Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Food & Environmental Protection Newsletter

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To Our Readers

Botswana beef accredited for export to European markets with IAEA support on routine food safety testing.

It is my great pleasure to present to all readers this first online publication of the Food and Environmental Protection (FEP) newsletter. As previously announced, this is a new initiative and our newsletter will be posted to our web-space and available to you electronically from now on. You should receive an email notification when a new edition becomes available. Not only is this more environmentally friendly, it also saves on costs and ensures that you receive very timely information.

As 2019 draws to a close, we are completing the review of our 2018–2019 activities and contributions to both IAEA and FAO work programmes. In addition, we are finalizing the 2020–2021 design and workplan for the FEP Subprogramme.

This newsletter highlights our progress and key activities related to our continuing efforts to support Member States in their development and application of nuclear and related techniques for improving food safety and control systems. For example, this issue's feature article focuses on integrated analytical approaches for pesticide management supporting food safety and sustainable agriculture. It introduces integrated analytical approaches for pesticide

management developed by the Joint FAO/IAEA Programme and provides briefing on the successful application of these laboratory approaches and standard operating procedures. Newsletter articles also give informative details about further achievements during the second half of 2019 and these include: the development of new Coordinated Research Project (CRP) proposals; the provision of technical assistance in the final design of Technical Cooperation Projects (TCPs) for 2020−2021; the organization and implementation of training courses and workshops; research developments at our Food and Environmental Protection Laboratory (FEPL); the provision of support and technical input through participation at international or interregional meetings, etc.

Two new proposals for CRPs were developed through consultations with experts in relevant scientific fields during this reporting period. The first is the CRP on "Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices", approved for implementation in 2020−2026. The main objective of this CRP is to support Member States in setting safe/guideline levels for veterinary drug residues in foods through disposition studies of radiolabelled substances in food producing animals, thus contributing to safeguarding consumers and promoting trade. The second CRP proposal was for coordinated research on "Innovation of Irradiation Technologies on Surface Treatment of Food Commodities" but, on the advice of our consultant experts it has since been altered to "Innovating radiation processing of food with low energy beams from machine sources" so that it may include low energy X ray as well as electron beam technologies. This second CRP proposal received formal approval at the December meeting of the Agency's Committee for Coordinated Research Activities. It targets research and innovation to facilitate practical applications of low energy electron and X ray techniques related to the irradiation of food and agricultural products.

Our team has provided continued technical support to national, regional and interregional TCPs, including organizing training courses, arranging expert missions, fellowships and procurements for food safety analytical laboratories and/or institutions, and providing technical guidance and support in the field; finalizing design of new technical cooperation projects, etc. For instance, notable training courses of the ongoing TCPs supported by technical officers in the field of food safety include: (1) Training on production of reference material to support food safety testing in African member states; (2) Regional training course on cost-effective analysis of targeted veterinary drug residues and mycotoxins in food; and (3) Regional training course on fundamentals of using nuclear techniques for verifying food authenticity. Meanwhile, the Section has worked very closely with all Divisions of the Technical Cooperation Department at the Agency and relevant counterpart institutions of various Member States in reviewing proposals and finalizing designs of new TCPs for implementation in 2020−2021. Finally, 38 new projects in the field of food safety have been selected and approved for implementation in next biennium, including five regional projects and 33 national projects. You may find an updated list of these TCPs and more detailed reports on the above-mentioned activities in this newsletter.

The work of the FEPL is very important to our Member States and our section. Recent R&D and work activities presented in this newsletter include: interlaboratory validation and extension of a multi contaminant method for a spice commodity (turmeric powder); untargeted metabolomics for the discrimination of honeys of various floral origins; headspace-gas chromatography-ion mobility spectrometric analysis of authentic argan oil from Morocco. A new project received extrabudgetary funding from the Japanese Government through the Peaceful Uses Initiative (PUI) and concerns "Enhancing Capacity in Member States for Rapid Response to Food Safety Incidents and Emergencies". The new project commenced with the first training workshop hosted at the FEPL. This event was a success and received very positive feedback from those who participated and learned more about the use of nuclear techniques to determine food origin and verify food authenticity.

International meetings and conferences are an important part of our work relevant to food safety and control and several reports can be found inside this issue including brief report on the ninth International Symposium on Recent Advances in Food Analysis; the 42nd session of the Joint FAO/WHO Codex Alimentarius Commission; the Twentieth Regular Meeting of the Inter-Agency Committee on Radiation Safety (IACRS); the 27th Regular meeting of the Inter-Agency Committee on Nuclear and Radiological Emergencies (IACRNE), etc.

Looking to the year ahead, I am sure that there will be many challenges and opportunities. We will begin a new cycle of strategic planning and design for the FEP subprogramme in 2022−2023 biennium and onwards. This is an excellent opportunity to build on our successes and plan for a future where we can work with our counterparts to support food control and safety in Member States with the application of nuclear sciences and related technologies.

I would like to thank you all for your continued support and encouragement. I would also like to thank my colleagues in the FEP Section and Laboratory for their dedication and commitment to the FEP Subprogramme. In closing, best wishes to you, our readers, and to your families for a happy, healthy and prosperous New Year.

Sincerely,

Zhihua Ye
Head, Food and Environmental Protection Section

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Feature Article

Food Safety and Sustainable Agriculture through Integrated Analytical Approaches for Pesticide Management

Andrew Cannavan and Britt Maestroni

The pressure to produce enough food for the world's ever-growing population has had a worldwide impact on agricultural practices. The use of pesticides has steadily increased over recent years to improve crop yields and in response to changing patterns of transboundary insect and fungal infestations driven by climate change. New active ingredients have also been developed and other chemicals are sometimes used inappropriately in agriculture. Flexible, targeted and cost-effective agricultural management systems are required to avoid potential food crises and emergencies caused both by plant pests and by the high levels of agrochemical inputs needed to control them, and to ensure the continuous production of safe food and the sustainability of the environment in which we live. To facilitate the implementation and continuous improvement of such systems and respond to changing social, economic and environmental conditions, laboratory and field analytical services are vital to provide data and feedback on food safety and environmental impact. Working with counterpart institutes in more than 30 countries, the Food and Environmental Protection Laboratory (FEPL) of the Joint FAO/IAEA Division has developed an innovative, resource-effective, integrated analytical approach for pesticide management to help meet these challenges and contribute to Goal 2 of the United Nations Sustainable Development Goals; to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture".

Identifying and providing objective indicators for pesticide management by strategic monitoring of agricultural practices is necessary to cost-effectively reduce the occurrence of harmful residues in food crops and preserve the environment. Focusing on implementing risk assessment approaches to reduce reliance on expensive pesticide residue testing, the FEPL initiated catchment-scale studies in several countries world-wide on integrated (one health) monitoring systems. Key to the approach was the monitoring of surface-water quality as an indicator of the effectiveness of pesticide management practices, in combination with pesticide monitoring in food. The strategy combines monitoring and modelling approaches, using analytical chemistry and biomonitoring methodologies to target high-impact rating pesticides in food, surface water and sediments in previously characterized catchments. This integrated multi-disciplinary approach enables upstream, preventative control of pesticide residues in food and allows assessment of the impact of pesticide management practices in developing countries where pesticide regulations may not exist or lack enforcement, facilitating management actions and improvement of agricultural practices.

Since food contamination does not recognize country boundaries, the approach used was to develop regional food safety laboratory networks to share data and experiences and enable optimisation of the methodology for each individual participant based on the models produced using collated data. A food safety laboratory network was initiated with the support of the Joint FAO/IAEA Division in the Latin America and the Caribbean region, the Red Analytica de Latino América y el Caribe (RALACA [1]). Institutes in Bulgaria, China, India, Kenya and Sri Lanka also contributed to the development and testing of the methodology.

The approaches developed under the initiative were published in 2018 in the book, "Integrated analytical approaches for pesticide management"[2]. This collates inputs from 26 institutes in 12 countries as well as from the FAO/IAEA Joint Division to provide generic guidelines on pesticide analysis and environmental monitoring. The analytical testing methodologies are summarized in a manual, "Analytical methods for agricultural contaminants"[3], comprising standard operating procedures for 30 analytical methods from 17 institutes in 7 countries and the FAO/IAEA Food and Environmental Protection Laboratory.

Some of the main results of this work in Member States are:

- Early warning systems for pesticide management practices that may result in food safety and environmental incidents are in place in selected catchments in Chile, Costa Rica, Ecuador, Guatemala, Panama.
- Risk maps have been developed for potentially harmful pesticides in the food chain in nine countries (Argentina, Brazil, Chile, Costa Rica, Cuba, Ecuador, Guatemala, Nicaragua, Panama, Uruguay)
- Better pesticide application practices, guidance and regulations on container disposal help to protect the health of agricultural workers.

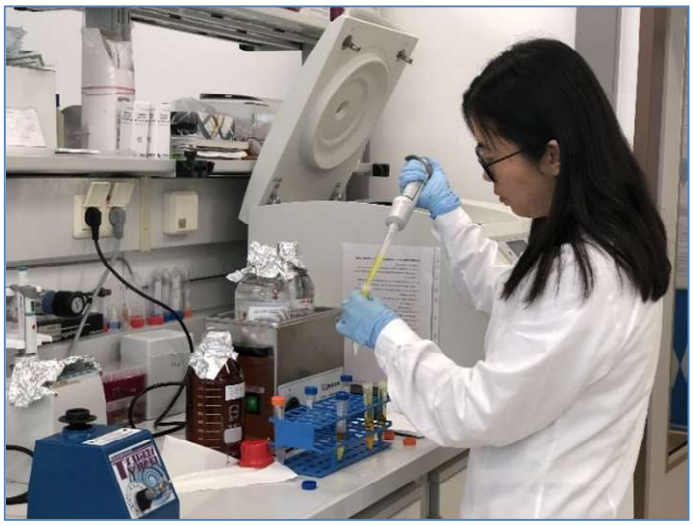
[1] http://www.red-ralaca.net/

[2] https://www.elsevier.com/books/integrated-analytical-approaches-for-pesticide- management/maestroni/978-0-12-816155-5

[3] https://www.elsevier.com/books/analytical-methods-for-agricultural-contaminants/maestroni/978-0-12-815940-8

- Pesticide application practices have been improved in Ecuador and Costa Rica.
- The integrated analytical approach was applied to support the control of pesticide residues and sustainable production of apples (Argentina), oranges and bananas (Brazil), grapes (Chile), rice and sugar (Costa Rica), broccoli & palm oil (Ecuador).
- Exports of food commodities were increased in Ecuador & Chile due to better compliance with social and trade standards.
- In China the local environmental protection agency (EPA) adopted and improved pesticide application management based on the risk assessment provided to the authorities by the participating laboratory.
- Analytical testing capabilities were improved and laboratory accreditation was achieved in food safety laboratories in 10 countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, Peru, Panama and Uruguay).
- RALACA now contributes to food safety and environmental sustainability in the Latin American region and is now an independent network comprising 56 institutions in 21 countries.
- The methodology developed contributed to updating the regulatory framework for water quality in Argentina, Chile, Costa Rica and Panama.
- Six countries successfully participated in proficiency testing for emerging contaminants in food and agriculture, including nicotine, diclofenac, ibuprofen and paracetamol (Argentina, Brazil, Chile, Costa Rica, Paraguay, Uruguay).

Future work in this field will include identifying gaps and gathering information to further develop regional early warning and crisis management capabilities, including risk communication.



Method Development in the Food and Environmental Protection Laboratory.

Biomonitoring for Food and Environmental Protection.

Forthcoming Events

Research Coordination Meetings of FAO/IAEA Coodinated Research Projects and Training Courses

Final Research Coordination Meeting on the Development of Electron Beam and X Ray Applications for Food Irradiation (DEXAFI) (D61024-CR-4), Chengdu, China, 16–20 March 2020.

Third Research Coordination Meeting on Field-deployable Analytical Methods to Assess the Authenticity, Safety and Quality of Food (D52040-CR-3), Penang, Malaysia, 30 March –3 April 2020.

Third Research Coordination Meeting on Integrated Radiometric and Complementary Techniques for Mixed Contaminants and Residues in Foods (D52041-CR-3), Beijing, China, 6–10 April 2020.

Training Course on the Detection and Control of Organic Contaminants in Food, Seibersdorf, Austria, 20– 30 April 2020.

First Research Coordination Meeting on Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices (D52043-CR-1), Vienna, Austria, 4–8 May 2020.

Consultancy Meeting on Irradiation Technology for Phytosanitary Treatment of Food Commodities and Promotion of Trade, Vienna, Austria, 15–19 June 2020.

Second Africa Food Safety Technical Meeting, Johannnesburg, South Africa, 6–10 July 2020.

Final Research Coordination Meeting on Development and Strengthening of Radio-Analytical and Complementary Techniques to Control Residues of Veterinary Drugs and Related Chemicals in Aquaculture Products (D52039-CR-4),Vienna, Austria, 10–14 August 2020.

Training Course on the Use of Profiling/Fingerprinting Techniques to Determine Food Origin and Verify Food Authenticity, Seibersdorf, Austria, 5–16 October 2020.

Second Research Coordination Meeting on the Implementation of Nuclear Techniques for Authentication of Foods with High-Value Labelling Claims (INTACT Food) (D52042-CR-2), Kingston, Jamaica, 2– 6 November 2020.

International Meetings/Conferences

First project coordination meeting TC Project on Food Irradiation (RAS5087), Hanoi, Viet Nam, 9–13 March 2020.

4th Meeting of the Codex Committee on Contaminants in Foods (CCCF14), Utrecht, Netherlands, 20–24 April 2020.

EuroResidue XI: Current issues and emerging trends in residue control, Egmond aan Zee, the Netherlands,18–20 May 2020.

Codex Committee on Residues of Veterinary Drugs in Foods (CCRVDF25), USA, TBA, 25–29 May 2020.

43rd Session of the Codex Alimentarius Commission, Rome, Italy, 6 –11 July 2020

Past Events

Food Irradiation Collaborating Centres, Vienna, Austria, 13–15 November 2019

Carl Blackburn

The IAEA has two collaborating centres that specialize in food irradiation. One is the Aérial Technology Resource Centre, near Strasbourg in France and the other is the US National Centre of Electron Beam Research at Texas A&M University, in Collage Station, USA. Both were represented at a recent technical meeting on IAEA Collaborating Centres in Nuclear Sciences and Applications, held at the IAEA Vienna, Austria, from 13–15 November 2019.

Aérial is a private but non-profit organization with experimental electron beam and X-ray facilities. A multidisciplinary team of approximately 30 people utilize low, medium and high energy electron beams and X-rays in their research. It has an accredited high dose dosimetry laboratory and other laboratories for microbiology, physical chemistry, sensory evaluation, nuclear magnetic resonance and freeze-drying, plus associated food laboratories for research and development. A recent achievement at Aérial is the construction, installation and qualification of the FEERIX high energy beam facility that houses a new rhodotron electron accelerator with high energy electron beam and X-ray lines4. This is a multidisciplinary research establishment and recent collaborations have included a series of training courses and implementing two dosimetry inter-comparison exercises for thirteen institutes in twelve countries. Over the past three years, experts from Aérial have undertaken eight IAEA missions to Brazil, India, Philippines, Poland, Malaysia and North Macedonia. In addition, Aérial has installed dosimetry equipment and provided related training in 17 institutions in developing countries. Readers will also recall that the major radiation processing conference, IMRP was also hosted in Strasbourg in early 2019 with Aerial as the regional sponsor, welcoming over 500 delegates from approximately 100 different countries.

The National Centre for Electron Beam Research (NCEBR) is an IAEA collaborating centre for electron beam technology for food, health and environmental applications. It is a university institution that trains students and serves projects from government and industry as well as fundamental academic studies. Topics not only include food safety and security but also range from environmental remediation, vaccines and therapeutics, polymer science, and space programme research. It promotes the use of electron beam technology and in recent years has worked on many proof-of-concept projects to probe commercial viability as well as technical validity of electron beam applications. For example, recent publications include a paper that demonstrates that electron beam irradiation to doses as low as 2 kGy could be a substitute for heat pasteurization of raw milk. This is strategically important because advances are occurring in the development of small electron beam lamps that can be fixed in-line and improve the in-factory handling of foodstuffs by avoiding energy losses associated with rapidly heating and cooling milk. Facilities at the NCEBR include a full commercial scale 10 MeV, 15 kW electron beam irradiator. International collaborations include working with specialists from Egypt, Mexico, Morocco, Philippines, Poland, and Thailand. An annual "Hands-on eBeam Workshop" has been offered over the past 10 years, training many from research, commercial and regulatory backgrounds. The 11th Annual Hands-On eBeam Workshop, takes place 20–24 April 2020 (Session 1: 20–22 April: medical devices and pharmaceuticals and environmental applications plus Session 2: 22–24 April: food, feed and phytosanitary applications)[5].

Ninth International Symposium on Recent Advances in Food Analysis, Prague, Czech Republic, 5–8 November 2019

Andrew Cannavan

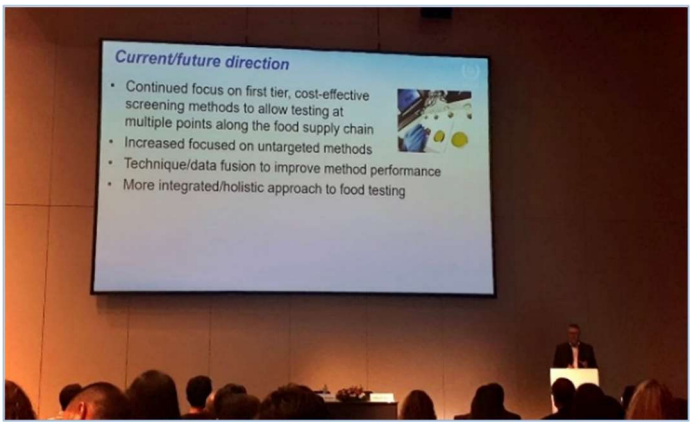
The International Symposium of Recent Advances in Food Analysis is a biennial event held in Prague, Czech Republic. The ninth Symposium in the series took place from 4– 8 November 2019. The programme included oral presentations, poster sessions, workshops and discussions on a wide range of food analysis-related topics, including the analysis of residues and contaminants in food; food authenticity and food fraud; QA/QC, and chemometrics and big-data handling; food forensics; novel food bioactives and supplements; and portable on-site food analysis. The symposium had approximately 850 participants from 60 countries around the world.

Mr Cannavan, Head of the Food and Environmental Protection Laboratory, participated in the symposium and gave an oral presentation, 'FAO/IAEA food authenticity research – some results in the field and future directions', in session 5, the first of two workshop sessions on "Experiences, achievements and challenges foreseen by EU Reference Laboratories and international collaboration". The presentation focused on assistance provided by FEPL to Member States over the last decade in response to increased demands to improve their capabilities to deal with issues

[4] https://www.aerial-crt.com/en/excellence-center-for-radiation-processing/

[5] http://ebeam-tamu.org/ebeam-workshop

such as food fraud and food authenticity. A number of analytical approaches have been developed under this research strand at IAEA and in collaboration with other projects focusing on various aspects of food integrity, such as those funded by the EU. Until recently, however, it has been somewhat difficult to translate the results of the research into actual applications in the food supply chain and to visualise their impact. In addition to capacity building in terms of the development of analytical methods, quality control materials and human resource expertise for authenticity testing, the work of FEPL in this field has recently shown significant impact in several countries. Results include the integration of nuclear, isotopic and related methodology into food control systems, food quality schemes and regulatory standards; bringing food testing capabilities closer to the field with rapid and simple screening methods; forging of important links between research and industry with respect to food authenticity and traceability of geographical origin; building awareness of the issues related to food fraud and the role of nuclear techniques in controlling the problems, and gathering 'baseline' data on food fraud and its control to facilitate targeted research and capacity building. Some examples of these results were elaborated in the presentation. An overview was also presented of current and future coordinated research focusing on the implementation of nuclear techniques for the authentication of foods with high-value labelling claims. The presentation was well received and led to individual and group discussions with delegates from Albania, China, Iran, Italy, New Zealand, Singapore with respect to future collaboration.



Mr Cannavan presenting RAFA2019.

Mr Cannavan and Mr Kelly (FEPL) also contributed to a presentation given by Mr McGrath, (Queen's University Belfast, UK) on 'Model transferability: an interlaboratory study using SCIO devices to test oregano authenticity'. As part of a European Innovation & Technology (EIT) Food project, 'Food fortress for raw materials and ingredients in Europe – gaining consumer trust through transparency of the supply chain', chemometric models to detect oregano authenticity, developed using NIR spectra obtained on a single SCiO instrument, were deployed. An interlaboratory study was undertaken as part of this EIT Food project and the IAEA coordinated research project, 'Field-deployable Analytical Methods to Assess the Authenticity, Safety and Quality of Food' (D52040). This study, involving more than 30 participants around the world, investigated the ability of the models to correctly identify authenticity status of oregano samples. Data were presented showing the characteristics of the instruments and the performance of developed models, which were encouraging.

A poster on collaborative work with FEPL, entitled 'Multi-contaminant analysis in turmeric powder by LC-MS/MS and GC/MS/MS' was presented by Ms Besil (Universidad de la República, Uruguay). The poster summarised work carried out in Uruguay and in FEPL to optimise and characterise the multi-contaminant method, with the evaluated performance characteristics and results from the application of the method to commercial samples.

Mr Cannavan (right) with the speakers and chairs of the session "Experiences, achievements and challenges foreseen by EU Reference Laboratories and international collaboration 1".

The symposium included many aspects of interest to current and future FEPL work, including analytical methodology, chemometrics and field deployable methods for food residue and contaminant control and food authenticity. 'Smart-Lab' sessions introduced developments in accessible food testing, including further miniaturization of analytical instruments for first-tier screening, using novel and emerging enabling technologies such as nanomaterials and advanced data-handling tools to develop portable, rapid and non-invasive instruments. This will significantly increase the numbers of food samples that can be tested. For example, prototype food scanners have already been developed using ordinary smart-phones as the read-out device. The cost-effectiveness and accessibility of these techniques mean that they could potentially be used to screen foods at multiple points along the food value- chain by stakeholders in the food industry, regulators and even consumers, which would significantly increase the effectiveness of control systems. The integration of such instruments into food testing systems is expected to trigger a paradigm shift in which laboratories applying the highly sensitive and specific nuclear and isotopic techniques that provide crucial information will

move from dealing with high numbers of compliant samples to fewer, more interesting samples that have been identified as suspicious. The more detailed information provided by the high-end techniques on the product characteristics that indicated non-compliance would facilitate follow up investigations and targeted recall or possibly prosecution. The development of methodology and testing the effectiveness and applicability in the field of the emerging generation of portable screening food scanners will be topics of the future research at the Seibersdorf Laboratories and in Member States through coordinated research projects.

The National Institute of Standards and Technology (NIST) Food Safety Workshop and Debrief, NIST Headquarters, Gaithersburg, USA 28–3 October 2019

Simon Kelly

The National Institute of Standards and Technology (NIST) has extensive experience in preparation and characterization of certified reference materials and providing measurement support through quality assurance programs for food nutrition. NIST is also poised to become a leading provider of metrology solutions to address many food safety challenges, ranging from heavy metals, natural toxins, and agrochemical residue contamination resulting from growth conditions to allergens, bacteria, or other contamination occurring during processing and/or packaging.

Food safety and food authenticity are inexorably linked through food fraud, which is increasingly conducted by organised crime syndicates. An example is the arrest of 20 individuals and the seizure of 150,000 litres of fake olive oil, made from a mixture of sunflower oil, soya oil, chlorophyll and beta-carotene, in Italy in May 2019. NIST organised the Food Safety workshop at their headquarters in Gaithersburg, USA between the 28–31 October 2019 to bring together experts from the food industry, government, academia, and international organizations with metrology experts to discuss challenges and possible solutions facing laboratories charged with ensuring the safety and authenticity of the global food supply. Mr Kelly (FEPL) was invited to give a lecture on "The Application of Multi-Element and Multi-Isotope Analysis; A Potential Tool to Prevent Food Fraud" in the session on "Authenticity, Fraud, and Adulteration". Mr Kelly presented an overview of the existing food authenticity stable isotope methods in the Codex Standard 234 and how these can be augmented with macro, micro and trace-element profiling by nuclear and complementary methods, such as inductively coupled plasma – mass spectrometry, to determine the production history and geographical origin of food. Mr Kelly also highlighted the challenges facing the implementation of stable isotope and trace element profiling to determine the provenance of food, such as the lack of food-matrix stable isotope reference materials and databases of authentic food products with which to compare suspected counterfeit food products. He then took part in a panel discussion answering questions related to the calibration and application of stable isotope methods to food authentication.

One of the initiatives discussed in the debriefing session was National Measurement Institutes (NMIs) such as NIST and the Laboratory of the Government Chemist (LGC) in the UK making a long-term commitment to maintain databases of authentic samples and data for food authenticity determinations as an extension to their role of providing reference materials. This included spectral databases for use with mobile and portable screening devices for enforcement officials.

After the workshop, the planning committee will work with other major contributors to prepare and publish a white paper summarizing needs and possible measurement science solutions and technology transfer opportunities in the areas of food safety and authenticity. The white paper will inform the future directions of NIST efforts in ensuring the safety of national and international food supplies. A second, complementary white paper on the broader international capabilities across NMIs and prospective actions to ensure global food safety will be also be generated.

NIST Food Safety Workshop Participants.

The Technical Officer, Mr Simon Kelly, participating in a panel discussion at the end of the session on "Authenticity, Fraud, and Adulteration".

Training Workshop on the Use of Nuclear Techniques to Determine Food Origin and Verify Food Authenticity, Seibersdorf, Austria, 7–18 October 2019

Andrew Cannavan, Simon Kelly, Britt Maestroni, Alina Mihailova

Technical support: Marivil Islam, Aiman Abrahim, Serik Permetov

The Peaceful Uses Initiative (PUI) project "Enhancing Capacity in Member States for Rapid Response to Food Safety Incidents and Emergencies", funded by the Japanese Government, held its first training workshop in the Food and Environmental Protection Laboratory (FEPL), Seibersdorf, 7–18 October 2019. The purpose of the training was to strengthen Member States' surveillance and research laboratory capacities in using the nuclear techniques, isotope ratio mass spectrometry (IRMS) and gas chromatography – ion mobility spectrometry (GC-IMS), to verify labelling claims related to the origin and authenticity of food products. This training was designed to underpin effective control measures to protect the public from fraud, including any associated unintended safety issues, mitigate the disruptive impact of emergencies affecting the food chain, and minimize disruption to trade in agricultural commodities.

The training workshop was attended by 22 scientists from institutes in 16 countries; Argentina, Bangladesh, Chile, China, Costa Rica, India, Indonesia, Iraq, Jamaica, Malaysia, Morocco, Pakistan, Republic of Korea, Sri Lanka, Thailand and Vietnam. The 10-day course included theoretical lectures and hands-on laboratory sessions. The first week focused on an introduction to food fraud and the application of IRMS; setting up an elemental analyser (EA) for bulk stable isotope analysis; routine coupled EA-IRMS operation; EA and IRMS fault finding and maintenance; preparation of honey protein to detect the addition of exogenous sugars, following the Association of Official Analytical Chemists methodology; detection of exogenous sugars to fruit juice, following a Codex method; calibration of the IRMS, data processing and analysis; quality control, proficiency testing and ion-source dismantling and cleaning.

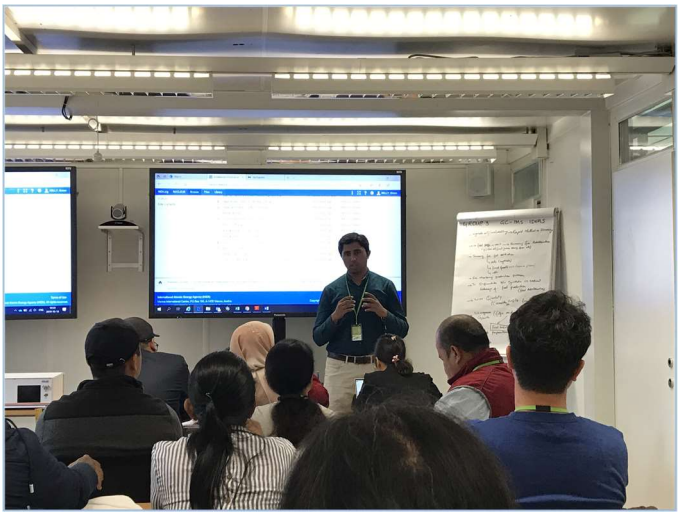
The course was implemented through a carousel of learning with the trainees split into four equal groups and the possibility for extended learning. In addition to the FEPL staff, this training was delivered by external experts from Japan (Ms Yaeko Suzuki) and the United Kingdom (Mr Gareth Rees) and cost-free support from ThermoFisher (Mr Christopher Brodie). The second week of the training focused on stable isotope data processing; applying stable isotopes and complementary techniques to characterise the geographical origin of food; a World Café exercise to plan a food authenticity project; an introduction to GC-IMS technology for the "visualisation of odour"; and a second round of hands-on laboratory based training on the practical use of the GC-IMS "Flavourspec" system supported by cost-free experts from G.A.S. Dortmund (Mr Hansreudi Gygax and Mr Daniel Sanders).

The training was very well received by the participants and anonymously assessed by 68% of them through on-line feedback as "excellent" or "very good". Further training workshops, supported by the Japanese PUI, will be held in 2020 covering 'the Detection and Control of Organic Contaminants in Food (Targeted Testing)' and 'the Use of Profiling/Fingerprinting Techniques to Determine Food Origin and Verify Food Authenticity'.

Expert lecturer, Ms Yaeko Suzuki (JPN), presenting sample preparation strategies for IRMS analysis to the workshop trainees.

Workshop trainees, external experts and FEPL staff outside the IAEA laboratories in Seibersdorf.

Workshop trainees fitting combustion and reduction tubes into an elemental analyser.



A Workshop Trainee giving feedback to the other participants on his groups' brainstorming session for applications of GC-IMS in food authenticity and origin determination.

Latin American Risk Assessment Symposium (LARAS) "Building-up a Regional Approach", Montevideo, Uruguay, 27–29 August 2019

Britt Maestroni

Ms Britt Maestroni (FEPL) travelled to Montevideo, Uruguay, to participate as an invited speaker in the Latin American Risk Assessment Symposium (LARAS) "Building-up a regional approach" that took place from 27 to 29 August 2019. The LARAS symposium was organized under the patronage of the Ministry of Livestock, Agriculture and Fisheries of Uruguay and the German Federal Institute of Risk Assessment (Bfr). It provided the audience with a multidisciplinary perspective on the societal and scientific challenges of risk assessment for ensuring food safety in Latin America. It also provided an excellent forum for networking between important food safety actors/ experts, to exchange state-of-the-art science and know-how as well as to raise awareness about food control systems to ensure food safety in an interconnected, interdependent world. The symposium was attended by more than 150 participants from Uruguay and other Latin American countries including Argentina, Brazil, Chile and Paraguay and experts from Brazil, Germany, Portugal and Spain.

Protection of the integrity of the food supply is of utmost importance in terms of food security, food safety and quality, consumer protection and international trade. In this context the aim of the symposium was to contribute to the further development of food safety control structures in Latin America (LA) and to sustainably improve risk analysis tools in the LA region. The programme included lectures from highly qualified and experienced Latin American and European experts on the topics of microbiological risk assessment, chemical risk assessment and antimicrobial resistance. Interactive workshops addressed current challenges in terms of governance, risk management, communication and science for risk assessment. The workshops provided an ideal opportunity for active engagement, collaboration and networking. Ms Maestroni chaired a session on microbiological risk assessment where the experts discussed a food safety crisis (EHEC crisis) from 2011 and the lessons learned from the two European countries that were mainly affected, Germany and Spain.

The work of the Joint FAO/IAEA Division in terms of capacity building for LA member states and the importance of quality data were also presented in the meeting discussions. The workshop participants worked in teams and prepared some simple statements to be presented to the decision makers associated with the meeting. These statements covered four different area and were:

Science:

- Make the political decisions for capacity building in risk assessment.
- The cost for health is not known because there is no risk assessment.

Risk management

- There is a need to strengthen links and exchanges in order to unify risk management in a multidisciplinary and multisectoral body at the regional level.
- Food safety in the Latin American region requires databases that should be compiled, updated, systematized and easily accessible.
- It is necessary to further promote technical cooperation among countries and expand current networks.
- In the event of an alert situation it is necessary to have a crisis management protocol that can count on experts in all areas.
- It is essential to generate harmonized simulation programs linked to crises, with unified criteria due to lack of harmonization of terms.
- It is essential to strengthen the mechanisms that guarantee complete traceability of the entire food chain.

Governance:

- Food safety must be a priority for Latin America.
- Food safety is a shared responsibility towards a new health in Latin America.
- Changing the model of food safety operations and organization in Latin America is not easy, but it is essential.

Communication of risks in a food safety crisis:

- Protocols, procedures and trained professionals are essential to achieve effective risk communication.

- The transparency generated by risk communication gives confidence and maintains the credibility of consumers (the population) and the markets.
- We request the urgent prioritization of the risk analysis tool for food safety policies and the risk communication component.

The statements from the working groups were presented to the decision makers present at the symposium and discussed in plenary in the final session. On the last day of the symposium Ms Maestroni also participated in a satellite meeting for political and institutional executives at which the IAEA RLA2018010 technical cooperation project planned to start in 2020 was presented. The objective of the satellite meeting was to identify next steps in advancing regional and international collaboration in the area of food safety risk analysis.

The symposium was appreciated by the participants and represented an opportunity to meet regional colleagues, exchange ideas and jointly discuss development issues and capacity building needs for future development of risk assessments in Latin America.

Latin American Risk Assessment Symposium participants in Montevideo, Uruguay.

The Latin American Risk Assessment Symposium Workshop Sessions.

42nd Session of the Joint FAO/WHO Codex Alimentarius Commission, Geneva, Switzerland, 8–12 July 2019

Zhihua Ye

The reporting officer participated in the 42nd Session of the joint FAO/WHO Codex Alimentarius Commission (CAC) at the International Conference Center in Geneva, Switzerland, 8–12 July 2019.

This CAC Session was attended by 538 delegates from 99 Member countries and 58 observers of international governmental (IGOs) and non-governmental organizations (NGOs), including United Nations agencies. Mr Tedros Ghebreyesus Adhanom, the Director General (DG) of WHO, and Mr Bukar Tijani on behalf of FAO DG welcomed participants and addressed the Commission.

The agenda of the Commission included six plenary sessions and five side events, on 'How to design and implement a successful Codex Trust Fund project'; 'FAO and WHO capacity development activities'; 'Observer panels on the future of food: E-commerce and novel foods' (these were two workshops focusing on IGOs and NGOs); 'the burden of foodborne diseases'; and 'How to fully utilize the Codex Online Commenting system (OCS). The latter was a specific training event for all Codex participants. The meeting also celebrated the World Food Safety Day.

Highlights of the adopted CAC42 report included:

• Adopting Maximum residue limits (MRLs) for 32 different pesticides in various foods and feeds and 154 food-additive provisions of the General Standard for Food Additives as well as several codes of practice and guidelines for rapid risk analysis, etc.;

• Extensive discussions on the proposed draft maximum limits (ML) for cadmium in chocolates containing or declaring <30% total cocoa solids on a dry matter basis and the inclusion of a provision for trisodium citrate in fluid milk;

• Discussing Codex work management and sustainable scientific advice from FAO/WHO including endorsement of the decision of CCEXEC77 to establish a sub-committee to develop practical guidance for Codex Subsidiary Bodies;

• Re-election of Chairperson, Vice-Chairpersons and Members of the Executive Committee.

The reporting officer represented the IAEA at all of the meeting's activities and attended all plenary sessions as well as side events as an observer from UN agencies with special respect to the activities of the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

As is the normal practice for observer organizations, the reporting officer prepared an information sheet on activities of the Joint Division that was submitted in time to the Codex

Secretariat for this Codex Commissions. It is important to note however, that henceforth the Codex secretariat has changed the procedure for observers and meeting participants submitting information to the commission, by establishing a specific webpage. This happened just a few weeks prior to the meeting. In accordance with this sudden change from the Codex Secretariat, one part of the approved information sheet on "Coordinated research contributing to future standards through Codex meclhanism" was submitted as an article to the observer's webpage, and was accepted by the Codex Secretariat for publication [6].

The Commission expressed its appreciation to Representatives of observer organizations including the IAEA for the useful information provided on the fruitful activities. Several delegations, especially from African countries such as Uganda and Kenya, expressed their appreciation to the IAEA and the Joint Division for continued support and contribution to capacity building in food safety analysis in the developing countries and that this is a top priority.

The 42nd session of the Joint FAO/WHO Codex Alimentarius Commission.

27th Regular Meeting of the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE), World Health Organization, Geneva, Switzerland, 11–14 June 2019

Carl Blackburn

This meeting of the IACRNE was hosted by the World Health Organization at its headquarters in Geneva and in total 12 international organizations participated [7]. The technical officer participated to report on FAO/IAEA Division programmatic work of interest to international organizations and parties to the Joint Radiation Emergency Management Plan (JPLAN) of the International Organizations; share information related to nuclear emergency preparedness and response activities, and; receive feedback on activities and plans in the area of food safety and control related to nuclear and radiological emergency preparedness and response.

This is a liaison meeting, each member organization provided verbal and written reports of their Emergency Preparedness and Response (EPR) activities since the previous IACRNE meeting held in November 2017. For example, the meeting discussed the next major international nuclear emergency exercise (ConvEx-3 exercise), that is to be planned over the coming years and will be hosted in 2021 by the United Arab Emirates and based on a scenario at their new nuclear power station, currently under construction.

There was also a great deal of interest in a project on radionuclides in food and drinking water. This work by the FAO, IAEA and WHO is related to non-emergency situations and not emergency preparedness. However, other organizations need to be aware of this work and the need for consistency with Operational Intervention Levels used in emergencies to restrict and control the food supply should it be affected by an accident.

The main output of the meeting was the agreed framework for IACRNE work activities as this gives the key dates and actions for JPLAN organizations in the coming years. The next regular meeting of the IACRNE is scheduled for 17– 19 March 2021 at the Organisation for Economic Co-operation and Development, Nuclear Energy Agency (OECD NEA) in Paris, France.

[6] http://www.fao.org/fao-who-codexalimentarius/news-and-events/news-details/en/c/1202972/

[7] The participating international organizations were as follows: Preparatory Commission for the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Euro-Atlantic Disaster Response Coordination Centre on the North Atlantic Treaty Organization (EADRCC), European Commission (EC), European Union Agency for Law Enforcement Cooperation (EUROPOL), Food and Agriculture Organization of the United Nations (FAO), International Atomic Energy Agency (IAEA), International Federation of Red Cross and Red Crescent Societies (IFRC), Organisation for Economic Co-operation and Development Nuclear Energy Agency (OECD NEA), United Nations Department for Safety and Security (UNDSS), United Nations Office for the Coordination of Humanitarian Affairs (OCHA), United Nations Environment Programme (UNEP), World Health Organization (WHO). In addition, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was also represented by UNEP.

Twentieth Regular Meeting of the Inter-Agency Committee on Radiation Safety (IACRS), World Health Organization, Geneva, Switzerland, 3–6 June 2019

Carl Blackburn

This meeting of the IACRS was hosted by the World Health Organization (WHO) at its headquarters in Geneva and eight Member Organizations plus four Observer Organizations participated[8]. The technical officer was representing the Food and Agriculture Organization of the United Nations (FAO) through the Joint FAO/IAEA Programme on Nuclear Applications in Food and Agriculture. The purpose of the IACRS is to promote consistency of policies and coordination of activities with respect to areas of common interest in radiation protection and safety at the international level. This includes applying radiation protection and safety principles and criteria for the development and implementation of standards and translating them into regulatory terms; fostering co-ordination of research and development; advancing education and training; promoting widespread information exchange; facilitating the transfer of technology and know-how and providing services in radiation protection and safety.

Participants provided reports on their activities and discussed areas of mutual interest. For example, the IAEA provided details on their plans to organize an International Conference on Radiation Safety at its headquarters in Vienna, Austria, from 9 to 13 November 2020 and details, including how to register, have since appeared online[9]. At the meeting it was agreed that the Conference should be arranged in cooperation with other international organizations, including the FAO.

Much of the agenda concerned radiation safety standards and implementation. Our hosts, the WHO invited several medical professional societies to provide feedback on radiation safety issues in the areas of health technologies, medical devices and, patient safety. The Swiss Federal Office of Public Health (FOPH) also presented information about their work and issues related to radiation safety.

A session was also devoted to existing exposure situations and the management of radioactivity in food and drinking-water. There was a great deal of interest in the FAO, IAEA and WHO project on radionuclides in food and drinking water and work to support the establishment of reference levels for both natural and human made radionuclides in food.

Each member organization takes it in turn to chair the meeting and the WHO will pass the chair to the IAEA at the next regular meeting scheduled for the end of 2020.

[8] **IACRS Member Organizations:** European Commission (EC); Food and Agriculture Organization (FAO); International Atomic Energy Agency (IAEA); International Labour Office (ILO); OECD/Nuclear Energy Agency (NEA); Pan-American Health Organization (PAHO);United Nations Environment Programme / United Nations Environment Programme as secretariat to the United Nations Scientific Committee on the Effects of Atomic Radiation (UNEP, UNSCEAR), and; World Health Organization (WHO): Maria del Rosario Perez, Switzerland. **IACRS Observer Organizations:** International Commission of Radiological Protection (ICRP); International Commission on Radiation Units and Measurements (ICRU) participated by video link; International Electrotechnical Commission (IEC), and; International Radiological Protection Association (IRPA).

[9] https://www.iaea.org/events/international-conference-on-radiation-safety-2020

Coordinated Research Projects

CRP Reference Number	Ongoing CRPs	Project Officer
D52039	Development and Strengthening of Radio-Analytical and Complimentary Techniques to Control Residues of Veterinary Drugs and Related Chemicals in Aquaculture Products	J.J. Sasanya
D52040	Field-deployable Analytical Methods to Assess the Authenticity, Safety and Quality of Food	S. Kelly A. Cannavan
D52041	Integrated Radiometric and Complementary Techniques for Mixed Contaminants and Residues in Foods	J.J. Sasanya Z. Ye
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 Matrics	J.J. Sasanya
D61024	Development of Electron Beam and X ray Applications for Food Irradiation (DEXAFI)	C.M. Blackburn

Food Irradiation, New Coordinated Research Project (CRP) " Innovating Radiation Processing of Food with Low Energy Beams from Maschine Soureces"

Carl Blackburn

On the 4th of December the Agency's Committee for Coordinated Research Activities in Nuclear Applications (CCRA-NA) formally approved a new CRP entitled "Innovating Radiation Processing of Food with Low Energy Beams from Machine Sources". CRP participants will be recruited in 2020 and the first Research Coordination Meeting is planned for early 2021 at the IAEA Headquarters. Details will shortly appear online but please contact us for copies of the research proposal[10] .

The research proposal for this 5-year CRP has its origins in a concept for future research that was produced by the Technical Officer. The concept was then elaborated into a draft CRP proposal in readiness for convening a consultancy meeting where experts would advise and finalize the proposed technical programme of work. The consultancy meeting was held at the IAEA Headquarters in Vienna, Austria from 7 – 11 October 2019. Six leading experts in the field of radiation processing from China, Japan, France, USA, Poland and Switzerland accepted the invitation to advise the sub programme on the CRP proposal, to develop its scope and content of the new CRP, and make any necessary recommendations.

Irradiating food 'in-house' (inside a food factory or packing facility) to enhance safety and quality as part of a normal food business operation has long been an aspiration. Currently irradiation is often outsourced; food is shipped to large irradiation facilities where high energy beams (gamma, electron or x-ray radiation with energy measured in millions of electron volts, MeV) are used to treat the food and the process is operated by specialist contractors. Recent developments in low energy electron beam (LEEB, electrons with energy measured in thousands of electron volts, keV)) technology has revolutionized aseptic packaging. Advancements in electron beam technology are shrinking the footprint of the devices used to generate ionizing radiation. With the relatively recent development of reliable, compact, cost-effective, LEEBs, a new class of applications is now possible – for example, installing an array of LEEB lamps to irradiate products as an integral part of a continuous sequence of operations inside a food factory. The benefits of high-speed, high efficacy treatments, with no chemicals and at room temperature, are now realized across a variety of packaging applications. Such developments are also attractive to the food industry.

Energy efficient LEEB are effective at decontaminating surfaces but leave the bulk of the food untreated. This contrasts with conventional food irradiation (e.g. with high energy electrons, gamma rays or x-rays), where the whole volume of food is irradiated. In addition, low energy x-rays

[10] Email: c.blackburn@iaea.org

(LEEX) can penetrate more deeply and in some cases through the entire food product. For example, LEEX based technologies are replacing radionuclide (caesium source) in many health-care blood irradiation programmes. The consultant experts recommended altering the title of the CRP so that it placed an emphasis on low energy beam irradiation and not surface irradiation only. Referring to surface irradiation would not include the use of low energy beams to irradiate food fully (for example the use of low energy x rays as a phytosanitary treatment for fresh fruits and vegetables my need the whole volume of the food product to be irradiated because eggs or larvae of insects may burrow deep into the commodity.

Experts from the food engineering industry and the electron beam / x-ray equipment industry (Bühler from Switzerland and Nuctech from China, respectively). Information provided by Bühler showed how the company decided to adopt LEEB following a review of many different technologies and primarily because of LEEB efficiency, potential energy savings, waste reduction capabilities and avoidance of chemicals. The expert from Nuctech provided information on various potential applications of LEEB in the food sector. She emphasized the value proposition of LEEB and as a technology provider. Nuctech has already started preliminary negotiations with the food industry in China about potential new technologies.

Japan had pioneered LEEB research with its focus on soybeans, rice, and wheat. However, links could not be made with the food industry at that time and, therefore, these technologies were not commercialized. Therefore, it is critically important for researchers to collaborate with appropriate food industry partners. It was thought that collaboration between future CRP participants and the food industry would enhance commercial adoption of the technology. The presentation from the USA highlighted the importance of fundamental microbiological research to understand how microbial pathogens respond to LEEB and LEEX. The presentation from Aerial (a technology resources centre) in France raised many questions and stimulated discussions in many areas. One of which was the importance of dosimetry and process control. The on-going Aerial collaboration with Bühler and Fraunhofer (LEEB pre-planting treatment of seeds) means that this technology centre can be very useful to CRP participants at multiple levels including access to LEEB technology. The Polish researcher from Poland showcased research at her institute. Using practical examples, she emphasized the need for proper process control and the importance of considering sub-surface layers when applying LEEB to foods. The complexity of sample presentation to the incident beam of radiation was also highlighted because it can lead to different depth dose profiles in treated products.

From bottom left to right, participants Huaili Qin, Urszula Gryczka, Setsuko Todoriki, Kyoko Narikawa.
From top left to right, Carl Blackburn, Suresh Pillai, James Sasanya, Alain Strasser. (Nicolas Meneses missed the photo opportunity).

A New Coordinated Research Project "Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices" Launched, Vienna, Austria, 15–19 July 2019

James Sasanya

The Food and Environmental Protection Section (FEP) has initiated a new coordinated research project (CRP) for the period 2020–2026 with the main objective to support Member States in setting safe/guideline levels for veterinary drug residues in foods through disposition studies of radiolabeled substances in food producing animals, thus contributing to safeguarding consumers and promoting trade. The CRP's expected outcome will be: enhanced technical (research) capabilities of Member States to, undertake disposition studies for veterinary drugs and related substances used in food production; generate scientific/residue data and facilitate setting of national or international safe residue levels in foodstuff; facilitate risk assessment and public health programmes and promote trade. This is relevant to several Sustainable Development Goals (SDGs) including 1, 2 and 3.

Various CRP outputs are expected including: radiolabeled data generated (residue depletion, disposition and distribution data for selected veterinary drugs and pharmacologically active substance in edible and associated tissues); Materials: useful analytical grade drugs, major residues and incurred tissues to facilitate future relevant research (and associated capacity building activities) will be produced; reports and research capabilities including publications (peer review, technical documents etc) and manuals for use by researchers and regulatory institutions as well as risk assessors and risk managers; and finally validated analytical methods and protocols. Proposals are now invited from interested institutions with relevant capabilities and goals.

As part of the CRP's development, a consultant's meeting was organized in Vienna, Austria 15–19 July 2019, to advise

the FEP. The purpose of the meeting was to develop a project proposal, including recommendations and strategies for effective implementation of the CRP, to support the establishment of maximum residue limits (MRLs) for veterinary drugs in food. This is specifically for those drugs that have been previously evaluated and an acceptable daily intake established. The meeting concluded that the research project is important to the IAEA and the FAO developing and developed Member States. This is consistent with the recommendation of the 23rd and 24th Codex Committee on Residues of Veterinary Drugs in Food (CCRVDF) that Member States could work together to fill information gaps that impede a JECFA risk assessment, which is required for the establishment of MRLs. The consultants agreed that strategic partnerships among the Member States and stakeholders, including the private sector, is critical and achievable. Developing countries currently have limited research capacity and knowledge and this project will contribute to addressing this limitation and empower them to develop sustainable partnerships.

Participants at the Consultant Meeting for new CRP on "Depletion of Veterinary Pharmaceuticals and Radiometric Analysis of their Residues in Animal Matrices.

Technical Cooperation Projects

Country/Region	Project No.	Title	Technical Officer
Algeria	ALG5030	Contributing to the Implementation of the National Agricultural Development Programme Through Strengthening Soil, Water and Nutrient Management Practices Including Food Safety Using Nuclear and Related Techniques	J. J. Sasanya
Angola	ANG5014	Upgrading Laboratory Services for Control of Food Quality for Human and Animal Consumption	J. J. Sasanya Z. Ye
Bahrain	BAH5002	Establishing a National Quality Control Standard for Foodstuffs and Fishery Products	J. J. Sasanya Z. Ye
Burundi	BDI5003	Strengthening National Capacities for Monitoring and Testing Veterinary Drug Residues 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. Kelly Z. Ye
Bahamas	BHA5001	Developing laboratory capacity for testing contaminants in animal and related products including fish in Bahamas	J. J. Sasanya
Botswana	BOT5017	Enhancing Capabilities for Inter-institutional Monitoring of Chemical Food Contaminants Using Nuclear/Isotopic and Complementary Analytical Techniques	J. J. Sasanya A. Cannavan
Botswana	BOT5020	Enhancing Capabilities for a Holistic Approach to Testing Food Hazards in Poultry Production and Products	J. J. Sasanya Z. Ye
Belize	BZE5011	Strengthening Laboratory Capabilities to Monitor Contaminants in Fisheries Products	J. J.Sasanya

Country/Region	Project No.	Title	Technical Officer
Cameroon	CMR5023	Strengthening Laboratory Capabilities to Monitor Contaminants in Fisheries Products	J. J.Sasanya
Cameroon	CMR5025	Improving Laboratory Testing Capabilities to Enhance the Safety and Competitiveness of Agricultural Products - Phase I	J. J.Sasanya
Colombia	COL5025	Improving Capacity to Diagnose Residual Pesticides and other Contaminants in Exotic Tropical Fruits to Make Food Exports More Acceptable on the International Market	J. J. Sasanya
Costa Rica	COS5036	Improving Analytical Capacity to Monitor Food Contaminants and Veterinary Drug Residues Using Nuclear/Isotopic and Complementary Techniques	J. J. Sasanya
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
Democratic Rep. of the Congo	ZAI5028	Controlling Food and Feed Contaminants in Fish Production	J. J. Sasanya
Dominica	DMI5002	Enhancing Capacity to Monitor Agrochemical Residues in Foods and Related Matrices	D. Battaglia 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
Eritrea	ERI5012	Developing Analytical Capabilities for Food Safety	J. J. Sasanya Z. Ye

Country/Region	Project No.	Title	Technical Officer
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 Z. Ye
Fiji	FIJ5004	Establishing a Food Safety Laboratory for Analysis of Pesticide Residues in Fresh Fruits, Vegetables and Root Crops	B. M. Maestroni Z. Ye
Georgia	GEO5001	Enhancing National Programmes for Testing and Monitoring Food Contaminants and Residues	J. J. Sasanya
Haiti	HAI5006	Increasing Productivity and Exportability in the Agricultural Sector through Soil and Water Management and Food Safety Monitoring	C. M. Blackburn J. J. Adu-Gyamfi J. J. Sasanya
Haiti	HAI5009	Strengthening Laboratory Capacity to Test and Monitor Food Contaminants	J. J. Sasanya
Iraq	IRQ5021	Developing Food Safety and Assurance System Using Nuclear and Other Related Technologies	J. J. Sasanya A. Cannavan S. Kelly
Cambodia	KAM5004	Strengthening National Capability for Food and Feed Safety	J. J. Sasanya D. Battaglia
Cote d'Ivoire	IVC5041	Strengthening Capabilities to Monitor Contaminants in Food and the Environment	J. J. Sasanya
Kazakhstan	KAZ5005	Building Capacities in Effectively Irradiating Food	C. M. Blackburn
Kyrgyzstan	KIG5001	Establishing Effective Testing and Systematic Monitoring of Residues and Food Contaminants and of Transboundary Animal Diseases	J. J. Sasanya I. Naletoski
Lebanon	LEB1010	Establishing an Isotopic Ratio Mass Spectrometry Laboratory Dedicated to Authentication and Provenance for Supporting the National Fraud Repression Scheme	M. Groening Z. Ye S. Kelly
Lebanon	LEB5016	Strengthening Capacity for Exposure Assessment of Residues and Contaminants in the National Diet	J. J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Mauritius	MAR5024	Building Capacity to Analyse Veterinary Drug Residues and Related Chemical Contaminants in Animal Products	J. J. Sasanya
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 Z. Ye
Mongolia	MON5024	Enhancing Food Safety Analytical Capabilities for Veterinary Drug Residues and Related Contaminants Using Isotopic Techniques	J. J. Sasanya D. Battaglia Z. Ye
Montenegro	MNE5004	Strengthening Technical and Institutional Capacities of the National Reference Laboratory for Food and Feed Control	Z. Ye A. Cannavan
Morocco	MOR5037	Enhancing Control of Chemical Food and Feed Contaminants, Animal Disease Diagnosis and Trade in Fresh Fruits	D. Battaglia J. J. Sasanya C. M. Blackburn
Mozambique	MOZ5010	Strengthening Confirmatory Analytical Capabilities for Veterinary Drug Residues and Related Contaminants in Animal Products	J. J. Sasanya
Namibia	NAM5015	Developing Capacity of the National Standard Institution and Agro-Marketing and Trade Agency in the Areas of Food Safety	B. Maestroni A. Cannavan
Nepal	NEP5007	Supporting Analysis of Pesticide Residues in Agricultural Products	B. Maestroni
Niger	NER5022	Strengthening Nuclear / Isotopic and Complementary Laboratory Capabilities for Monitoring Contaminants in Food, Feed and Water	D. Battaglia J. J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Niger	NER5023	Strengthening Capacity of the Public Health Laboratory to Monitor Food Contaminants	J. J. Sasanya
Nicaragua	NIC5012	Strengthening the Monitoring and Control System for Food Contaminants	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
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
Philippines	PHI5035	Advancing Laboratory Capabilities to Monitor Veterinary Drug Residues and Related Contaminants in Foods	J. J. Sasanya
Rwanda	RWA5002	Strengthening Laboratory Capacity to Analyse and Monitor Food Contaminants by Standards Board	J. J. Sasanya
Senegal	SEN5038	Strengthening Laboratory Capabilities for Analysing Veterinary Drug Residues and Contaminants in Food	J. J. Sasanya A. Cannavan
Seychelles	SEY5010	Strengthening Laboratory Capabilities to Enhance Food Safety Using Nuclear and Complimentary Analytical Techniques	J. J. Sasanya
Sri Lanka	SRL5048	Strengthening National Capability for Food and Feed Safety	A. Cannavan A. Mihailova
Sudan	SUD5039	Enhancing the Capacity to Monitor Pesticide and Veterinary Residues in Food Using Nuclear and Complementary Techniques	J. J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Sudan	SUD5040	Strengthening the Evaluation of Quality, Monitoring and Control Programmes for Food Contaminants	J. J. Sasanya
Thailand	THA5056	Strengthening Food Safety Laboratory Capacities	J. J. Sasanya D. Battaglia
Uganda	UGA5040	Strengthening Multi-Sectoral Food Contaminant Monitoring Programmes Through the Effective Use of Nuclear, Isotopic and Complementary Techniques	D. Battaglia J. J. Sasanya
Uganda	UGA5042	Strengthening Capabilities of Two Central Food Safety Laboratories and Selected Regional Veterinary Centres of Public Health	D. Battaglia J. J. Sasanya
Vanuatu	NHE5002	Strengthening Agro-Food Laboratory Quality Infrastructure	Z. Ye J. J. Sasanya
Viet Nam	VIE5022	Promoting Interlaboratory Comparison and Accreditation in Testing Chemical Contamination for Food Safety	B. M. Maestroni Z. Ye
Zambia	ZAM5032	Strengthening and Expanding Analytical Capacity to Monitor Food Contaminants using Nuclear/Isotopic and Complementary Tools	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
Asia	RAS5078	Enhancing Food Safety Laboratory Capabilities and Establishing a Network in Asia to Control Veterinary Drug Residues and Related Chemical Contaminants	J. J. Sasanya D. Battaglia G. J. Viljoen
Asia	RAS5081	Enhancing Food Safety and Supporting Regional Authentication of Foodstuffs through Implementation of Nuclear Techniques (RCA)	S. Kelly Z. Ye
Asia	RAS5087	Promoting Food Irradiation by Electron Beam and X Ray Technology to Enhance Food Safety, Security and Trade (RCA)	C. M. Blackburn

Country/Region	Project No.	Title	Technical Officer
Latin America	RLA5069	Improving Pollution Management of Persistent Organic Pollutants to Reduce the Impact on People and the Environment (ARCAL CXLII)	B. M. Maestroni J. J. Sasanya
Latin America	RLA5079	Applying Radio-Analytical and Complementary Techniques to Monitor Contaminants in Aquaculture (ARCAL CLXXI)	J. J. Sasanya
Latin America	RLA5080	Strengthening the Regional Collaboration of Official Laboratories to Address Emerging Challenges for Food Safety (ARCAL CLXV)	B. M. Maestroni A. Cannavan
Latin America	RLA5081	Improving Regional Testing Capabilities and Monitoring Programmes for Residues/Contaminants in Foods Using Nuclear/Isotopic and Complementary Techniques (ARCAL CLXX)	J. J. Sasanya
Inter-Regional	INT5154	Improving Food Safety through the Creation of an Interregional Network that Produces Reliable Scientific Data Using Nuclear and Isotopic Techniques	J. J. Sasanya D. Battaglia

Strengthening Analysis and Monitoring of Radionuclides in Foods in Bahrain, Manama, Bahrain, 13–17 October 2019

James Sasanya

An expert mission was undertaken from 13 to 17 October 2019 to support the testing and monitoring of radionuclides in food in Bahrain, by the Public Health Laboratory in Manama. This mission and associated training involved evaluation of capabilities and needs aimed at facilitating the establishment of a national quality control for foodstuffs including fisheries products. Work-done entailed sampling and sample preparation in foodstuffs (and related matrices) for analysis of radionuclides by gamma and alpha spectrometry; and providing general and technical guidance on sampling and sample preparation of fisheries products for analysis of radionuclides by gamma and alpha spectrometry. Additional work included radiochemistry of actinides in fisheries products for analysis by alpha spectrometry; radiochemistry of polonium in fisheries products for analysis by alpha spectrometry; and presentations/discussion on the national programme for monitoring of radionuclide in food and related samples.

Participants at a training on sampling and analysis of radionuclides in food and related matrices in Bahrain.

Twenty-five participants including technicians, chemists, inspectors and other trainees from different stakeholders' institutions such as the Supreme Council for the Environment, Directorate of Fish Wealth, Ministry of works, municipalities, and urban planning; and Ministry of Health (Food control section) benefited from the training. Additional capacity development is recommended so the laboratory can better support other institutions in the region including networking.

Supporting Analytical Capabilities on Food Safety in Botswana, 7–11 October 2019

Zhihua Ye

The technical officer undertook an expert mission to Gaborone, Botswana, under an ongoing technical cooperation project (TCP) BOT5017. The primary objective of this mission was to provide technical guidance on analytical capabilities and their application to routine food safety testing and assess progress made under BOT5017. Further discussion would include upcoming TC project plans for 2020–2021. This included interacting with food safety stakeholders, field visits to bovine and poultry farms and relevant slaughter and processing plants. The current food safety project involves three laboratories namely: Botswana National Veterinary Laboratory (BNVL) and Plant Protection and Quarantine Laboratories (PPQL) of the Ministry of Agriculture, and National Food Safety Control Laboratory (FSCL) of Ministry of Health.

The Officer met the BNVL Scientific Manager (Project Counterpart, CP) and took a guided laboratory tour of several sections at BNVL, including the Residues Analysis, Microbiological Analysis, Food Hygiene and Dairy Hygiene as well as supporting units such as Media Preparation in Serology Section. During the tour, the Section/Unit Heads and various staff introduced their work with remarks on their role in the implementation of the food safety projects. They also showed various facilities and equipment purchased by IAEA, and appreciated the valuable support including training of staff and procurement of 4 state-of-the-art analytical instruments. This has had significant impact to the capacity building in the institution and the country and has facilitated maintenance of Botswana's beef export, a critical component of the country's economy.

The Officer reviewed the progress of work/activities implemented under BOT5017 in last two years and identified together the main outputs from the project with the CP; including 16 analytical methods validated, 10 personnel trained (outside the country) and many others trained locally through five expert missions and three training courses. Nine of the trained staff met are now part of the human resource capabilities that help in training other African food safety and analytical laboratory scientists.

The Officer discussed the workplan for the newly approved TCP BOT5020 with the CP in detail and the planned activities and budget were updated.

The Officer visited the FSCL and met five staff members who have also benefited from trainings outside the country including modern analytical tools and techniques as well as quality management system. They introduced the role in the project and expressed their appreciation to the Agency's support and willingness to continue their collaboration with BNVL on behalf of the Ministry of Health in future IAEA food safety project.

The Officer then visited the PPQL, met the Director and staff who introduced their participation in the project, including external training, two procurements and co-organizing a training course on pesticide residues analysis.

Two field trips during this DT were really impressive, one was to see the food safety control system in the bovine slaughter and processing plant of Botswana Meat Commission (BMC) at Lobatse and another to the quality assurance systems in the chicken farm and slaughter/processing stands of Vetagric Suppliers (PTY) Ltd. The BMC food hygiene/safety control system is a very good example showing how the TCP project helped improve animal production and food safety in the country.

The officer met with NLO and AFRA coordinator at the National Radiation Protection Inspectorate and the Director of MOA Department of Veterinary Services. Both of these governmental authorities expressed their appreciation for the Agency's support to building food safety analytical capability and food control systems in general in the country. They expressed their willingness to continue the collaboration with the Agency on application of nuclear techniques in food safety projects. There is also commitment to receiving more fellows and scientists to train at BNVL through the Agency TC programme.

Poultry selected for developing holistic approach to testing food hazards in Botswana with IAEA support in 2020–2021.

Regional Training Course (RTC) on Fundamentals of Using Nuclear Techniques for Verifying Food Authenticity (Part II), Beijing, China, 23–27 September 2019

Simon Kelly

The fourth training course of the Regional Cooperation Activity (RAS5081) "Enhancing Food Safety and Supporting Regional Authentication of Foodstuffs through Implementation of Nuclear Techniques" was held at the Institute of Quality Standards and Testing Technology for Agro-Products, Beijing, China, 23– 27 September 2019. The course was the second part of a fundamental introduction to the use of nuclear techniques for verifying food authenticity and covered the use of isotope ratio mass spectrometry (IRMS), inductively coupled plasma – mass spectrometry (ICP-MS), atomic absorption spectrophotometry (AAS), near infrared spectroscopy (NIRS) and multivariate statistical analysis of data (MVA). The course comprised both theoretical lectures and practical training with a strong emphasis on laboratory-based activities, where the 24 participants received 'hands-on' training. The 24 trainees were from 14 different countries; Bangladesh, Cambodia, China, India, Indonesia, Republic of Korea, Malaysia, Mongolia, Myanmar, Pakistan, Philippines, Sri Lanka, Thailand and Viet Nam. One of the other important aspects of the course was that four of the six expert trainers were from institutes within the regional project consortium and had previously attended the second "train the trainer" RTC in the use of advanced nuclear techniques for verifying food authenticity at the University of Science in Penang, Malaysia from 19 to 23 November 2018. The course therefore served two purposes; to further develop the knowledge and skills of the 24 regular participants and to initiate the four regional and local trainers in the self-sustainability of the consortium to provide courses in the application of nuclear techniques to detect food fraud.

Nuclear techniques have been shown to be very effective in authenticating food products, i.e. detection of adulteration and/or counterfeiting. For example, isotope analysis of foodstuffs can provide an indication of its point of origin. Project RAS5081 is building on the previously developed regional capacities and capabilities in the application of nuclear and isotopic techniques for food authenticity, origin and safety and uses an integrated approach to develop systems for verification of the provenance and authenticity of food. These systems have the potential to provide independent verification of information-based traceability systems and provide information on the integrity of the food product itself. As the application of stable isotopes and trace elements is relatively new in the area of food traceability, the course is one of the mechanisms to further strengthen and highlight their applicability as useful tools in a system for verification of origin of food. The training was designed to help the participants understand the requirements for collecting high-quality isotopic and trace elemental data. The course also provided a strong foundation for Member States that are relatively new to the topic and relevant nuclear analytical techniques.

The training was very well received by the participants having had an opportunity to be exposed to (a) relevant analytical methods and techniques (IRMS, ICP-MS and NIR spectroscopy), (b) methods for calibration, data processing and quality control, and (c) suitable reference methods to verify food authenticity and origin, specifically AOAC Official Method 998.12 – 'Detection of Added High Fructose Corn Syrup in Honey' and ENV 12140 – 'Determination of Stable Carbon Isotope Ratios of Sugars from Fruit Juices' as well as trace element analysis of rice and chemometric methods for multi-variate data analysis.

Regional Expert trainer Ms Syahidah Akmal Muhamad (middle) providing hands-on training in AOAC Official Method 998.12 – Detection of Added High Fructose Corn Syrup in Honey.

Local Expert trainer Ms Yan Zhao (standing) lecturing on the application of stable isotope analysis to verify the origin of meat products and the development of meat matrix certified stable isotope reference materials in China.

Coordinating and Planning to Enhance Food Safety (Residues and Contaminants) Control in Asia, Ulaanbataar, Mongolia, 2–6 September 2019

James Sasanya

A coordination and planning meeting under IAEA non-agreement regional food safety technical cooperation project launched in 2016 to address the needs of Member States in Asia on food safety and trade was held in Mongolia to review work done and plan for the future including development of comprehensive collaboration strategies.

The Officer joined and assisted 30 participants including project coordinators from Bangladesh, China PR, Indonesia, Jordan, Lao P.D.R., Lebanon, Malaysia, Mongolia, Myanmar, Pakistan, Papua New Guinea, Philippines, Singapore, Sri Lanka, Syrian Arab Republic, Thailand, and Viet Nam.

Countries in the Asia-Pacific region face a common burden of animal disease/pests, have similar farming practices and encounter unsafe levels of residues and contaminants in foods that result in import and export restrictions or the need to adhere to such stringent requirements. The project was thus initiated to help the Member States address some of these challenges. Project activities included group training, joint participation in scientific meetings, common methods of analyses, exchange of information and expertise among others. All planned activities have been implemented and the significant impact, including accreditation, set-up, and operationalization of laboratories for testing residues and food contaminants, have been achieved. Closer collaboration among participating countries including sharing of knowledge, analytical techniques, and material has been built and strengthened.

The meeting was addressed by (among other Government Officials) the Honorable Minister of Food, Agriculture and Light Industry (MoFALI) Ch. Ulaan who expressed Government's gratitude to the IAEA for the Technical Cooperation support the country has been receiving which is a valuable complementary input to Government Plans for ensuring safety of locally consumed foods as well as exports. He singled out the strengthening of human resources capabilities and the improvement of analytical instrumentation.

The counterparts shared the benefit of the project including impacts in the individual countries and the region in general. Significant contributions have been made to the establishment and/or improvement of food safety testing capabilities in 16 Member State laboratories in the Asia Pacific region. The first residue testing laboratories were established in countries such as Jordan, Syrian Arabic Republic and Papua New Guinea and these are now conducting tests. More than 10 analytical techniques were accredited, and seven countries attained or maintained ISO accreditation. More than 15 standard operating procedures developed and shared among the participating countries. Twelve of the participating countries have established or maintained national monitoring programmes for residues and contaminants and a good number of these support not only public health programmes, but also help maintain food exports within the region and beyond. Collaboration has also been built and strengthened with countries helping each other to improve their laboratory testing capabilities e.g. Pakistan supporting Papua New Guinea build further confidence in food hazard testing and troubleshooting; Lebanon supporting Jordan in the testing of pesticide residues; Thailand supporting Cambodia and Myanmar etc. Regional capability to train other scientists has also been enhanced with more than five countries capable of hosting fellowships and scientific visits.

Nevertheless, during implementation of the project,other needs were identified for urgent and further support such as, continued participation in proficiency testing to help more countries attain accreditation; training on field sampling, measurement uncertainty, setting of maximum residue limits (standards that impact trade) and enhancing knowledge on determining uncertainty of measurement.

Participants at a RAS5078 Food Safety Regional Coordination Meeting in Ulaanbataar, Mongolia.

Regional Training Course on Cost-effective Analysis of Targeted Veterinary Drug Residues and Mycotoxins in Food, Sepang, Selangor, Malaysia, 26–30 August 2019

James Sasanya

The training on veterinary drug residues and mycotoxins contaminants of public health and trade concerns to Asia was organized at the Veterinary Public Health Laboratory,

Department of Veterinary Services, Malaysia in collaboration with the College of Veterinary Medicine, Iowa State University. The event was attended by 29 participants from 13 countries including the host and involved: screening and confirmatory analysis of the targeted residues/contaminants; cost effective sample/matrix preparation; and comparative data analysis. The participants were addressed by the Director General of Veterinary Services, Dr Quaza Nizamuddin bin Hassan Nizam, who welcoming the opportunity to support for Malaysia to share its experiences on food safety testing of residues and contaminants and how the private sector (such as instrument vendors) make significant contributions. The DG therefore appreciated and encouraged continued networking among the participants.

Through the training, valuable experience and knowledge were gained on (among others), validation of testing protocols and performance criteria and how to determine matrix effect on confirmatory analysis of the residues/contaminants. The event has contributed to enhancing capabilities of the host in Malaysia and other institutions, to train other participants, such as through the IAEA capacity building programmes.

Regional food safety trainees in Malaysia, August 2019.

Enhancing competence Laboratoire Central de Controle de la Securite Sanitaire des Aliments (LCSSA) in Benin, 22–26 July 2019

James Sasanya

In recognition of the significant role LCSSA plays in promoting food safety control system in Benin and how it supports exports of a range of foodstuff, a need was established to strengthen the laboratory's competency by improving the quality management system. An expert mission was therefore implemented 22–26 July 2019 to among others, provide training on: general requirements for testing and calibration laboratory with special emphasis on ISO 17025:2017; implementation and auditing; preparation for integration of a Laboratory Information Management System (LIMS); maintaining accreditation; and conducting a mock laboratory (audit) assessment.

Participants at a national training on Food Safety Laboratory Quality Management.

The training also aimed at addressing preliminary challenges the LCSSA highlighted including: understanding and implementing the transition from ISO 17025:2005 to ISO 17025:2017; designing workflow for mapping out laboratory processes from sample receipt to reporting; risk identification, grading, mitigation strategies/actions and monitoring of the effectiveness of the mitigation measures; how to audit the new ISO 17025:2017 standard and finally understanding the new ISO 17025:2017 requirements.

Following the training LCSSA's internal auditors are now able to conduct audit of laboratory operating under ISO 17025:2017. A LIMS has been recommended and this will be established soon.

African Member States Equipped/Trained on Production of Reference Material to Support Food Safety Testing, South Africa, 1 July–8 August 2019

James Sasanya

Four Scientists from Botswana (the Botswana National Veterinary Laboratory, BNVL), Benin (LCSSA), Nigeria (National Agency for Food and Drug Control) as well as Morocco (ONSSA) were recently trained on production of reference material to support analysis of residues and contaminants in food in Africa. This six weeks matrix reference materials production training was implemented at the National Metrology Institute of South Africa for six weeks and was among others aimed at addressing the limitation in the access and affordability of food safety reference materials in Africa.

The training targeted specific needs in each country such as antimicrobials penicillin in bovine kidney for Botswana and tetracycline in chicken for Morocco; aflatoxins in peanut for Nigeria and pesticides in Cassava for Benin.

Briefly the content of the training included: an overview of reference material production requirements according to ISO 17034:2016; various processing techniques for reference material; testing of the homogeneity of the prepared materials; stability testing and value assignment of the material as well as data processing and statistical data evaluation. The fellows also learnt and gained more experience on uncertainty of measurement for the various reference material.

The fellows are expected now to train others in the country and also pass the knowledge on to other sister countries in the region. The knowledge and experience gained at NMISA, an internationally recognized metrology body will also improve quality standards in the four countries and beyond.

The participants also learnt about the requirements and preliminary work including the preparation, preservation, storage and shipping (and associated paper-work) of matrices required for production of reference material.

Participants training on production and analysis of reference material.

Developments at the Food and Environmental Protection Laboratory

FEPL Booth at the Diplomats' Seminar Science Fair, Vienna, Austria, 28 August 2019

Andrew Cannavan

The annual seminar for diplomats was held in Vienna International Centre from 26–28 August 2019. The seminar included a science fair, at which the participating diplomats could visit nine different stations provided by the Departments of Nuclear Energy, Safeguards, Nuclear Safety and Nuclear Sciences and Applications, view displays and demonstration activities and discuss the work of the various sections represented with Agency staff.

The Food and Environmental Protection Laboratory (FEPL) represented the Joint FAO/IAEA Division, providing one of three stations from the Department of Nuclear Science and Applications. The theme of the display was "Is your food what you think it is? Do you know what you are eating?". The science fair was well attended and appreciated by the participants in the Diplomats' Seminar. The FEPL display had a number of interested visitors who discussed the relevant issues around food safety and authenticity and the work of the Food and Environmental Protection subprogramme to help address those issues.

Mr Cannavan, Head of FEPL, discusses food safety and authenticity with participants in the Diplomats' Seminar Science fair.

Untargeted Metabolomics for the Discrimination of Honeys of Various Floral Origins

Alina Mihailova and Marivil Islam

In recent years, there has been a growing consumer demand for monofloral honeys that are considered more valuable than multifloral honeys due to their more appreciated flavour, aroma and particular pharmacological attributes. Highly priced types of monofloral honeys (e.g. sidr, manuka, acacia) are a potential target for dilution or substitution with cheaper honeys, and thus the verification of the botanical origin of honey is an important issue from the authenticity point of view.

In accordance with the European Union legislation (Regulation (EU) 1169/2011; Directive 2001/110/EC, amended 2014/63/EU) and Codex Alimentarius Standard for Honey (CODEX STAN 12-1981; 1987 and 2001 revisions), detailed labelling of honey products with complete information about their botanical and geographical origin is mandatory. These aspects are particularly relevant in terms of both product quality and authenticity.

Conventional methods, which are commonly used in quality control of honey, are pollen analysis (melissopalynology), physico-chemical methods (e.g. 5-hydroxymethyl furfural (HMF), enzyme activity, moisture and mono- and disaccharide analysis) and the sensory evaluation. In particular, the analysis of pollen used for the differentiation of the botanical origin is time-consuming and requires highly-skilled personnel, available only in specialized laboratories.

Recent developments in high resolution mass spectrometry techniques and chemometrics has led to an increased interest in the application of untargeted metabolomics to the authentication issues of food products, including honey. The main advantage of using untargeted metabolomic approach is that it can detect thousands of secondary metabolites, which otherwise may remain undetected, if a targeted approach is used. Some of these secondary metabolites can be unique for a particular honey type, and thus may serve as authenticity markers.

Untargeted metabolomics analysis using UPLC-QTOF-MS was previously applied at FEPL for the analysis of honey, and the approach proved promising for the discrimination of honeys of different botanical and geographical origins. The current FEPL study had the objective to further expand the methodology, previously developed at FEPL, using a larger sample set of honeys. Untargeted metabolomic fingerprinting using UPLC-QTOF-MS and multivariate data analysis was applied for the authentication of 274 monofloral honeys from 6 floral origins (manuka, acacia, clover, macadamia, orange blossom and thyme). Honey samples were obtained from markets and honey producers in 18 countries (Australia, Canada, China, Fiji, France, Germany, Greece, Hungary, Italy, Japan, Mexico, New Zealand, North Korea, Poland, Russia Federation , Spain, UK, USA). Samples were extracted in methanol/water (1:1,

v/v) and analysed on the UPLC-QTOF-MS system in positive ionisation mode.

The results of the Principle Component Analysis (PCA) showed that most of the manuka samples were grouping separately from the rest of the samples, however a significantly large within-group variability and several outlier samples were observed in the manuka sample group (Figure 1). Other analysed honey types also showed a high within-group variability, and thus the goodness of fit (R2) and prediction (Q2) of the PCA model were not sufficiently high. The variability within sample groups can be mainly attributed to the large overall size of the sample set and geographical and climatic differences among the production countries. Supervised Orthogonal Projection to Latent Structures Discriminant Analysis (OPLS-DA) models were built to assess the discrimination between each floral origin of honey and the other five floral origins i) combined and ii) individually (an example of OPLS-DA plots is shown in Figure 2). The results of the OPLS-DA showed good discrimination between some of the analysed honey groups, e.g. manuka, clover and macadamia honeys were well separated from each other. Detailed data mining and further analysis of tentative markers for each floral origin was performed using XVar plots, S-Plots, Variable Importance in Projection (VIP) plots and Hierarchical Clustering Analysis (HCA). The analysis showed that the high variability within each honey group was a limiting factor for the selection of markers that were unique for each floral origin. Thus, the transfer of the methodology to the triple-quadrupole LC-MS system for further confirmatory analysis was not performed at this stage.

This study investigated metabolome-wide differences of monofloral honeys obtained from the markets and producers in 18 countries. The results showed a large within-group variability, which can be attributed to the diversity of the geographical origin of the samples. The source of the samples (predominantly market) may have introduced additional variability in the dataset as the authenticity of the samples in the case of market samples could only be assumed. The authenticity of the samples is of paramount importance for the generation of robust discrimination models and unique marker identification. For the untargeted metabolomics approach to allow the identification of markers, unique for a particular type of authentic monofloral honey, the effect of the floral origin on the metabolic fingerprint of honey should overrule all other factors such as geographical origin, climatic conditions, season, processing, storage etc. The results of the study showed that the untargeted metabolomics approach for the discrimination of honeys of different floral origins may be best suited for the use within a particular country or region where there is a less significant variation in the geography and climatic conditions. Further work could focus on the combination of untargeted metabolomics and other analytical techniques (e.g. LC-MS/MS, IRMS, GC-IMS) for the authentication of floral, geographical and/or production origin of honeys within a particular geographical region.

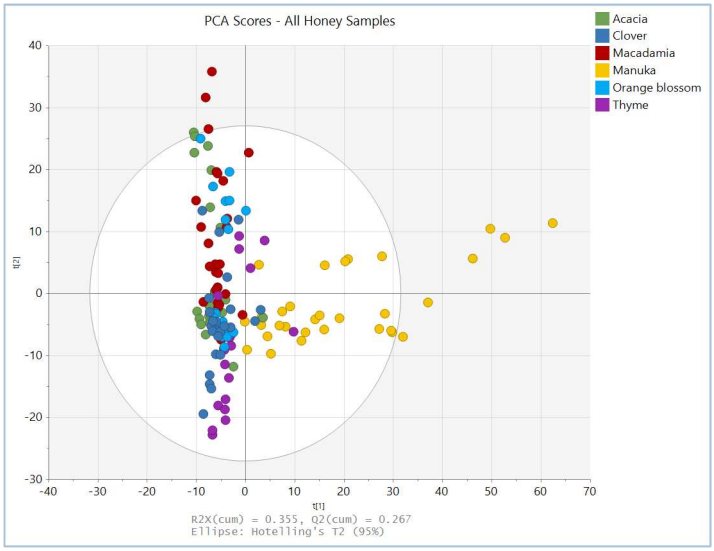


FIG.1. PCA scores plot of 6 types of monofloral honeys (acacia, clover, macadamia, manuka, orange blossom and thyme) in ESI+ mode. The plot ellipse represents the 95% confidence limit for the Hotelling's T2 (95%).

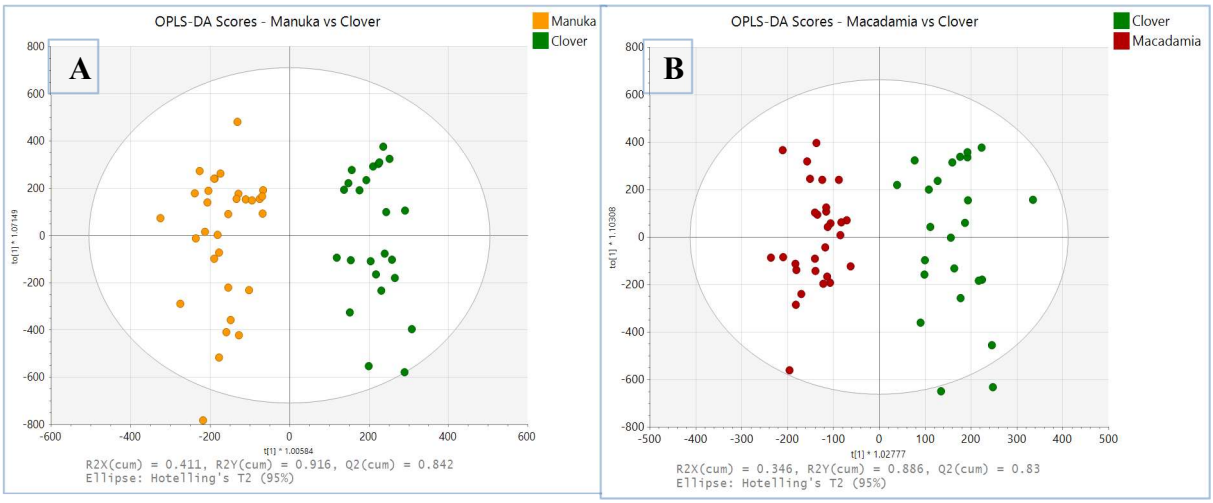


FIG. 2. OPLS-DA plot of clover honey vs manuka (A) and macadamia (B) honeys in ESI+ mode. The plot ellipse represents the 95% confidence limit for the Hotelling's T2 (95%).

Interlaboratory Validation and Extension of a Multi Contaminant Method for Turmeric Powder

Britt Maestroni, Ying Liang

Turmeric (Curcuma Longa L.) is an economically important spice and medicinal plant that grows primarily in tropical regions including India, Thailand, Pakistan, China, Sri Lanka, Peru, Haiti and Jamaica. Asian countries consume a large amount of the worldwide turmeric production.

As a medicine, turmeric is used for prevention and therapy of diseases. The main clinical targets of turmeric are the digestive organs: in the intestine, for treatment of diseases such as familial adenomatous polyposis; in the bowel, for treatment of inflammatory bowel disease; and in the colon, for treatment of colon cancer. As a food it is used as a spice in curry-based dishes, and it is also used as a food supplement for its antioxidant, anti-inflammatory, antimicrobial, and antimutagenic properties. Turmeric has gained more and more attention in the last years not only for its beneficial properties, but also for its safety implications.

The Environmental Protection Agency (EPA) in the United States of America has set Maximum Residue Limits (MRLs) for a variety of pesticides in root and tuberous vegetables, including turmeric. Canada has set MRLs for 42 pesticides in turmeric root, and the European Union and the Codex Alimentarius Commission has also set MRLs for 490 pesticides.

As reported previously, the FEPL optimized a multi-contaminant sample preparation protocol for the determination of selected representative pesticide residues, aflatoxins and persistent organic pollutants. The method finally selected was an adaptation of the IAEA modified QuEChERS sample preparation technique based on an ethyl acetate extraction followed by dispersive solid-phase extraction. The clean-up step was performed using primary-secondary amine , RP-C18 and MgSO4, with the amounts of the salts and adsorbents optimized for turmeric. The whole procedure was validated for 75 pesticides at 10, 20 and 50 µg kg-1 in turmeric powder, with analysis by LC- and GC-MS/MS.

In the latter half of 2019 the method was collaboratively tested with the GACT laboratory in Uruguay. The key method performance parameters investigated were specificity, linearity, trueness, within and inter-laboratory repeatability and reproducibility, limit of quantitation and matrix effects. Recoveries for the studied pesticides ranged from 60 to 110 %, and the RSDs were lower than 20 % for the majority of the evaluated pesticides. Comparable results were obtained in both laboratories. The analytical method performance by LC-MS/MS was compared for 28 compounds and shown in Figures 1 (A and B) and 2.

The method was also applied to the analysis of 21 commercial samples bought in Austrian supermarkets. One to four pesticides residues were detected in 11 samples, namely chlorpyrifos, malathion, phorate sulfoxide and permethrin. Three of the positive samples were declared and marketed as organic samples. This demonstrates the importance of developing and validating a method for Curcuma longa L. powder and applying it to the routine control of turmeric powders.

In addition to the general rule of offer and demand, the trading price for spices is also dictated by the intensity of the colour. Therefore, a potential adulteration of turmeric powder is from the addition of yellow-orange dyes. Examples of dyes of food safety concern are the Sudan dyes which are banned within the EU due to their carcinogenicity. For this reason, to take into account potential food safety risk and indicators of food fraud and illegal practices, the analytical method was further expanded to include additional molecules such as Sudan dyes (Sudan I and Sudan IV) and butter yellow dye. Additional mycotoxins were also included in the analyte list: citrinin, deoxynivalenol, zearalonone and ochratoxin A. These compounds were successfully optimized on the LC-MS/MS instrument and then included in the multi-contaminant method. However only the dyes and the previously optimized aflatoxins showed acceptable recoveries with the current sample preparation method. Turmeric is a complex matrix for residue analysis due to its high content of secondary metabolites, mainly polyphenols (curcuminoids) and essential oils, which can cause interferences in the detection and extraction of the target analytes. Future work will try to address a sample preparation procedure that can take into account the very different physico-chemical properties of the additional mycotoxins and eventually incorporate them in the final scope of the multi-contaminant method.

The results of the collaboration between GACT and FEPL were presented as a poster at the international congress (RAFA 2019, see related article in this newsletter).

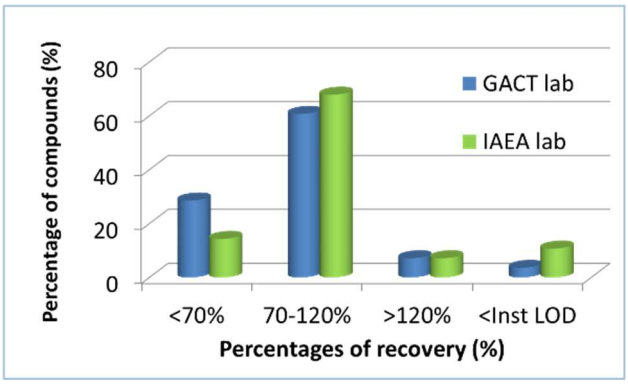


FIG. 1A. Trueness evaluation at 10 µg/kg in IAEA FEPL and GACT laboratories by LC-MS/MS.

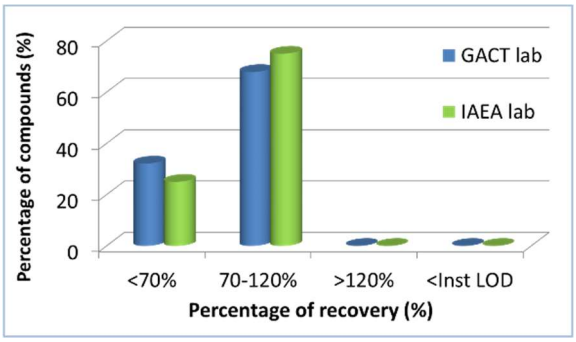


FIG. 1B. Trueness evaluation at 50 µg/kg in both laboratories by LC-MS/MS.

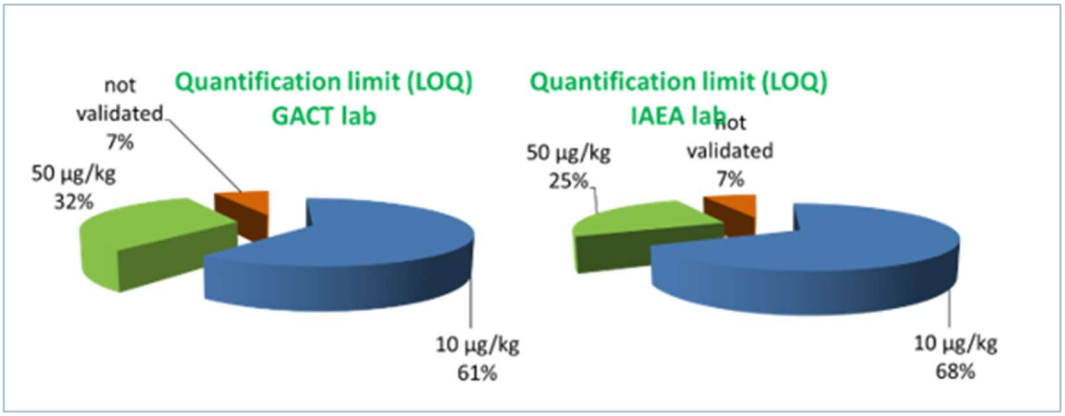


FIG. 2. Quantification limits obtained at IAEA FEPL and GACT laboratory.

Headspace-Gas Chromatography-IonMobility Spectrometric Analysis of Authentic Argan Oil from Morocco

Marivil Islam, Shunru Jin, Simon Kelly

In recent years, argan oil has become one of the most prized oils in the world due to its delicate hazelnut taste and multiple pharmacological properties. In addition to mono-unsaturated and saturated fatty acids, argan oil also contains diverse minor components such as polyphenols, tocopherols, sterols, squalene, and triterpene alcohols. The high content of antioxidants along with essential fatty acids are primarily responsible for its beneficial effects. Due to its extensive use in the cosmetic industry as well as in food, both the production and price of argan oil has increased and consequently so have the economic incentives for adulteration with cheaper oils. The need has arisen, therefore, for more effective quality control screening methods aimed at detecting adulteration of argan oil.

The oil most frequently used to extend argan oil is sunflower oil because of its relatively similar fatty acid composition. Various techniques such as high-performance liquid chromatography (HPLC), gas chromatography (GC), inductively coupled optical emission spectrometry (ICP-OES), and fluorescence spectroscopy have been applied to detect adulteration of argan oil. However, relatively lowcost screening techniques are attractive in order to control the quality and authenticity of vegetable oils. Fourier-transform infrared spectroscopy (FTIR) has been successfully used and is well recognized as a 'fingerprinting' tool for monitoring adulteration problems in food products. However, one of the restrictions of FTIR is that it does not lend itself to automated batch analysis, which can significantly limit its application. As a result, there is still a requirement to develop an accurate, efficient and low-cost automated analytical screening method.

Head space-gas chromatography-ion mobility spectrometry (HS-GC-IMS) is a nuclear technique used for rapidly screening volatile organic components in food. Combined with chemometric analysis it is a powerful tool, which has been successfully applied to the authentication of olive oils. In this study we applied HS-GC-IMS for the first time to detect the adulteration of Moroccan argan oil with sunflower oil. The system used for headspace analysis was a FlavourSpec GC-Ion Mobility Spectrometer (G.A.S. GmbH, Dortmund, Germany), which uses a tritium ionization source.

Authentic samples of argan oil were obtained from a coordinated research project (D52040) counterpart in Morocco. The samples comprised argan oil from the three regions of Morocco (Troudante, Tiznit Sidi Ifni and Chotouka Ait Baha), with 10–13 samples taken from each region. Simulation of fraudulent adulteration was performed through fortification of a pooled sample of the argan oils with 5%, 10%, 20% and 30% sunflower oil. A mixture of six

ketones was used for quality control to check the performance of the equipment during the analytical run. The determination of the headspace volatiles was performed using six replicates for each sample. The spectra were processed through an integrated vocal software (VOCal 0.1.0; Firmware version 3.11). Volatile organic compounds (VOC) were carefully selected through their respective heat maps (Figure 1).

The sample results were evaluated by principal component analysis (PCA) to check for any differences and groupings. The PCA plot in Figure 2 shows that the argan oil samples adulterated with sunflower oil at different levels were distinguishable from the authentic argan oil. The data was further processed by partial least square regression (PLS), showing similar discrimination.

A regression plot (Figure 3) shows the observed versus predicted values of the level of adulteration, giving a predicted fraction (Q2, 2 principal components) of 0.99, indicating excellent predictive power. The average prediction error was lower than 20% at 5% adulteration, falling to 4% error at 30% adulteration.

In conclusion, these preliminary results suggest that the method may be suitable as a rapid screening method to detect the adulteration of argan oil with sunflower oil. The statistical model could clearly distinguish the groups at adulteration levels between 5 and 30% and could predict, with a low prediction error, the presence of adulterant at 10% w/w. The combination of a benchtop headspace IMS device with chemometric modelling offers great promise as a reliable and rapid automated screening tool to detect adulterants in food.

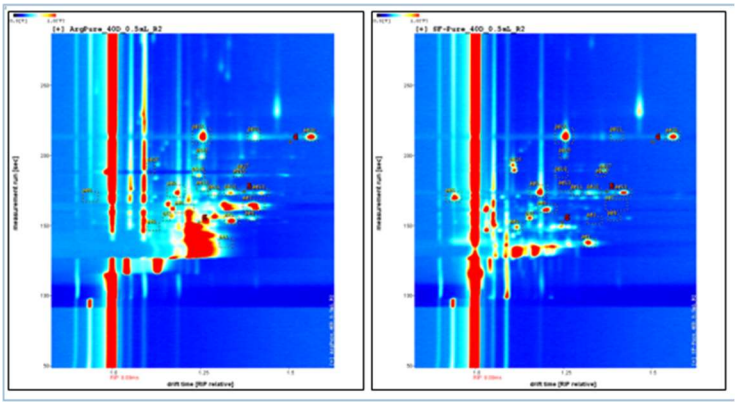


FIG. 1. HS-GC-IMS heat maps of pure argan oil (left) and the adulterant (sunflower oil).

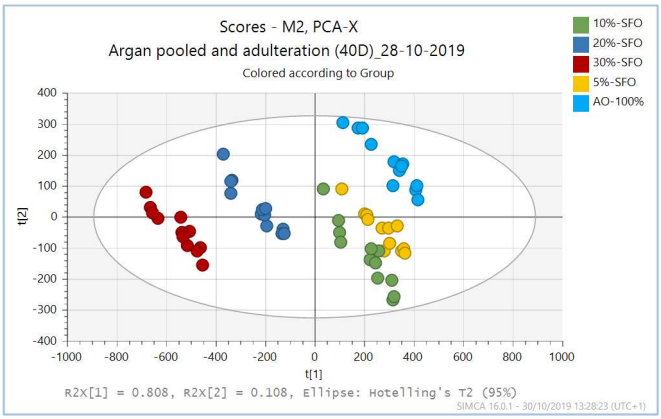


FIG. 2. PCA-X scores of pure argan oil and argan oil adulterated with sunflower oil.

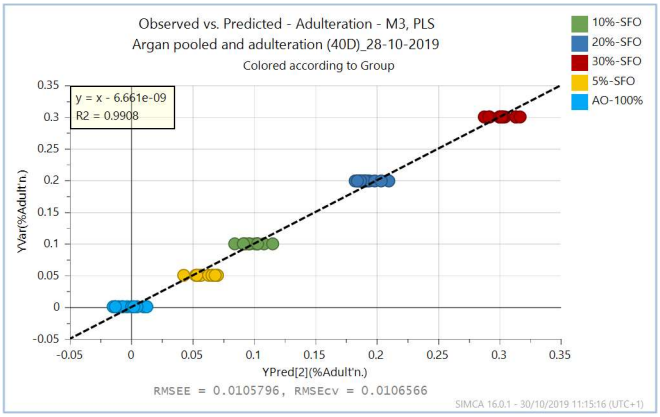


FIG.3. Regression plot of observed versus predicted adulteration levels.

FEPL Fellows

In August 2019 Ms Jin, Shunru, a biosystems engineering post-graduate student from Zhejiang University, Hangzhou, China, completed her 11-month assignment in FEPL under the FAO Fellows Programme. Shunru worked on various projects during her stay in FEPL, including contributing to research on screening techniques for the authenticity of argan oil and other commodities using infrared and ion mobility spectrometric techniques. Shunru returned to Hangzhou in September and the work carried out in FEPL will help her to complete her PhD thesis. We wish Shunru all the best for her future career.

Mr Mohd Noor Hidayat Adenan, a research officer from the Malaysian Nuclear Agency, undertook a one-month fellowship on authentication of edible bird's nest using isotope ratio mass spectrometry and chemometrics in June 2019. The fellowship was funded under TCP MAL5030, "Strengthening National Technical Capability in Food Traceability of Edible Bird's Nest through the Application of Nuclear and Related Technologies".

Mr Hameed Ouda Al-Saedi from the Ministry of Science and Technology in Iraq participated in the FEPL training course "The Use of Nuclear Techniques to Determine Food Origin and Verify Food Authenticity", 7–18 October 2019 under TCP IRQ5021, "Developing a Food Safety and Assurance System Using Nuclear and Other Related Technologies".

Mr Nuwan Karunarathna, from the University of Perideniya, Sri Lanka, completed a one-month fellowship in November 2019. Mr Karunarathna was trained on the operation and maintenance of a Shimadzu liquid-chromatography-tandem mass spectrometry system and its application for the analysis of veterinary drug residues and other residues and contaminants in food. The training was carried out under SRL5048, "Strengthening National Capacity for Food and Feed safety".

FEPL Consultants

FEPL hosted a scientist from Queen's University Belfast (United Kingdom), Dr Olivier Chevalier, for a 10-day consultancy during September and October 2019, funded by FAO under the FAO staff development programme.

Dr Chevallier works at the Institute for Global Food Security (IGFS), Queen's University Belfast and has extensive experience in the application of liquid chromatography - high resolution mass spectrometry (LC-HRMS) to food analysis for food safety and authenticity purposes. The objectives of his work correspond to those of FEPL in terms of the development of methodology for food safety and authenticity using targeted and untargeted analysis.

The scientific visit supported the research planned under Subprogramme 2.1.3, Improvement of Food Safety and Food Control Systems, Project 2.1.3.002, Traceability for food safety and quality to enhance international trade, one of the main planned outputs of which is "Validated methods for food authentication, traceability and contaminant control to improve food safety and quality and facilitate trade". Dr Chevallier and FEPL staff discussed untargeted and targeted metabolomics analysis to facilitate the further development of analytical methods for transfer to Member State laboratories. The topics covered included experimental design for untargeted and targeted metabolomics, instrumental and data quality control measures, data mining and marker identification, advanced statistical and modelling tools. A direct output of this scientific visit is a FEPL protocol for untargeted metabolomics data analysis that can be transferred to the Member State laboratories.

Two consultants provided expertise and knowledge transfer in various aspects of stable isotope ratio measurements for the training course "Use of Nuclear Techniques to Determine Food Origin and Verify Food Authenticity" held by FEPL from 7–18 October 2019. Ms Yaeko Suzuki from the Japanese National Agriculture and Food Research organization (NARO) and Mr Gareth Rees, Agroisolab, UK, provided lectures and hands-on practical training sessions on the principles, operation, routine maintenance and troubleshooting of stable isotope mass spectrometry and on the application of the technique to tackle issues such as detection of the adulteration of honey with C4 sugars.

Announcements

Eleventh Annual Hands-On eBeam Workshop, IAEA Collaborating Centre and National Center for Electron Beam Research at Texas A&M University, College Station, Texas, USA, 20–24 April 2020

This course offers a unique opportunity to learn about electron beam (eBeam) technology at a commercial scale facility. One of the aims is to facilitate understanding of electron beam technology and how it can be exploited for commercial applications. The lectures and practical sessions enable participants to learn about different techniques and applications and one of the strengths is that this includes hands-on training in dosimetry, dose-mapping, and single and double beam configurations. For the convenience of the attendees, the workshop is divided into 2 sessions: Session 1, April 20–22, medical devices and pharmaceuticals and environmental applications; Session 2, April 22–24, food, feed and phytosanitary applications. There are discounts for early registration. More information can be found online[11].

African Food Safety Workshop, Johannesburg, South Africa, 6–10 July 2020

Plans are underway to hold a second African Food Safety Conference 6–10 July 2020 in Johannesburg, South Africa. This is a follow-up and result of a similar event held in Pretoria, South Africa, June 2018 covering a range of topics related to food safety, including pesticide residues, veterinary drug residues, food pathogens, and mycotoxins, among others.

Second African Food Safety Workshop

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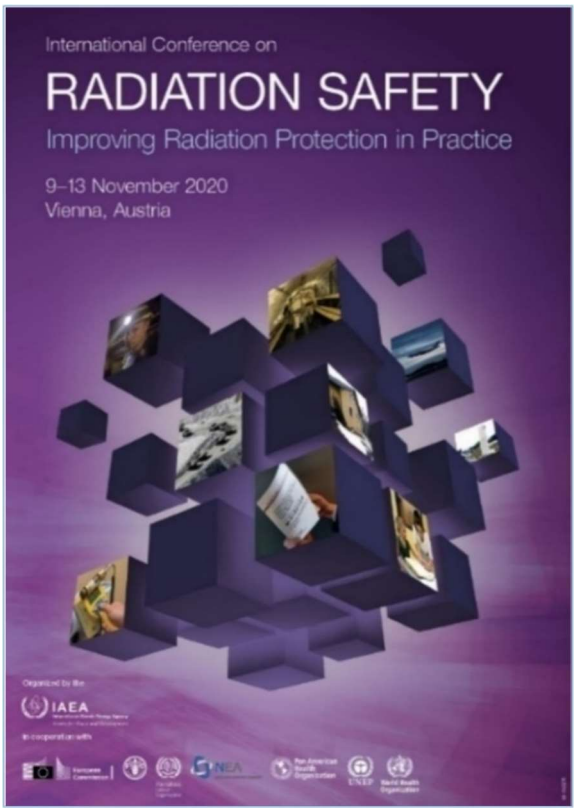
The event will promote the comparative advantage of nuclear/isotopic and related techniques and enhance science-based, risk-based principles in standard setting and regulatory decision making and contribute to public health and supporting trade including recent developments on the continent such as the African Continental Free Trade Agreement. The event will also contribute to further strengthening of the African Food Safety Network (AFoSaN)[12]. .

International Conference on Radiation Safety, IAEA Vienna, Austria, 9– 13 November 2020

The Joint Division is happy to announce that it is representing the FAO to work in cooperation with the IAEA and other international organizations in organizing a major international conference on radiation safety. Details are available online [13] and this conference at the IAEA Headquarters in November 2020 will include topics related to radiation safety for food and agriculture.



International Conference on Radiation Safety.

[11] http://ebeam-tamu.org/

[12] https://www.africanfoodsafetynetwork.org/

[13] https://www.iaea.org/events/international-conference-on-radiation-safety-2020

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