity of the Public Health Laboratory to Monitor Food Contaminants	J.J. Sasanya
Niger	NER5025	Improving Food and Biological Hazard Detection, Food Preservation and Mutation Breeding	J.J. Sasanya C.M. Blackburn S. Sivasankar
Vanuatu	NHE5004	Strengthening Agro-Food Laboratory Quality Infrastructure — Phase II	J.J. Sasanya
Nicaragua	NIC5012	Strengthening the Monitoring and Control System for Food Contaminants	J.J. Sasanya
Oman	OMA5008	Enhancing National Capabilities in Food Safety and Traceability	S.D. Kelly
T.T.U.T.J. of T. Palestinian A.	PAL5010	Strengthening Capability to Monitor Contaminants in Food and Related Matrices through Nuclear and Complementary Analytical Techniques	J.J. Sasanya
Panama	PAN5027	Strengthening Analytical Capabilities for Risk-based Monitoring of Agricultural Products for Internal Consumption	J.J. Sasanya
Panama	PAN5030	Strengthening Laboratory Capacity in Monitoring Veterinary Drug Residues and Contaminants in Milk and Honey Using Nuclear/Isotopic Techniques	J.J. Sasanya
Philippines	PHI5035	Advancing Laboratory Capabilities to Monitor Veterinary Drug Residues and Related Contaminants in Foods	J.J. Sasanya
Qatar	QAT5009	Enhancing National Food Safety Capacity to Test and Monitor Residues/Contaminants Using Nuclear and Related Isotopic Techniques	J.J. Sasanya C.M. Blackburn
Romania	ROM5010	Enhancing Food Safety and Quality of Consumer Protection	C.M. Blackburn J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Rwanda	RWA5003	Strengthening Laboratory Capacity of the Standards Board to Analyse and Monitor Chemicals (Veterinary Drug Residues and Related Contaminants) in Foods — Phase II	J.J. Sasanya A. M.V. M. Rodriguez y Baena
South Africa	SAF5018	Establishing National Capacities for Monitoring and Control of Pesticide Residues in Agricultural Produce	B.M. Maestroni
Seychelles	SEY5014	Developing Toxicological Analytical Capability for Monitoring and Biomonitoring Exposure to Toxic Agents in Biological and Environmental, as well as Food and Water Matrices	J.J. Sasanya
Singapore	SIN5001	Enhancing Food Safety	C.M. Blackburn J.J. Sasanya
Sri Lanka	SRL5048	Strengthening National Capability for Food and Feed Safety	A. Cannavan A. Mihailova
Sudan	SUD5040	Strengthening the Evaluation of Quality, Monitoring and Control Programmes for Food Contaminants	J.J. Sasanya
Uganda	UGA5042	Strengthening Capabilities of Two Central Food Safety Laboratories and Selected Regional Veterinary Centres of Public Health	J.J. Sasanya
Democratic Rep. of the Congo	ZAI5028	Controlling Food and Feed Contaminants in Fish Production	J.J. Sasanya
Zambia	ZAM5032	Strengthening and Expanding Analytical Capacity to Monitor Food Contaminants using Nuclear/Isotopic and Complementary Tools	J.J. Sasanya
Africa	RAF0050	Promoting Institutional Capacity Building Through Triangular Partnerships (AFRA)	V. Gershan J.J. Sasanya
Africa	RAF5084	Strengthening Food Contaminant Monitoring and Control Systems and Enhancing Competitiveness of Agricultural Exports using Nuclear and Isotopic Techniques (AFRA)	J.J. Sasanya
Africa	RAF5088	Building Capacity for Food Irradiation by Facilitating the Commercial Application of Irradiation Technologies — Phase II (AFRA)	C.M.Blackburn B. S. Han C.I. Horak
Asia/ Pacific	RAS5081	Enhancing Food Safety and Supporting Regional Authentication of Foodstuffs through Implementation of Nuclear Techniques (RCA)	S.D. Kelly
Asia/ Pacific	RAS5087	Promoting Food Irradiation by Electron Beam and X Ray Technology to Enhance Food Safety, Security and Trade (RCA)	C.M. Blackburn
Asia/ Pacific	RAS5096	Strengthening Multi-Stakeholder Food Safety Monitoring Programmes for Chemical Contaminants and Residues in Plant and Animal Products Using Nuclear/Isotopic Techniques	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Asia/ Pacific	RAS5099	Developing Climate Smart Crop Production including Improvement and Enhancement of Crop Productivity, Soil and Irrigation Management, and Food Safety Using Nuclear Techniques (ARASIA)	J.J. Sasanya M. Zaman
Latin America/ Caribbean	RLA5069	Improving Pollution Management by Persistent Organic Pollutants to Reduce Impact on People and the Environment (ARCAL CXLII)	B.M. Maestroni
Latin America/ Caribbean	RLA5079	Applying Radio-Analytical and Complementary Techniques to Monitor Contaminants in Aquaculture (ARCAL CLXXI)	J.J. Sasanya
Latin America/ Caribbean	RLA5080	Strengthening the Regional Collaboration of Official Laboratories to Address Emerging Challenges for Food Safety (ARCAL CLXV)	B.M. Maestroni
Latin America/ Caribbean	RLA5081	Improving Regional Testing Capabilities and Monitoring Programmes for Residues/Contaminants in Foods Using Nuclear/Isotopic and Complementary Techniques (ARCAL CLXX)	J.J. Sasanya
Latin America/ Caribbean	RLA5084	Developing Human Resources and Building Capacity of Member States in the Application of Nuclear Technology to Agriculture	J. J. Adu-Gyamfi I. Naletoski W.R.E. Hoeflich C. Zorilla J.J. Sasanya

Strengthening Analytical Capabilities for Food Authenticity Testing in Bangladesh and Oman

Simon Kelly

Food safety has been identified as a top priority sector for Oman and has been reflected as such in their 2018–2023 Country Programme Framework. Presently, some food samples, particularly vegetables, are screened for pesticide residues, heavy metals, and other organic and inorganic contaminants using a range of techniques such as liquid chromatography-mass spectrometry (LC-MS), gas chromatography-mass spectrometry and inductively coupled plasma-mass spectrometry. Through the national technical cooperation (TC) project OMA5008, 'Enhancing National Capabilities in Food Safety and Traceability', methods have been validated for veterinary drug and pesticide residues, and heavy metals analysis, with technical staff trained accordingly. OMA5008 also supports the Omani Government's decision to create a national Food Safety and Quality Centre under the auspices of the Ministry of Regional Municipalities and Water Resources. However, the national capacity for methods to detect economically motivated adulteration of food is lacking.

A national training course on LC-MS for the detection of melamine and other nitrogen-rich compounds in milk and milk products was organised from 24 to 28 July 2022 at the Central Laboratory for Food Safety, Food Safety and Quality Center, Ministry of Agriculture, Fisheries and Water Resources, Muscat, Oman. The quality and authenticity of milk and milk powders (often used for infant formulas) remains a significant problem in many countries. Due to the relatively basic and non-specific nature of milk protein determination using the commonly applied Kjeldahl technique and nitrogen conversion values, the economic incentive exists to enhance the apparent protein content, and consequent value, of milk by adding nitrogen-rich compounds such as melamine and urea. The course leader, Dr Ilya Strashnov (University of Manchester, UK) delivered lectures and hands-on training covering sample extraction and preparation and LC-MS analysis to detect and confirm the presence of melamine and other analogous adulterants in milk. During the training several retail milk products were prepared and analysed by LC-MS, including samples of liquid milk, yoghurt, tinned cream, infant formula and milk powder. The training was described by the participants as vibrant, enriched with activities both in theoretical lectures and practical laboratory exercises. The level of engagement

was very good and clearly demonstrated the benefits of in-person training over on-line only training.

This capacity building exercise will provide the opportunity for the Omani food safety laboratories to routinely conduct market surveillance in the future to help ensure consumers are protected from fraud and any potential health risks associated with the consumption of melamine, such as renal failure, especially in vulnerable groups such as infants.

Dr. Ilya Strashnov with trainees from several Omani Governmental food safety and chemistry laboratories, such as the Food Safety and Quality Centre (Muscat), the United Integrated Laboratory, the Ministry of Agriculture, Fisheries and Water Resources laboratory and the Al Joudah Food Technology and Trading Laboratory.

A similar training course was led by Dr Strashnov in Bangladesh at the Institute of Food and Radiation Biology (IFRB), Dhaka from 16 to 20 October 2022. Bangladesh has an agriculturally based economy producing a wide range of food commodities with wide geographical distribution. Bangladesh is now exporting significant amounts of food products such as raw and dried fish, cereals, drinks and beverages, spices, vegetables, and processed foods. However, the country is facing challenges in the sector of food production and trade, such as false descriptions, substitution with cheaper ingredients, and adulteration, as well as incorrect origin labelling. Food fraud incidents are frequently reported in the media, which is seriously affecting market development as well as consumers' confidence.

As part of the national TC project BGD5032, 'Building Capacity in Improving Food Safety Using Nuclear and Other Complementary Analytical Techniques', a training course on high-performance liquid chromatography combined with diode-array-detection (HPLC-DAD) for the detection of melamine and other nitrogen-rich compounds in milk and milk products was delivered by Dr Strashnov. During the course of the 5-day training theoretical lectures were delivered along with hands-on laboratory training sessions. This included the analysis of several retail market samples, including powdered milk, infant formula and malt based powdered beverages. The level of engagement from the trainees was very high and resulted in frequent discussions of scientific problems and solutions driven by the participants themselves. The IFRB laboratories have benefitted from the IAEA technical cooperation programme during which new analytical equipment has been installed, including HPLC-DAD, Fourier transform infrared and near infrared spectroscopy instruments and molecular biology sample preparation facilities. The training course has permitted HPLC-DAD to be successfully implemented for routine high-throughput screening for melamine in powdered milk, infant formula and related milk products.

Dr. Ilya Strashnov with trainees from the Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Dhaka, Bangladesh.

Supporting Food Safety Initiatives in the Bahamas

James Sasanya

While the Food Safety and Technology Laboratories (FSTL) is the go-to institution of the Bahamian Ministry of Fisheries, Marine Resources and Agriculture and is tasked with ensuring food is tested for safety and quality, its capabilities are in the growing phase. IAEA support in addressing the gap in analytical capability, including human resource development and establishment of state-of-the-art instrumentation, has therefore been significant. Equipment for the screening and quantification of chemical residues and contaminants in food has been established at FSTL and is in use. Further IAEA support, supplemented by funding from the U.S. State Department under the PUI initiative, has also been delivered. During a recent mission to Bahamas (25–29 July 2022), Mr James Sasanya provided on-site technical guidance on sampling followed by screening of animal products for residues, reviewed and advised on site-preparation of new analytical instrumentation for confirmatory analysis, identified gaps to fill at both the chemistry and microbiology laboratories, and assisted the counterparts in designing a new TCP for the 2024–2025 cycle.

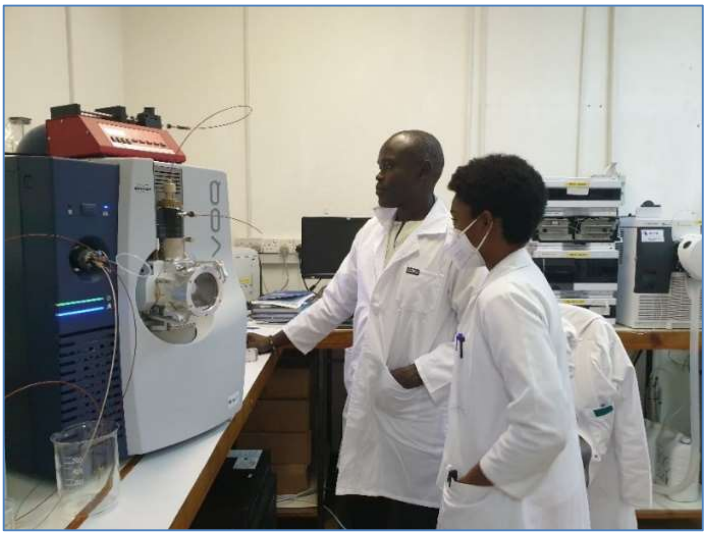
Stakeholder meetings were also held during the mission, notably with the Bahamas Agricultural Health and Food Safety Authority (BAHFSA) who urgently need the services of the FSTL. Some of objectives of BAHFSA, particularly the Food Safety and Quality Division, are to: regulate food safety and quality at every stage of the food chain, regulate all food, including fish and meat, and generally to protect human health, and consumer interests, including fair practices in trade. This requires the contribution of laboratories such as the FSTL and the capabilities now being

built. A laboratory information management system is now being established and this will add more value to the process of accreditation and better routine service delivery.

Strengthening Food Safety Testing and Control in Seychelles

James Sasanya

As in many IAEA developing Member States, the food safety system in Seychelles still requires continued support to improve its capabilities. The Seychelles Public Health Laboratory (SPHL) of the Ministry of Health is a key stakeholder and is the counterpart for a national TCP through which training and analytical equipment are provided. Between 29 August and 2 September 2022, Mr James Sasanya provided on-site training to six SPHL staff on the effective use of an ultra high performance liquid chromatography-tandem mass spectrometry system to test chemical hazards such as veterinary drug and pesticide residues, and contaminants, especially mycotoxins. A number of analytical methods were provided and a standard operating procedure for residues of several anthelmintics is now being tested by SPHL. The analysts have also now set up a method for multiple mycotoxins.



Training on use of UHPLC-MS/MS in Seychelles.

Mr Sasanya met the country's National Food Control Committee during their periodic meetings and delivered a presentation on IAEA's support to Seychelles and how committee members can utilize the capabilities built at the SPHL. Training was also provided to a group of food safety stakeholders including staff of the Food Control Unit, SPHL, veterinary public health, inspectors and field veterinarians including those in charge of a slaughterhouse. This training focussed on sampling of foods to support reliable and representative testing and surveillance. A number of guidelines and literature to enhance knowledge on sampling were provided. Opportunities to further enhance the analytical capabilities of the SPHL were reviewed and gaps identified, such as the urgent need to establish a robust laboratory information management system and installation of an ICP-MS and/or high-resolution instrumentation. During a meeting between Mr Sasanya, the project counterparts, the Commissioner of Public Health, and the Director General of the Public Health Authority, it was revealed that the Government of Seychelles is committed to the construction of a new comprehensive Public Health Laboratory starting in 2024 and is seeking partnerships for this initiative.

Training in Africa to Support Effective Participation in Proficiency and Inter-Laboratory Tests in the Broader Frame of ISO 17025 Accreditation

James Sasanya

This Joint FAO/IAEA Centre-supported training was hosted by the Central Veterinary Laboratory, Zimbabwe, from 5 to 9 September 2022, and was attended by 59 participants from the following 22 countries: Benin, Burkina Faso, Burundi, Cameroon, Ghana, Kenya, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Seychelles, Sudan, Tunisia, Uganda, Zambia and Zimbabwe. The main purpose of the event was to support African Member States in effective participation in proficiency testing (PT) and inter-laboratory comparison schemes (ILCs) in general, including corrective measures and experience-sharing.

The event addressed a range of topics such as: ISO/IEC 17025:2017 – an overview and the role of PTs and ILCs; their linkages to quality management and accreditation; as well as assessing testing and calibration laboratories for ISO accreditation. The participants also learnt more about analytical approaches and human resource requirements for effective implementation of PT and ILCs and reviewed a number of examples and case studies on assessment of laboratories. Issues such as how to initiate and coordinate a ring trial (a case study for Zimbabwe's Central Veterinary Laboratory) and individual country experiences on participation in PTs, the outcomes of such exercises and corrective measures to be taken where necessary, were also covered.

There was a call by participants for increased coordination of ILCs/PTs opportunities at the national level and additional training on the implementation of ISO17043, clearance of non-conformities and root-cause analysis. Training on implementing a risk-based approach to food safety and development and implementation of quality management system according to ISO17025 for laboratories not yet accredited were also identified as areas to address. Some participants also showed interest in further training on method validation, measurement uncertainty and internal auditing.

Trainees on PTs/ILCs in Zimbabwe, September 2022.

Coordination Meeting for Asia-Pacific Regional Food Safety Project to Strengthen Multi-Stakeholder Food Safety Monitoring Programmes for Chemical Contaminants

James Sasanya

The IAEA non-agreement regional food safety TCP RAS5096, launched in 2022 to address food safety needs of Member States in Asia, had its first coordination meeting, which was held virtually, 6–8 September 2022. The project focuses on improving food safety systems by strengthening national programmes and associated activities for effective and reliable testing, monitoring, and control of chemical residues and contaminants in foodstuff of animal and plant origin. The hazards include, but are not limited to, veterinary drug and pesticide residues, mycotoxins, toxic metals, and radionuclides. These have public health and trade implications, and their control requires a multi-stakeholder approach through systematic national testing, monitoring and surveillance and associated data generation, to realize greater impact. Operational and competent laboratories are critical components of monitoring/surveillance systems. To date, the following countries are involved in the project: Afghanistan, Bahrain, Bangladesh, Indonesia, the Islamic Republic of Iran, Jordan, Kuwait, Lao PDR, Lebanon, Malaysia, Mongolia, Myanmar, Oman, Pakistan, Palestine, Philippines, Qatar, Saudi Arabia, Sri Lanka, Syria, Thailand, United Arab Emirates and Viet Nam.

The purpose of the meeting was to review the national capacity and plan of each counterpart involved specifically in strengthening food safety monitoring programmes for chemical contaminants and residues using nuclear/isotopic techniques, and to discuss and agree on a workplan and set up the project baseline against which the future success will be measured. Twenty-five participants from 15 countries and three IAEA staff attended. The IAEA officers guided the meeting with respect to their management, technical and administrative responsibilities.

The meeting was productive and well appreciated by the counterparts. It provided an opportunity to understand the status, plans and needs of the participating countries and promote the multi-institutional approach to addressing food safety issues. The project document was reviewed and workplans discussed and revised as necessary, incorporating emerging needs. The project provides a platform for capacity enhancement and strengthening networking in the region.

Helping Vanuatu to Improve Food Safety and Quality Infrastructure

James Sasanya

Vanuatu, a Small Island Developing State (SID), is largely an agro-based economy with at least 80% of the population in farming, contributing ~20% of the GDP. To ensure that the population consumes safe and good quality food and that the agricultural exports (e.g., kava) are competitive, it is imperative that the country builds or strengthens its laboratory testing and quality infrastructure. With the support of an IAEA TCP 'Strengthening Agro-Food Laboratory Quality Infrastructure', this situation is gradually changing due to the capability that is being built at the Department of Agriculture and Rural Development (DARD) of the Ministry of Agriculture, Livestock, Forestry, Fisheries, and Biosecurity, as well as the Vanuatu Bureau of Standards (VBS). Analytical tools have been established for screening and quantifying a range of chemical hazards such as mycotoxins, veterinary drug and pesticide residues in plant and animal food products.

During a recent mission to Vanuatu (17–21 October 2022), Mr James Sasanya installed a radio receptor assay system, along with other minor equipment, at the VBS and provided training to a number of laboratory staff. These analysts are now capable of screening some food samples for targeted residues and contaminants . Mr Sasanya also installed spare parts for the ultra high performance liquid chromatography-diode array-fluorescence detection system and ensured that the equipment was operational. Efforts are underway to strengthen capabilities of these two sister laboratories with supply of better equipment and further training of staff.

Testing laboratory at the Vanuatu Bureau of Standards.

ARASIA Regional Training on Monitoring Residues in Food

James Sasanya

This training course was held in Amman, Jordan, 13–17 November 2022, in cooperation with the Jordan Food and Drug Administration (JFDA), within the framework of an TCP RAS5099, "Developing Climate Smart Crop Production including Improvement and Enhancement of Crop Productivity, Soil and Irrigation Management, and Food Safety Using Nuclear Techniques (ARASIA)". The course had nineteen participants from Jordan, Kuwait, Lebanon, Oman and Saudi Arabia; counterparts from Syria and Yemen could not attend at the last minute. The purpose was to train ARASIA Member States on establishing and implementing national monitoring programmes for residues of pesticides in foods, for consumer protection and promoting trade. The course included lectures, discussions and hands-on exercises on a comprehensive framework for residue monitoring, including legal aspects and inter-institutional participation; planning and implementing a pesticide surveillance/monitoring programme; and design of monitoring plans and sampling procedures. The participants also addressed the need for a robust audit trail for all samples and keeping track of results of a programme to facilitate further action where necessary, as well as robust and accurate analytical methods for pesticide residues. Experiments on pesticide residue testing were also performed at JFDA's chemistry laboratory and each country shared their experiences and the status of their pesticide residue monitoring, including operational and analytical challenges. Great attention was attached to the role of quality management in residue monitoring laboratories. Participants were guided on the application of Codex standards and guidelines to national monitoring programmes and how to use national residue monitoring data to support Codex standards and guidelines. Case studies, including a national network of institutions involved in pesticide residue monitoring, such as in India, were reviewed. The participants also discussed opportunities and challenges associated with use of extended-storage reference materials, including certified reference materials.

Participants at the regional training course on pesticide residue monitoring in Amman, Jordan.

Workshop on Accelerating the Adoption of E-Beam/X ray Technologies in the Asia and the Pacific Region

Carl Blackburn

The above workshop was held in Daejeon, Republic of Korea from 14 to18 November 2022. This is a technical cooperation initiative helping to transfer knowledge on machine source irradiation for different applications. It was implemented by the Regional Office of parties to the Asia and Pacific Regional Cooperative Agreement (RCA), in cooperation with the Office of Radiological Security (ORS) of the US Department of Energy/National Nuclear Security Administration.

The workshop focused on providing practical information to potential end-users of radiation processing technology and other stakeholders who are interested in adopting machine-based sources of ionizing radiation for different technological applications – both in commerce and in research. In addition to detailed discussion of the underlying opportunities and technology specifics, this workshop also included discussions on the economics of implementing the different technologies in terms of how to take forward and initiate a new facility, the associated capital costs, operating costs, and ideal locations for siting different kinds of units. The Food Safety and Control section participated to give an overview of nuclear applications of in food and agriculture, with a specific focus on food and phytosanitary irradiation.

Building Capacity for Food Irradiation by Facilitating the Commercial Application of Irradiation Technologies - Phase II

Carl Blackburn

The coordination meeting of the above technical cooperation project (RAF5088) was held at the IAEA in Vienna from 21 to 25 November 2022.

Food security and safety remain major concerns and are now a priority for African Member States. The region has a diverse range of foods, many indigenous, and their safety and quality must be ensured to protect consumers and, where possible, to remain competitive on regional or international markets. Losses in the supply chain and maintaining food quality tend to be key issues for both imports and domestically produced foods. In the Africa region, most countries are not able to fully realize the commercial use of food irradiation. A few countries are using irradiation technology for the sterilization of medical products and the irradiation of dried food, and several countries have access only to small scale irradiators, mostly for research and development. Some countries have developed feasibility

studies under previous technical cooperation projects but need to develop them further and initiate business plans before they can move forward. The goal of the project is to increase the number of countries with available feasibility studies and business plans for irradiation facilities. The intended outcome is to generate more capacity for food to be irradiated in the region in the longer term.

Participants in the coordination meeting discussed a 'milestone approach' for developing, implementing and managing a project to establish new or refurbished irradiation facilities. Representatives from Algeria, Botswana, Egypt, Ethiopia, Kenya, Libya, Mauritius, Morocco, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sudan, Tunisia and Tanzania reviewed their project workplans and agreed on the needs to accomplish this development work. The meeting included an overview of different irradiation technologies and their commercial applications. It provided guidance on using the 'milestone approach' to assess and provide justification for a new or up-graded irradiation unit. This approach involves developing a strategic plan and making assessments of key infrastructure issues as well as undertaking cost-benefit analyses, and is in the process of being published as an IAEA document. It is developed from a systematic approach to implementing research reactors and has three main pillars for conducting a comprehensive feasibility study and, if appropriate, developing business plans.

In their reports to the meeting, participants provided their preliminary strategic overview and their assessments of national infrastructure under nineteen infrastructure headings. A few participating countries are taking part to produce detailed scoping feasibility studies in order to consider their future development priorities for the uptake of irradiation technology. Many participants were interested in enhancing existing capacities and expertise to establish new or up-graded irradiation facilities.

Regional (Asia-Pacific) Training on Sampling, Use of Statistics, Risk Assessment and ISO/IEC 17025

James Sasanya

A two-week training course was organized from 28 November to 9 December 2022 in Faisalabad, Pakistan, in cooperation with the Nuclear Institute for Agriculture and Biology (NIAB), under the framework of the regional TCP RAS6096, 'Strengthening Multi-Stakeholder Food Safety Monitoring Programmes for Chemical Contaminants and Residues in Plant and Animal Products Using Nuclear/Isotopic Techniques'. The purpose of the event was twofold: 1) to promote national and regional capabilities to generate reliable food safety laboratory test results through the implementation of good statistical practices in analytical method establishment and application, routine food safety testing and monitoring programmes, as well as improving knowledge on risk assessment; 2) to enhance institutional capabilities for the interpretation of ISO/IEC 17025 requirements and improve assessors' knowledge and skills in planning, implementing, leading and follow-up of assessments, corrective measures, and facilitating laboratory accreditation. The event attracted 43 participants from Afghanistan, Bangladesh, Indonesia, Jordan, Lebanon, Mongolia, Oman, Pakistan, Philippines, Sri Lanka, Syria and Thailand.

The first week focussed on basic statistics for analysts in the food safety laboratory and their application to representative sampling procedures, as well as collaboration among counterpart institutes. The hazards covered veterinary drug and pesticide residues as well as mycotoxins in a range of common food matrices. Risk assessment for chemical hazards was also covered. The second week dealt with laboratory assessment; principles, practices and techniques used by assessors and how their findings and observations are communicated for meaningful change. Other topics included: the role of international accreditation cooperation, e.g. the international organisation for accreditation bodies, ILAC (International Laboratory Accreditation Cooperation), including recognition and oversight of local accreditation; document review exercises; and drafting assessment and non-conformity reports. A mock assessment was performed for two food safety laboratories at NIAB and the National Institute for Biotechnology and Genetic Engineering.

NIAB food safety laboratory for mock assessment during the training.

Achievements of TCP RLA5069 'Improving Pollution Management of Persistent Organic Pollutants to Reduce the Impact on People and the Environment'

B. Maestroni, P. Gatti and P. Murillo Fuentes

Persistent organic pollutants (POPs) are chemical compounds with a widespread presence throughout the planet. Their main characteristics are their bio-stability, long half-life, slow biodegradation, and their accumulation in fatty tissues in living organisms. Within the POPs,

organochlorine compounds can be identified. They have their origin in the 1940s when they were introduced as insecticides in agriculture. These compounds, which are currently banned in most Latin American countries, persist in the environment and are transferred to humans through food and water intake, among other routes of exposure. During lactation, milk is one of the main routes of elimination of organochlorine compounds from the human body, making this an important route of exposure for babies, which can consume large amounts of milk (870 mL/day) and can reach or exceed acceptable daily intake levels.

A six-year IAEA regional project on 'Improving Pollution Management of Persistent Organic Pollutants to Reduce the Impact on People and the Environment' came to an end during the second semester of 2022. Ten countries from the Latin American and the Caribbean (LAC) region, namely Argentina, Bolivia, Chile, Colombia, Costa Rica, Ecuador, México, Dominican Republic, Paraguay and Uruguay, participated throughout with commitment, ideas, improvement and data on POPs in mother's milk and other different matrices. The Food Safety and Control Laboratory contributed to the project through the activities of the technical officer. IAEA provided consumables and analytical standards, capacity building activities and resources to attend meetings and prepare communication videos, among other inputs. Clear progress was achieved in the analytical capabilities of participating laboratories for the analysis of POPs in human milk and the environment. A compendium of analytical methods was prepared and shared amongst laboratories. In general, multi residue methods were applied by the laboratories and the advantage of this type of analysis was evident in terms of the information generated during the project. All laboratories validated their methods at the lowest achievable limit of quantitation, in many cases compensating for the lack of sensitivity of their analytical instrumentation with a very thorough sample preparation strategy. Analytical results were compared between laboratories and a proficiency test was organized as to demonstrate the reliability of the laboratory's data. All countries carried out the analysis of human milk samples. Five countries carried out the analysis of POPs also in cow's milk, linking the exposure to POPs to the average food intake of the female population. Three countries carried out monitoring of water resources, soil and sediments.

Benefits have included enhanced collaboration among Latin American laboratories, with regard to the analytical methodology and the interpretation of the results. One aspect to highlight was the greater involvement in the activities of the RALACA food safety laboratory network, consolidating the role of the network as a useful instrument for cooperation in the LAC region. Progress was also made in the sampling criteria adopted for human milk, environmental samples and food products and a compendium of sampling methods was generated. Progress was made in the identification, analysis and management of the risks from POPs in each participating country. Capacities have been generated for dietary risk assessment using deterministic and probabilistic approaches, and for the preparation of risk maps. New lines of research of importance to the LAC region have been identified. Finally, the communication aspects of the project benefitted from the dissemination of results through two videos and technical and scientific publications.

The results of the project are being compiled in a manuscript that will be submitted to a peer reviewed journal.

Helping Lesotho to Build Food Safety Testing Capabilities

James Sasanya

Lesotho is heavily dependent on imported food. However, most of the imported food (80-90 %) and about 20% of the locally-produced food lacks appropriate safety and health standards. Ensuring public health requires the development and improvement of a sound food safety control system. Testing laboratories are in particular limited in trained personnel and necessary analytical instrumentation. The IAEA, through the Joint FAO/IAEA Centre, is currently intervening by developing the food safety laboratory at the Department of Livestock Services. Capabilities for quickly screening for a range of chemical residues and contaminants have recently been established and relevant training provided. Mr James Sasanya undertook a mission to Maseru, 20–24 June 2022, to provide training and guidance to ten laboratory staff on the analysis of veterinary drug residues in milk, meat and egg samples using a radio receptor assay instrument. Mr Sasanya provided relevant protocols, standard operating procedures and literature and also guided laboratory discussions to boost the analysts' confidence to independently conduct tests. He also guided the counterparts in preparing the laboratory for installation of confirmatory analytical instrumentation. Discussions were also held with various stakeholders, such as the Ministry of Trade and Industry, to promote a multi-institutional approach to solving national food safety challenges, including sharing of facilities, equipment and knowledge. The management of the Ministry of Agriculture and Food Security, including the Principal Secretary, and the Director of Livestock Services expressed their support to build and sustain the national food safety control system.

Laboratory staff at the Department of Livestock Services training on screening of drugs residues in animal products.

Developments at the Food Safety and Control Laboratory

Discrimination of Organic and Conventional Strawberries

Alina Mihailova, Evans Rockson Tawiah, Marivil Islam, Simon Kelly

Organic products tend to retail at a higher price in comparison with their conventionally grown/produced counterparts. Although the 'added value' of these products is guaranteed by the certification processes and regular farm inspections that should warrant their complete traceability at all stages of production, processing and trade, such paper trail-based systems can be falsified. Significant cases of fraud, where conventional produce has been mislabeled and passed off as organic, on a large scale, have been reported over the past several years worldwide. For consumer confidence and the integrity of the whole organic food and drink supply chain it is therefore highly important that, in addition to certification, the claimed specifications of foods can be analytically verified in an objective and independent way.

Various analytical techniques have been applied over the past decade for the authentication of organic products. Stable isotope and elemental analysis have been the most widely tested approaches, however successful verification of organic production often cannot be achieved based solely on these techniques. More and more studies are coming to the conclusion that the authentication of organic food products is unlikely to be achieved by the measurement of a single or only a few selected markers.

FSCL has assessed the potential of rapid screening approaches, such as portable and benchtop infrared spectroscopy techniques and gas chromatography - ion mobility spectrometry, followed by untargeted high resolution mass spectrometry (HRMS)-based metabolomics analysis for differentiation between organic and conventional strawberries from Spain.

A total of 20 organic and 20 conventional strawberry samples from Spain, supplied by the fruit juice industry self-control body,SGF International, were used for this study. Samples were frozen, blended into a paste, freeze-dried, ground, and kept in a desiccator prior to analysis. Rapid screening analyses were performed using the following techniques: portable near-infrared (NIR), benchtop Fourier Transform near-infrared (FT-NIR) and benchtop Fourier Transform infrared spectroscopy with attenuated total reflectance (FTIR-ATR) module (spectral range: 13514 - 9346, 11550 - 3950, and 4000 - 450 cm^{-1}, respectively) as well as gas chromatography - ion mobility spectrometry (GC-IMS). Untargeted HRMS-based metabolomics analysis was carried out using UPLC system coupled to the quadrupole time of flight (QTOF) mass spectrometer. Mass spectral data were acquired in both positive and negative ion mode over the range from m/z 50 to 1200, in continuum format.

For each of the screening techniques used, different spectral data pre-processing algorithms were applied and compared. In addition, low-level data fusion was performed and evaluated for the following techniques: a) FTIR-ATR + FT-NIR; b) FTIR-ATR + GC-IMS; c) FT-NIR + GC-IMS; d) FTIR-ATR + FT-NIR + GC-IMS.

An unsupervised chemometrics approach, principal component analysis (PCA), was used to assess the data quality and evaluate the initial groupings of the organic, conventional, and quality control samples. Further, a supervised chemometrics approach, orthogonal partial least squares discriminant analysis (OPLS-DA), was applied to discriminate organic and conventional strawberry samples using the data from each of the applied analytical techniques. The comparison of the model performance, done using the goodness of fit, the predictive ability of the OPLS-DA as well as the correct classification rate of the samples from the test dataset, showed that the fusion of the spectral data from FTIR-ATR or FT-NIR with the data from GC-IMS resulted in an improved predictive power of the model in comparison with the models from each of these screening techniques used individually. Considering the shorter analysis time required for the FT-NIR in comparison with FTIR-ATR, the fusion of FT-NIR and GC-IMS data would be advisable.

The score plot of the OPLS-DA model, built using fused FT-NIR and GC-IMS data of the whole sample set is shown in Figure 1. Model validation, performed by using an independent test set that was not used in the generation of the model, showed that the model was able to correctly predict the production origin of all organic and 90% of conventional samples.

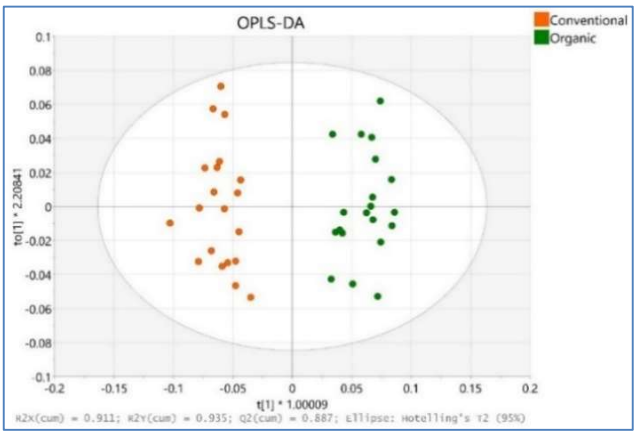


FIG. 1. Score plot of the OPLS-DA model obtained using the fused FT-NIR and GC-IMS data of organic and conventional strawberry samples.

To further explore the compounds that were significant for the discrimination between organic and conventional strawberries, an untargeted HRMS-based metabolomics analysis using UPLC-QTOF was performed. The score plots of the OPLS-DA models, built using mass spectral data of the whole sample set in positive (A) and negative (B) ion mode, are shown in Figure 2. The models achieved good separation between the two types of strawberry samples and were able to correctly predict the production origin of all organic and conventional samples from the test dataset.

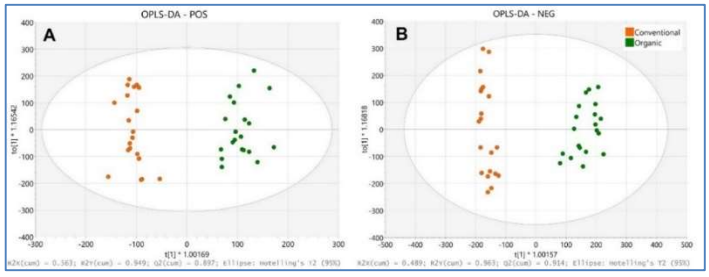


FIG. 2. Score plot of the OPLS-DA model from HRMS-based metabolomics analysis of organic and conventional strawberry samples in positive (A) and negative (B) ion mode.

Further, the selection of features, which were significant for the discrimination of organic and conventional strawberries, and the identification of chemical compounds was carried out. The putatively identified compounds included flavonoids (e.g. coumarin, quercetin, apigenin) and organic acids. Confirmation of these compounds using a targeted LC-MS/MS analysis will be carried out.

This has been a feasibility study that employed a very small sample set, which is not sufficient for generating models using rapid screening approaches. Nevertheless, these first results are very promising and suggest the potential of the application of rapid screening techniques and low-level data fusion for the differentiation between organic and conventional strawberries. A greater number of samples, covering natural sample variability (e.g. geographical, annual, varietal variability), is required to test the robustness of this approach. Further analysis and the external validation of the models will be carried out in 2023 upon receipt of a new batch of strawberry samples.

Geographical Discrimination of Palm Oil Using Fourier Transform Near-infrared Spectroscopy

Alina Mihailova, Evans Rockson Tawiah, Marivil Islam, , Simon Kelly

Palm oil is one of the most economically important products in Malaysia. The traceability of palm oil within the supply chain is a complex and challenging issue. Several certification schemes, such as Malaysian Sustainable Palm Oil (MSPO) and Roundtable on Sustainable Palm Oil (RSPO), have been set up to assure the sustainability of palm oil production and its traceability through the supply chain. The current measures in place for the traceability of palm oil production are based largely on paper trails and audits. Although the certification of palm oil production should ensure complete traceability of the oil at all stages of production, including processing and marketing, it can be prone to falsification. It is therefore highly important that, in addition to traceability and certification schemes, cost-effective and robust analytical approaches are available to verify the claimed geographical origin of palm oil.

Traceability of palm oil requires a sample to carry a characteristic chemical fingerprint that reflects its place of origin. Near-infrared spectroscopy offers a non-targeted multi-analyte screening capability and has been reported to be suitable for the verification of authenticity and geographical discrimination of different food commodities, including edible oils. This analytical technique has low operational costs, rapid analysis and high sample throughput, little or no sample preparation, and no need for chemicals or specialized laboratory facilities.

In this study Fourier transform near-infrared (FT-NIR) spectroscopy, coupled with principal component analysis (PCA) and orthogonal partial least squares discriminant analysis (OPLS-DA), was applied for the geographical discrimination of crude palm oil samples from Malaysia.

Crude palm oil samples (n = 354) were collected over six months (February-July 2019) at 4 different locations: Peninsular Malaysia (East, South and Central) and East Malaysia. The crude samples were analysed in FSCL by FT-NIR in heated transmission mode using a spectral range from 11550 to 3950 cm^{-1}. Prior to chemometrics analysis data were pre-processed using the second derivative function.

A supervised chemometrics approach, OPLS-DA, was able to discriminate palm oil samples collected in East Malaysia from those obtained from the Peninsular Malaysia. The score plot of the OPLS-DA model, built using a training dataset (n = 236), is shown in Figure 1. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values, were 0.506, 0.950 and 0.897, respectively.

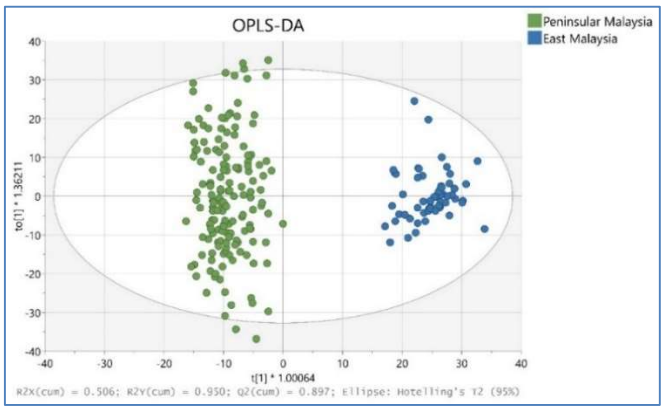


FIG. 1. Score plot of the OPLS-DA model for the discrimination of crude palm oil samples collected from Peninsular and East Malaysia.

The external validation of the OPLS-DA model was performed using an independent test dataset (n = 118).

The model was able to correctly classify 97.46% of the samples according to their geographical origin.

As the next step, the study assessed if OPLS-DA could discriminate the samples from all 4 geographical locations. The model generated achieved reasonably good discrimination, as shown in Figure 2. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) generated using the training dataset (n = 236), were 0.619, 0.884 and 0.758, respectively.

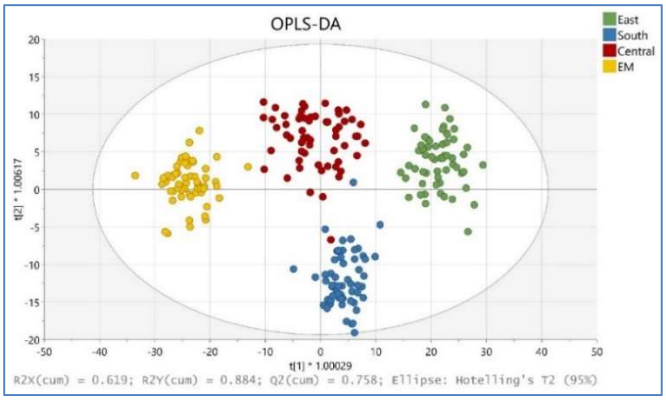


FIG. 2. Score plot of the OPLS-DA model for the discrimination of crude palm oil samples obtained over 6 months from East Malaysia (EM) and 3 regions of Peninsular Malaysia (East, South and Central).

The validation of the OPLS-DA model was performed using an independent test dataset (n = 118). The model was able to correctly classify 92.37% of the samples according to their geographical origin. Further, OPLS-DA was able to discriminate samples from the 3 geographical locations within the Peninsular Malaysia region. This is illustrated in the score plot of the OPLS-DA model, built using a training dataset (n = 176), shown in Figure 3. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values were 0.571, 0.894 and 0.748, respectively.

The external validation of the OPLS-DA model was performed using an independent test dataset (n = 88). The model was able to correctly classify 93.18% of the samples according to their geographical origin

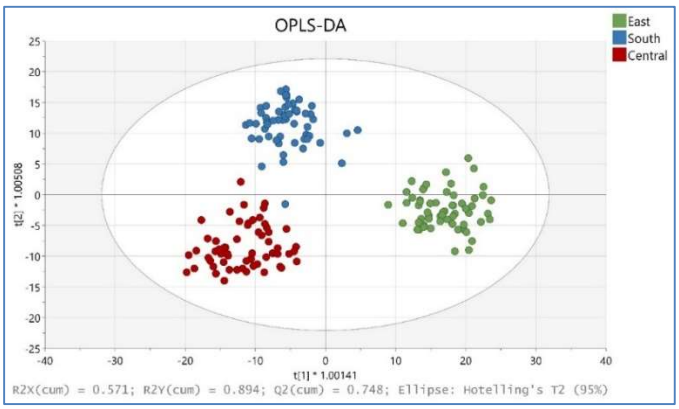


FIG. 3. Score plot of the OPLS-DA model for the discrimination of crude palm oil samples collected from 3 regions of Peninsular Malaysia.

In addition to the analysis of the FTIR data, a low-level fusion of gas chromatography- ion mobility spectroscopy data (reported in the previous issue of the FSC Newsletter) and the FT-NIR spectral data was performed. The performance of the fused models was assessed for the geographical discrimination of palm oil from: a) Peninsular Malaysia and East Malaysia; b) all 4 sampling regions; c) 3 regions of Peninsular Malaysia. The use of the fused data did not show a significant improvement in the discriminative power of the OPLS-DA models in comparison with the use of FT-NIR as a single technique. Future work will focus on the optimisation of the discriminative model, generated using FT-NIR spectral data, and further model validation using a new batch of crude palm oil samples.

The Long Night of Research, Vienna International Centre, Vienna, Austria

Christina Vlachou

The Long Night of Research (Lange Nacht der Forschung) is an Austria-wide event for science communication, in which researchers share their achievements with the general public. It is held every two years and is coordinated by several Austrian government ministries. After the 2020 event, which took place virtually, this year's Long Night of Research included an extensive on-site program at 280 exhibition locations throughout Austria and celebrated its tenth anniversary together with 135,000 visitors on 20 May 2022.

Vienna International Centre (VIC) opened its doors for this event for the third time. From 5 to 11 pm, in 18 stations in the VIC Rotunda, the science and research of the Joint FAO/IAEA Centre, the IAEA and several other UN organisations was presented to more than 1000 external visitors of almost all age groups, from children and youngsters to the elderly, and to several hundred staff members, their families and friends.

The Food Safety and Control Laboratory (FSCL) exhibition booth focused on testing for food safety and authenticity, posing the question "Is my food safe? Is my olive oil and honey authentic?". Food is an essential part of our daily lives. We all want our food to be safe and we want to be able to trust that a jar contains what its label states. This is important not only to individual consumers, but also to global trade.

Visitors had the chance to see how hand-held and bench-top devices can be used to test food authenticity, and to learn more about contaminants and food safety. Nuclear and related techniques can be used to control food safety and to fight food fraud – the deliberate mislabelling of food products. For example, by determining stable isotope composition of various foods, scientists can extract information on where a food product comes from and what it contains. Applying liquid or gas chromatography combined with mass spectrometry, information about the levels of contaminants, additives and chemical present in food can be obtained. However, the instruments used are

often costly, require specialised laboratory facilities and significant expertise to operate and interpret the results. Continuous development and miniaturisation of analytical instruments has opened up the potential for access to a new level of practical testing. Cost-effective and easily used screening tools are being developed using small hand-held devices and bench-top laboratory instruments to provide first tier testing, which complements the advanced techniques. This is important not only to individual consumers, but also to global trade. The FSCL team gave hands-on demonstrations of screening tests for the assessment of authenticity, detection of adulteration, or detection of the occurrence of specific additives or pesticide residues.

The FSCL team at their Long Night of Research exhibition booth.

During the authenticity demonstrations, visitors were invited to 'blind' inspect (visually and by smell) an authentic extra-virgin olive oil sample, and olive oil samples adulterated with cheaper oils (sunflower, soybean, rapeseed oils), and to choose which they thought was the authentic sample. They could then test the samples with a hand-held micro-near-infrared spectrometer connected to a tablet, to match the spectrum with a spectral library of the authentic oil. Ten seconds after the small hand-held device was placed on top of a petri-dish filled with oil sample, a prediction of the identity of the tested oil appeared on the tablet. The result was confirmed by testing on a bench-top Fourier transform mid-infrared spectrometer. The demonstration included automatic interpretation of the results using a simple '3 step' analysis – place a drop of oil on the instrument, take the measurement and read the result as either "Pass" (for authentic oil) or "Fail" (for non-authentic).

The food safety demonstrations focused on the application of surface-enhanced Raman spectroscopy (SERS). Visitors learned how measurements for aspartame, an artificial sweetener, are performed with the portable SERS device in soft drinks. Aspartame presents a health hazard to individuals suffering from phenylketonuria, therefore the usage of this sweetener should be highlighted on the labelling of the product. The second part of the SERS demonstration allowed the visitors to identify if the fungicide thiabendazole can be detected on the surface of organic bananas. Thiabendazole is authorized for usage on the surface of bananas in conventional agriculture, but is prohibited in organic agriculture. The visitors were shown how to take a swab from the surface of bananas, perform the SERS measurement and detect if the bananas were treated with thiabendazole or not.

All demonstrations were very well attended, with queues forming frequently for the hands-on testing, and queries and discussion with FSCL staff in front of the exhibition booth. There were visitors from a broad range of backgrounds and experience, including students, university professors, scientists, school children (including large groups of pupils from Vienna International School) and other interested members of the public, and a keen interest in the subject. The hands-on demonstrations fostered discussion around food safety and authenticity. Visitors were also informed about some of the other areas of FSCL's work in food safety, authenticity, support for traceability systems, and contaminant control through a rolling video display, which included presentations by FSCL staff members, animated graphics and slide shows. Participation of the IAEA and the Joint Centre's Agriculture and Biotechnology Laboratories in The Long Night of Research provided a unique opportunity to showcase the peaceful uses of nuclear energy and nuclear applications.

Hands-on demonstrations of some food safety screening methods for the public.

Mycotoxins Analysis

Britt Maestroni, Sofia Bussalino, Beatriz Pérez-Fernández

According to FAO, safe food in sufficient quantity is a fundamental human right. Food safety refers to the conditions and practices that preserve the integrity of foods to prevent residues and contaminants and food-borne illnesses. Food safety needs to be ensured at all levels of the farm to fork chain. Unfortunately, food hazards can occur at every stage of the chain, and it is important that "One Health" approaches are applied to protect public health and trade. One of the greatest threats to food safety is the contamination of foods and crops with mycotoxins. These are natural toxins produced by filamentous fungi when environmental conditions, such as humidity and temperature, are ideal for the fungi to produce them through

a secondary metabolic pathway. It has been estimated that 25% of worldwide crops are contaminated with mycotoxins. Among all known mycotoxins, aflatoxins are the most important from a toxicological perspective and their levels are strictly regulated. Aflatoxins are carcinogenic, immunogenic and teratogenic to animals and humans, among other effects. Aflatoxins are also of concern for trade of feed and food. The economic impact of aflatoxin contamination in food was estimated in 2008 at billions of euros annually. It is imperative, therefore, for member states to address the issue of mycotoxins, including having the relevant analytical capacities to detect them in foods. It has been reported that even with very good practices (e.g., storage, handling, harvesting etc.), the prevention of mycotoxin production is not fully assured. Furthermore, many mycotoxins are difficult to eliminate through food processing since they are stable to heat, physical and chemical treatment. Sound testing and monitoring programmes are therefore necessary to reduce the risk of consumer exposure. Food safety laboratories need to be well equipped and to have relevant validated analytical methods. IAEA is assisting Vietnam and Belize in building capacity in mycotoxins analysis under relevant technical cooperation projects. Both countries are interested in screening for mycotoxins and implement confirmatory approaches to determine aflatoxins contamination. A novel screening technique, an electrochemical immunosensor, to detect traces of total aflatoxins in pistachio was previously developed and optimized under a technical contract for TCP VIE5022 and reported in a previous article. At FSCL, an analytical method for the determination of aflatoxins in pistachio samples by liquid chromatography coupled to tandem mass spectrometry (LC-MS/MS) was validated and successfully used to cross validate the performance of the electrochemical screening immunosensor at trace levels. A manuscript has been prepared and will be submitted for publication in a peer reviewed journal.

The work on mycotoxins at FSCL also addresses their control in corn flour and tortillas, under a collaborative project with Belize, TCP BZE5011. Due to the high consumption rate of tortillas made from corn flour and water, the government of Belize seeks to gather baseline information on the contamination of tortillas with mycotoxins, especially aflatoxins, to enable the implementation of management actions. A fellow from the Belize Agriculture Health Authority trained for four months in the FSCL in mycotoxin analysis by LC-MS/MS. A method for the determination of aflatoxins in corn flour using immunoaffinity column clean-up was developed and optimized. The method is currently being validated for the determination of the aflatoxins B1, B2, G1 and G2 in corn flour, before being extended to the testing of corn tortillas produced in Belize. The results of the study will submitted for publication in a peer reviewed journal.

Pesticide Residue Analysis

Britt Maestroni, Shuichi Nakaya, Sofia Bussalino

Pesticides are used on many foods and crops worldwide to fight pests and maintain agricultural yields. Their control is critical to ensure regulatory compliance for trade and public health purposes. During the second semester of 2022, the FSCL continued to develop, optimise and validate cost-effective sample preparation techniques and confirmatory analysis for the multi-residue determination of pesticides and their metabolites in matrices such as honey and biobeds.

A liquid chromatography tandem mass spectrometry (LC-MS/MS) method was developed for the analysis of neonicotinoid pesticides in honey, to be transferred to Ecuador and South Africa, under technical cooperation projects supported by IAEA. Neonicotinoids have been implicated as one of the factors that lead to the development of the honeybee colony collapse disorder syndrome. Apart from its huge economic implications, the global decline in bee populations poses a threat to global food production and security. Studies have shown that neonicotinoids may translocate to the nectar and pollen of plants treated with neonicotinoid formulations, representing a potential risk to pollinators, and could also end up in the honey produced by bees. The European food safety authority is currently re-evaluating the risk of neonicotinoids and the debate on these pesticides is still open. To maintain biodiversity and to ensure the quality of traded honey, it is important to control residues of neonicotinoid pesticides in bees and honey.

A stable isotope dilution assay was developed and optimised in FSCL for the determination of the neonicotinoids, 6-chloronicotinic acid, acetamiprid, clothianidin, dinotefuran, imidacloprid, thiacloprid and thiamethoxam. After equilibration with the analyte, the ratio of a labelled internal standard to the analyte remains constant despite possible losses of the compound during sample preparation and clean-up, due to their nearly identical chemical and physical properties. Analysis by LC-MS/MS allows differentiation between the analyte of interest and its stable-isotope labelled version and, since the amount of the internal standard is known, the content of the analyte can be calculated by the ratio of the analyte signal to the internal standard signal.

The validation of a method for the determination of pesticides and relative metabolites in biobed samples was also completed, as part of a collaboration with the University of Uruguay. The active ingredients of pesticide formulations applied in the field degrade totally or partially, through biological, physical and chemical processes such as enzyme degradation, photodegradation or hydrolysis, into smaller molecules called metabolites. Residues of metabolites can be found in environmental and food matrices along with the parent compounds, and they are of concern due to their toxicity to humans and animals, and to the environment. In certain cases, the toxicity of metabolites can surpass that of the corresponding parent compound. The method developed

and validated by FSCL and the University of Uruguay will be used to determine if the pesticide degradation processes within the bioreactors used in the agricultural areas are effective and complete. A manuscript is currently being prepared together with the University of Uruguay and will be submitted for publication to a peer reviewed journal.

FSCL Staff

Mr Shuichi Nakaya completed his work in FSCL in September 2022. Shuichi had joined the FSCL team in 2020 for a two-year position as a cost-free expert under the PUI project "Enhancing Capacity in Member States for Rapid Response to Food Safety Incidents and Emergencies". He worked on the development and transfer to Member States of analytical methods for the detection and control of contaminants and residues in food by liquid chromatography mass-spectrometry We would like to thank Shuichi for his great contribution to the FSCL's activities, and we wish him every success for his career ahead.

Mr Vamsi Golla completed his 12-month internship in FSCL in October 2022. During his stay in our laboratory, Vamsi made a valuable contribution to the team's work on the development of EA-IRMS and GC-MS/MS methods to verify the geographical origin of rice and green coffee beans, whilst benefiting from the IAEA internship training and development opportunity. We would like to thank Vamsi and wish him the very best in all his endeavours.

We would also like to thank Ms Aminata Faustmann for her support to FSCL staff as a team assistant from March 2021 to August 2022, and to wish her all the best in her current assignment as a Dosimetry Services assistant in NAHU.

FSCL is very happy to welcome new members to our team.

Mr An Li joined FSCL in July 2022 as a cost-free expert for one year. Li has a PhD in Agro-food quality and food safety, and since 2013 holds the position of Deputy Director of the Agrifood Safety Laboratory at the Institute of Quality Standard and Testing Technology of the Beijing Academy of Agriculture and Forestry Sciences. He has expertise in stable isotope mass spectrometry and his work in FSCL is focusing on food authenticity studies, including the geographical origin and the detection of adulteration of honey through the measurement of the stable hydrogen isotope (δ^2H) value of the saccharides involved.

Ms Beatriz Pérez-Fernández joined FSCL in July 2022 for a one-year consultancy. Beatriz holds a BSc in Chemistry and a MSc in Analytical and Bioanalytical Sciences. Her PhD work comprised the development of electrochemical (bio)sensors for the determination of analytes of interest for agri-food control. In FSCL, she will be working on the development and transfer to Member States of rapid analytical methods for the control of contaminants such as mycotoxins and pesticide residues, using lateral flow or electrochemical techniques that combine the usage of immunosensors and screen-printed carbon electrodes.

Ms Joanna Malgorzata Mletzko re-joined the Joint FAO/IAEA Centre as a team assistant in July 2022, after working since March 2021 in the Office of Procurement Services at the IAEA Headquarters in Vienna. Joanna will provide administrative support to FSCL and APHL staff.

FSCL Fellows

In July 2022, Ms Colette Samantha Eusey - Cuello, from the Food Safety Department of the Belize Agricultural Health Authority (BAHA) joined FSCL for a 4-month fellowship under the TCP BZE501. During her fellowship, Collette worked on method validation studies for pesticide residues and mycotoxin analysis using LC-MS/MS, including sample preparation techniques and instrumental analysis for the determination of neonicotinoids in honey, pesticides and metabolites in biobeds, and mycotoxins in corn flour and tortillas. Colette enhanced her knowledge of method development and validation and gained skills in optimizing instrument parameters, data analysis and the maintenance of the LC-MS/MS equipment. This hands-on experience will help her in the daily operation of a similar instrument in BAHA. We wish Colette every success and look forward to continuing the collaboration on the mycotoxin project in tortillas.

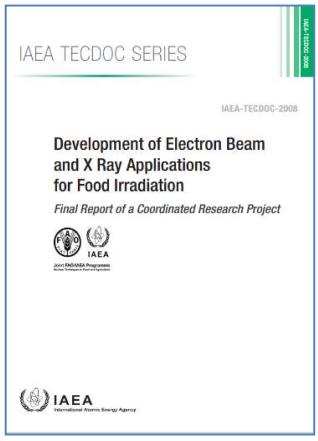
In September 2022, Mr Enrique Mejias, Researcher at the Center for Nuclear Technologies in Vulnerable Ecosystems, Nuclear Research and Applications Division of the Chilean Nuclear Energy Commission, joined FSCL for a 5-week fellowship under the TCP CHI5053. Enrique's work is related to the application of nuclear techniques to improve the production process and quality control of Chilean honey. In FSCL, he was trained in the detection of exogenous C4-plant sugars, such as high fructose corn syrup, in honey using EA-IRMS. The knowledge and experience that he acquired during his fellowship will strengthen Enrique's capabilities and facilitate the implementation of new EA-IRMS equipment in his laboratory.

Ms Nur Hafizati binti Abdul Halim, a Research Officer at the Department of Biotechnology and Bioscience of the Malaysian Nuclear Agency, joined FSCL for a 2-month fellowship in October 2022 under TCP MAL5032. Hafizati has been involved in authenticity assessment projects using isotopic techniques for a variety of foods, such as cocoa beans, halal meats, and mangoes. During her fellowship, she was trained in the detection of exogenous C4-plant sugars in stingless bee honey using EA-IRMS and in the application of the dual-water equilibration technique to determine the non-exchangeable hydrogen isotope composition of extracted protein to aid in the determination of honey geographical origin. On her return to Malaysia, Hafizati will implement this training in the Malaysian Nuclear Agency's stable isotope laboratory for the quality control of stingless bee honey, which is a premium food product in Malaysia. and thus prone to economically motivated adulteration.

Announcements

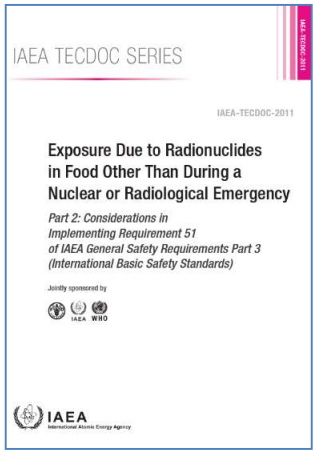
TECDOC-2008, Development of Electron Beam and X ray Applications for Food Irradiation

Gamma irradiation of food is a mature, relatively simple and reliable technology. However, more use of alternative irradiation technologies, based on electrically generated sources, would help complement the available capacity. Electron beams and X rays generated from electricity are technologies that avoid the procurement, transport, storage, disposal, and security issues associated with the use of radioisotopes that produce gamma radiation. Arising from IAEA Coordinated Research Project D61024, this publication reports on research to develop new tools in food irradiation and to rapidly ascertain treatment parameters before irradiation, it includes new developments in high energy (MeV) and low energy (keV) electron beam and X ray irradiation. Comparative studies of gamma, electron beam and X ray irradiation for food and phytosanitary uses are also presented.



TECDOC-2011, Exposure Due to Radionuclides in Food Other than During a Nuclear or Radiological Emergency

This is intended to assist regulatory bodies, policy makers and others with responsibilities relating to radionuclides present in food and the management of exposure in normal situations (i.e. excluding nuclear or radiological emergencies). It has been developed by the FAO (through the Joint FAO/IAEA Centre), IAEA and WHO and is jointly sponsored by the three organizations. Its focus is on technical considerations for the implementation of Requirement 51 of Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, IAEA Safety Standards Series no. GSR Part 3, in the area of food safety. In particular this publication provides a proposed approach for the management of radionuclides in food for consideration in implementing Requirement 51 in GSR Part 3. The publication will be of practical value to all those with roles in food safety or radiation.



TECDOC-2002, Accessible Technologies for the Verification of Origin of Dairy Products s an Example Control System to Enhance Global Trade and Food Safety

This is the final report of a coordinated research project which ran from 2013 to 2018. Dairy commodities are of high priority for improved traceability and authenticity control due to their relatively simple processing procedures, high level of trade and frequent use as an ingredient in in products destined for vulnerable consumer groups such as infant formula for young children. The methodology presented is intended to act as a template that can be transferred to other food commodities as required.

Food Safety and Control E-Learning Courses

New e-learning courses are available in the IAEA's Learning Management System, Cyber Learning Platform for Network Education and Training (CLP4NET). The e-learning courses are available for free and can be completed at any time and at your own pace. There are both open and protected courses available.

The open courses available are:

1. Analytical Methods to detect and control Organic Contaminants in food
2. Chemometrics Add-in for Excel (CAFE)
3. Elemental Analysis for Isotope Ratio Mass Spectrometry

The list of open courses is available in the Course Catalogue – IAEA website. To access the full list of courses, visit CLP4NET.

How to enrol

To enrol in the courses, users need to create a NUCLEUS account and log-in to the CLP4NET platform. To register a new NUCLEUS account, click here.

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