Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Food Safety and Control Newsletter

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To Our Readers

The Food Safety and Control Section's booth at the International Symposium on Food Safety and Control, 27-31 May 2024 (Photo courtesy of Ms M. Islam, IAEA, 2024)

On 31st May, we concluded a five-day International Symposium on Food Safety and Control, detailed in the feature article of this newsletter. During the same week, Qatar's Food Safety Laboratory became a new IAEA Collaborating Centre for Food Safety and Control, bringing our Collaborating Centres to five; others are in Costa Rica, France, UK and the USA.

Five coordinated research projects (CRPs) were implemented. One such CRP is on "Innovating the Radiation Processing of Food with Low Energy Beams from Machine Sources", for which the 3rd technical meeting was organized in April 2024, in Buenos Aires, Argentina hosted by the Comisión Nacional de Energía Atómica.

We also provided technical support to several IAEA national and regional technical cooperation projects. Examples include a regional project on "Applying Nuclear Technology in Agriculture, Water Resource Management and the Environment in Caribbean Member States (CARICOM)", for which the first hybrid coordination meeting was held in Vienna, Austria in March 2024. Also, in the Latin America and Caribbean region, a new project on "Strengthening the Monitoring Programmes of Pesticide Residues and Mycotoxins in Food Through the Establishment of a Proficiency Test Programme in Official Laboratories in Latin America and the Caribbean" involving several countries was initiated and the first coordination meeting held virtually.

For Africa, a new regional project "Enhancing Human and Analytical Capacities for Food Safety Standards" was initiated and in May 2024, a hybrid coordination meeting was held in Nairobi, Kenya, while for Europe, the regional project "Improving Food Safety Through the Early Detection of Microbial Pathogens" was launched with the first coordination meeting held in Vienna, June 2024. Asia-Pacific also received support under two continuing regional projects "Strengthening Multi-Stakeholder Food Safety Monitoring Programmes for Chemical Contaminants and Residues in Plant and Animal Products Using Nuclear/Isotopic Techniques" and another multi-disciplinary project "Developing Climate-Smart Crop Production including Improvement and Enhancement of Crop Productivity, Soil and Irrigation Management, and Food Safety Using Nuclear Techniques (ARASIA)". A number of national projects were also implemented, and we have started reviewing concepts for the 2026–2027 Technical Cooperation Programme cycle.

At the Food Safety and Control Laboratory (FSCL), work was initiated on rapid screening of aflatoxins using Surface Enhanced Raman Scattering. The FSCL validated the homogenization process for cassava, millet, and groundnut samples in preparation for analysis of contaminants. Elemental profiling of both essential and toxic elements in these crops using energy dispersive X ray fluorescence is also ongoing.

The regional discrimination of Paw San Rice cultivated in two different locations in Myanmar was investigated using carbon and oxygen stable isotope analysis. Similar work is ongoing on near-infrared spectrometry for rapid food safety and authenticity screening at FSCL. This includes development of analytical methods for the geographical discrimination of rice and the verification of authenticity of black pepper.

The FSC represented (in person) the Joint FAO/IAEA Centre at the 17th Session of the Codex Committee on Contaminants in Foods held in Panama City, Panama from 15 to 19 April 2024. We also participated virtually at the opening session of the 55th Session of the Codex Committee on Pesticide Residues held in Chengdu, Sichuan Province, People's Republic of China, from 3–8 June 2024.

From 3 to7 June, the Joint FAO/IAEA Centre participated in the 12th meeting of the representatives of competent authorities identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. From 20 to 24 May 2024, the FSC also attended the 71st meeting of the United Nations Scientific Committee on the Effects of Atomic Radiation at the Vienna International Centre. Furthermore, at the invitation of the World Health Organization (WHO), the FSC participated in an inception meeting of the WHO Alliance for Food Safety held from 6 to 8 May 2024 in Geneva, Switzerland.

The global challenge of sub-standard and falsified antimicrobials is of interest to FSC. Such antimicrobials could contribute to the development of antimicrobial resistance. The FSCL intends to establish a formal agreement with the University of Oxford's Medicine Quality Research Group, who is leading a 4-year Welcome Trust Collaborative project.

The Food Safety and Control Section (FSC) continues to support food safety networks in Africa, Asia as well as Latin America and the Caribbean. In the framework of the African Food Safety Network (AFoSaN), the African Food Safety Workshop 2024 is being planned in Marrakech, Morocco from 7 to 11 October 2024. We welcome your support and participation.

Lastly, we welcomed new colleagues at the FSCL, including Ms Sofia Bussalino from Argentina, who started a three months' consultancy in March 2024 as well as Ms Chang Xu and Ms Yuzhu Han, both interns from China. Ms Martina Domanik joined FSCL as a Team Assistant. We bid farewell to Ms Beatriz Pérez-Fernandez, a consultant from Spain, who joined FSCL in September 2022 until March 2024, as well as Ms Susana Fiadey from Ghana, who has been an intern at FSCL since June 2023. We thank the departed and departing colleagues for their contributions.

James Sasanya
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Feature Article

2024 FAO–IAEA International Symposium on Food Safety and Control Showcases Impact and Identifies New Areas of Work

James Sasanya, Christina Vlachou, Carl Blackburn and Esther Makeche

The symposium was attended by nearly 533 participants, mostly in person. The high-level opening session that was expertly moderated by the Deputy Director General (DDG) and Head of the Department of Nuclear Sciences and Applications (NA), Ms Najat Mokhtar, was graced by the Director Generals of the IAEA, Mr Rafael Mariano Grossi, and the FAO, Mr Qu Dongyu who joined virtually. A video to showcase some work done in Costa Rica on food safety raised the curtains. The IAEA DG, in his remarks, noted how the symposium and the various food safety topics of discussion were of timely global importance, and that the work of the two organizations was of strategic importance, holding tangible, concrete and effective value to Member States, especially developing country economies. He added that, with unsafe and poor-quality foods, and countries being unable to certify that their foods are good for exports, millions of dollars and jobs are at risk of loss, and livelihoods and families are significantly affected. Efforts by the IAEA in cooperation with the FAO – a great example in the UN family – are therefore of more direct and immediate socioeconomic impact to Member States not merely being a scientific venture. However, it is crucial that these efforts and services are scaled up with the help of partners, for even greater impact, the DG IAEA added. He called on various partners to join and complement the efforts and noted how the Atoms4Food flagship initiative will be an effective delivery tool when we join hands.

These remarks were echoed by his counterpart, the FAO DG who also appreciated the 60-years of collaboration with the IAEA in addressing food security. He noted that food safety and food supply are fundamental for agrifood systems' transformation, and these can be achieved using nuclear techniques which are important in measuring, managing and controlling food safety, and are complementary to the One Health approach, he said. He further noted that promoting such agrifood system transformation would have economic, social and environmental effects. The symposium was therefore a very good opportunity to exchange knowledge, information and ideas that are relevant to these endeavors, he concluded.

The symposium greatly benefited from the presence of other dignitaries such as the President OPEC Fund International, Mr Abdulhamid Alkhalifa, who highlighted the importance that the fund attaches to food and agriculture including large investments in countries within Africa such as Benin and Botswana as well as in Asia with Viet Nam as an example. Mr. Alkhalifa called for more collaboration with the IAEA and FAO (UN Agencies) and with other financial institutions to address food safety and security needs. The Permanent Secretary, Ministry of Lands and Water Affairs, Mr Kekgonne Baipoledi in attendance, was the keynote speaker under the topic "Global Food Safety Situation in Relation to Climate Change, Trade and One Health Approach". He shared Botswana's experience in food safety and how the country has benefited from a long-standing cooperation with the IAEA jointly with the FAO. He, nevertheless, highlighted a number of challenges that could be addressed through such efforts as the Atoms4Food Initiative. The Director, Cabinet of the Minister of Agriculture, Livestock and Fisheries, and Republic of Benin, Mr Dossa Aguemon, shared the country's experience in improving the food safety system with the support of the IAEA, resulting in improved analytical service delivery and enhancing of exports. The need for further cooperation was emphasized.

The Managing Director of the United Nations Industrial Development Organizations (UNIDO) Mr Gunther Beger, noted how food security is a top priority to UNIDO, including heavy investments and that UNIDO is keen on continued partnerships with sister organizations such as the IAEA and FAO.

Mr Pleiner-Duxneuner, Managing Director, Austrian Agency for Health and Food Safety, shared the country's and the EU's experience in developing a sound food safety and control system by following three principles: (a) investing in the whole value chain supported by multiple institutions under a single agency; (b) having rules, regulations and standards that work and are respected by relevant stakeholders; (c) proper collaboration, communication and timely information-sharing such as through the rapid alert system.

The opening technical session involved two invited speakers. The first presentation was delivered by Mr Suresh Pillai a Professor of Molecular Microbiology at Texas A&M University (USA) and Director of the National Center for Electron Beam Research. He presented on "Irradiation, Microbiology, Public Health, and Trade – the Interconnectedness", emphasizing the importance of using machine sources (accelerators), to address many challenges in phytosanitary irradiation, food preservation and control of pathogens. Food irradiation is growing in many parts of the world, especially in the America's and Africa is a potential growing market and these countries need relevant support.

The second speaker was Dr Markus Lipp, Senior Food Safety Officer at the FAO. He presented the topic "Diet Vs Food - Safeguarding Consumer Health" highlighting the importance of an "infectious dose". He clearly explained the difference between diet and food consumption.

Ms Veronica Cesio (Uruguay) and Ms Christina Vlachou (Head, Food Safety and Control Laboratory, (FSCL) chaired the session on chemical residues and contaminants in food and feed where a number of presentations covered a broad range of chemical and biological hazards with a number screening and confirmatory analytical techniques addressed. The session noted the need for more studies on the safe application of agrochemicals and proper monitoring of residues of pesticides and veterinary medicines among other contaminants. Also, there is a need to control known and emerging contaminants in food as well as novel foods among others. The enhancement of capabilities for testing and determining occurrence of mycotoxins, toxic metals, other hazards such as microplastics and the establishment or strengthening of their routine monitoring was also noted. The session observed how important it is for countries to apply testing capabilities to the whole food chain from source to consumption and address other contributors to unsafe food such as unsafe water. The session recommended further work on use of existing facilities such as cyclotrons to produce radioisotopes for application in food safety especially undertaking of animal studies and generating data for standards-setting. This would require promoting of capabilities in radiosynthesis. Laboratories were also encouraged to invest in screening techniques such as, but not limited to, radio-receptor assays to facilitate cost effective food safety testing especially for low-/middle-income countries.

The session on public-private partnerships; funding agencies; the food industry; and policy making was chaired by Ms Eleonora Dupouy (FAO) and Mr Molnar Gabor (UNIDO). It involved participants from the African Development Bank (AfDB), Asian Development Bank (ADB), International financial cooperation (IFC), FAO, UNIDO and IAEA. Potential funding opportunities were discussed. The session observed that food safety should be regarded as a shared responsibility for food business operators, consumers, and government among other stakeholders. The session participants encouraged promotion of a food safety culture and improving food safety awareness and practices. The need for increased public-private partnership coordination was highlighted. In the same session, a joint FAO–IAEA–UNIDO food safety programme proposal was presented by representatives of the three organizations and received good feedback including expression of interest from a number of participants.

The session on preparing for and responding to emergencies; incidents affecting the food supply; and measurement of radionuclides chaired by Mr Ryan Newkirk (WHO) and Mr Damian Ihedioha (AfDB) provided important information and research that will contribute to preparation and response activities for food-related emergencies. The food safety and nuclear-based science and activities presented during the session were wide-ranging, including topics related to: food safety preparedness; investigating outbreaks; testing commodities; estimating effective doses of radioactivity; testing countermeasures to reduce radioactive contamination; analyzing pesticide residues through collaborations with IAEA; and new guidance from IAEA, the FAO, and the WHO that focuses on managing exposures due to radionuclides in food. The breadth of the information presented underscores the importance of a multidisciplinary approach – which includes the intersection of food safety, emergency management, and nuclear science – to further protect food supply and strengthen food control systems.

The session on food irradiation chaired by Mr Alain Strasser (France) and Mr Carl Blackburn (IAEA) noted that although commercial food irradiation mostly uses gamma rays from cobalt-60, there is a growing interest in using the alternative technologies of electron beam and X ray irradiation. Several presentations showcased how irradiation technology has many benefits. These include effective reduction of microbial load in dried foods such as powdered African nutmeg as well as herbs and spices, ensuring the safety and long shelf-life of emergency food rations (e.g., energy bars) and long-life ethnic foods such as Gudeg (stewed jackfruit dish from Indonesia). Others were use of irradiation to produce sustainable and “smart” packing to enhance food safety and extending shelf-life of packaged foods such as meats and to increase extraction yields of active compounds in food for example lettuce among others. Research investigating irradiation’s ability to “functionalize” food – making it more nutritious – giving it health-promoting characteristics by improving bioactivity, bioavailability or enhancing antimicrobial activity was reported. The session observed that dosimetry-modelling studies are helping to advance food irradiation processing. An example is the choice of low, medium, and high energy electron beams as phytosanitary treatments. This session also addressed feasibility studies, considering all economic and technical parameters necessary to design the right facility for given products. It was further noted that the commercial up-take of phytosanitary irradiation is growing in some parts of the world. While there are many treatment protocols in the international standards for phytosanitary measures, research is continuing to ensure that treatments are effective against a wide range of pest species posing a risk to trade and shipments of fresh fruits and vegetables across quarantine boundaries.

The session on food authenticity and fighting food fraud chaired by Ms Michele Lees (France) and Mr Christopher Elliot (UK) highlighted the critical role of advanced scientific, isotopic, nuclear and complementary techniques along with robust regulatory frameworks for ensuring food authenticity. The presentations underscored the need for continued innovation in analytical methods, such as stable isotope analysis, nuclear magnetic resonance, and proteomics, to detect the constantly evolving food fraud challenges, but also the importance of ensuring that methods are fit for purpose, cost-effective and that adequate databases are available. Sharing information on the incidence of food fraud and raising awareness of effective methods to control fraud in Member States is essential and can act as a disincentive for organized crime involvement, the session noted. Collaborative efforts at national and international levels are essential, to standardize these methods, improve the transparency of supply chains, protect consumers and honest traders, and enhance or facilitate trade. The session recommended investing in R&D to support the development of advanced analytical techniques to stay ahead of emerging food fraud issues; enhancing regulatory frameworks by implementing and enforcing stringent regulations to deter food fraud, complemented by robust monitoring systems; promoting transparency by encouraging food producers and suppliers to adopt traceability systems that allow consumers to verify product authenticity and finally, educating stakeholders to increase awareness among consumers, producers, and regulators about the importance of food authenticity.

A session on standards-setting, metrology and risk assessment was chaired by Ms Sarah Cahill (FAO) and Mr Horacio Heinzen Gonzalez (IAEA) noted that food safety is guided by rules, regulations and standards that must be strictly followed. Everyone has a stake in setting and implementing these international food safety standards and guidelines.

The session highlighted some of the ongoing data generation efforts round the world to support standard setting, such as on maximum residue levels for antimicrobials. It also highlighted data on mycotoxins, including emerging mycotoxins with several presentations showing the need for future research on emerging mycotoxins and standards/regulations to address co-exposure to mycotoxins. Research and monitoring efforts on other hazards including, polyaromatic hydrocarbons, cyanotoxins and pesticide residues highlighted the importance of good methodology to collect data. Such data guides risk management actions. Monitoring of radionuclides in various products including honey produced from areas near Fukushima where flowering plants were being investigated was also presented.

A notable area where the IAEA and FAO and other stakeholders were encouraged to do more work is on radiolabeled food-animal studies expanding the scope of matrices and animals (considering different sexes; laying birds) beyond current research activities. Another area for discussion was on the maximum permitted energy levels of X rays for treating food from the currently permitted maximum level of 5 MeV to 7.5 MeV that many countries are using. It was noted that the role the FAO/IAEA Joint Centre plays in supporting global food safety standards is well appreciated by the Codex Alimentarius family (on 188 Member states and the EU). This includes efforts such as: R&D on depletion studies; capacity building; building and maintaining a database of analytical methods; innovations in food irradiation. Participants were encouraged to engage national codex authorities, identifying standards-related issues before they become a problem.

The session on detection and characterization of pathogens in food, and antimicrobial resistance (AMR) was chaired by Ms Ellitson Paloma and Mr Carl Blackburn. The beauty and hustle of pathogen detection in the face of new global or hitherto ignored challenges was presented but noting that while efforts have been made to address these challenges there are still analytical/diagnostic technology limitations especially in developing countries and disparity between countries although cross border transmission of pathogens, emerging pathogens and early-detection challenges are real in a global village where a crisis in one region affects distant locations.

The session also discussed mass testing and strategic sampling; a call for effective application of data generated using nuclear and complementary techniques to address global food safety challenges was highlighted. A number of papers addressed how to strengthen AMR testing and surveillance and controlling the safety of indigenous foods especially those sold on local/street markets.

The session on One Health was chaired by Mr Sami Darkaoui (Morocco) and Mr Jeffrey Lejeune (FAO) with a keynote presentation on “What the Transdisciplinary Nature of One Health Means: Opportunities and Challenges”. A historical perspective of One Health that started in 1855 with a focus on zoonoses was presented. Indeed, most of the One Health work has been built around zoonotic diseases; it is important that food plays a central role. This status has evolved over the years and requires involvement of not only scientists and laboratories etc. but policy makers and communities as well. Equity between sectors and disciplines as well as a trans-disciplinarity approach are required for the success of the One Health approach. It was noted however that a trans-disciplinarity approach may only apply to complex problems and that sometimes it is better to be specific, with a targeted audience following proper situation analysis. Also, we shouldn’t reinvent the wheels of One Health where applicable, but rather strengthen what is available. Challenges encountered by countries in developing transdisciplinary collaboration were highlighted. There was a call to strengthen the assessment, management and communication of food safety risks; enhancing data generation and data management; implementing integrated risk assessment and the need to significantly invest resources in One Heath and to translate it into policy. Further presentations addressed the need to harmonize food safety regulation; country experiences on implementation of AMR surveillance, noting the lack of quantitative data (most countries are data–deprived) and how challenging the sharing of such data if produced, is.

The symposium benefited from a presentation on a risk-informed approach to One Health resilience and the need to view it from the lenses of national security since health and food security are a national security issue. Human, animal, plant and environmental health are interconnected in many ways so that any disruptions potentially catastrophic to the whole chain. Participants were challenged to improve national capabilities to predict the future through robust risk assessment and consider One Health using a whole-of-community, whole-of-government system of stakeholders and capabilities.

The One Health session also addressed the characterization of exposure to food-borne contaminants and potential link to nutrition and associated health outcomes; the need for more research on rarely–considered hazards such as bromide was also presented. A good example was a study on how to protect the unborn child from such hazards, following investigations on tissue bromide residues in cows and calves experimentally exposed to inorganic bromide in feed. Other cross-cutting presentations covered tracing of AMR in the food supply chain: from farm to fork; co-exposure to deoxynivalenol (mycotoxin) and *Campylobacter jejuni* (pathogen) and increasing intestinal permeability and bacterial translocation in broiler chicken; chemotherapy and contamination risks in livestock production systems; and case study on heavy metal content and risk assessment in breast milk and associated food.

Twenty exhibitors, mostly from the private sector including equipment suppliers and vendors as well as two Member States participated, and several bilateral meetings were held with the non-traditional partners to explore possibilities for partnerships relevant to food and agriculture: human health and other areas of work in Nuclear Sciences and Applications. Discussions revolved around activities that could strengthen the work of the IAEA laboratories in Seibersdorf.

The Joint Centre also held a number of bilateral meetings with international financial cooperations such as AfDB, ADB and IFC. Additional bilateral meetings were held with the high–level representatives from Benin and Botswana. The two country-officials also held bilateral discussions with staff from the IAEA's Division in charge of Africa.

As a result of the symposium, a number of participants inquired about how to participate in the Atoms4Food Initiative to improve their food safety control systems (along the source-to-consumption chain) including the strengthening of laboratory testing and monitoring; setup of facilities; establishing regulatory framework and creating awareness of food irradiation among end users and food producers as well as food consumers etc.

A side event was held to show the significant role women play not only in the production of food but also in ensuring its safety. The importance of training women in science and technology and facilitating knowledge-application to food safety and food security were also addressed. This has a multiplier effect in society, presenters including the DDG NA and Ambassadors from Türkiye and Spain among others noted. A call was made for more young women to take advantage of initiatives such as the Marie Skłodowska–Curie fellowship programme.

The symposium concluded by noting that support the IAEA (in partnership with the FAO) provides to Member States on food safety and control is bearing fruits as demonstrated by the numerous oral and poster presentations and the video on Costa Rica. Nevertheless, it was noted that more can be done to comprehensively contribute to addressing the global burden of food borne illnesses and trade-related challenges. There is a need for a holistic approach at all stages of the food system from the source to consumption. Ensuring a safe and good quality food supply goes beyond science, to management and political support. The symposium highlighted that all efforts to improve the food safety and control systems must consider joint approaches. The Atoms4Food Initiative can contribute solutions. Papers presented at the symposium are being received for preparation into a publication.

Forthcoming Events

Research Coordination Meetings and Training Courses

Final Research Coordination Meeting on Implementation of Nuclear Techniques for Authentication of Foods with High-Value Labelling Claims (INTACT Food) (CRP D52042), Vienna, Austria, November 2024.

Third Research Coordination Meeting on Novel Irradiation Technology for Phytosanitary Treatment of Food Commodities and Promotion of Trade (CRP D61026), Strasbourg, France, 9–13 December 2024.

African Food Safety Workshop 2024, Palm Plaza Hotel, Marrakech, Morocco, 7–11 October 2024.

Codex Committee on Veterinary Drug Residues in Food (CCRVDF), USA, 21–25 October 2024.

Past Events

Forensic Epidemiology and Impact of Substandard and Falsified Antimicrobials on Public Health (FORESFA) – Second Annual Laboratory Working Group Meeting

Simon Kelly

Substandard and falsified (SF) antimicrobials are an underappreciated global health challenge, that disproportionately affects low-income countries. Professor Paul Newton, Head of the University of Oxford's Medicine Quality Research Group is leading a 4–year Welcome Trust Collaborative Award project to establish an innovative, multidisciplinary research hub that will improve understanding, and inform global policy and enforcement, on SF medicines. The project consortium is composed of leading specialists investigating the application of forensic genomics and isotope biogeochemistry, social network analysis and statistical modelling. The collaborators will work together to answer two main research questions. The first is how can novel genomic, chemical and isotopic analyses, with social network techniques, be used to characterize the trade routes of SF antimicrobials, and their constituents, to inform action to improve global pharmaceutical supply quality. This will be addressed through high-throughput sequencing and novel chemical and isotopic analysis of falsified and authentic antimicrobials to determine their comparative bio-geochemical 'fingerprints'. Furthermore, social network analysis will be performed to investigate origins and trade routes from accessible reports. The second question to be addressed is what the modelled impacts of SF antimicrobials on patient outcome and global public health are; especially those stimulating antimicrobial resistance (AMR), and how can these be mitigated. A One Health approach will be used to aid understanding of which pathogen-antimicrobial pairs are promoted by consumption of SF antimicrobials.

Members of the FORESFA project Laboratory Working Group meeting in Trento Italy, 15–16 January 2024. (Photo courtesy of Ms Luana Bontempo, Fondazione Edmund Mach)

The Food Safety and Control Laboratory (FSCL) is in the final stages of negotiating a collaboration agreement with the University of Oxford to participate in the Wellcome Trust Funded project. Mr Simon Kelly was invited to present FSCL's existing applied and adaptive research, which aligns with the objectives of the FORESFA project, to trace the geographical origin of excipient material, such as maize starch, used in SF medicines at their second annual Laboratory Working Group (WG) meeting at the Fondazione Edmund Mach in Trento, Italy, from 15 – 16 January 2024. It is already known that food grade materials are frequently used in SF medicines, instead of pharmaceutical grade products, due to their lower cost and availability. Mr Kelly presented results of the hydrogen stable isotope analysis method used in FSCL to verify the geographical origin of corn (maize) starch, which is often used in SF medicine tablets as a 'filler' along with other hydrogen bearing excipient materials such as potato starch, bovine lactose, soya lecithin, xanthan gum, and wood cellulose. He also presented a method for the extraction of starch from dried maize kernels for isotopic analysis, demonstrating the repeatability of the process through stable hydrogen isotope ratio data. This methodology is important in order to build a database of starches extracted from maize cultivated in known geographical locations. The measurement of the ratio of the stable isotopes of hydrogen (deuterium/protium, 2H/1H) can reveal information regarding both the geographical and botanical origin of plant materials due to systematic geo-spatial variations, and morphological and biochemical differences in plants influencing 2H/1H ratios, respectively. However, this information is retained by the non-exchangeable (NE), or intrinsic, hydrogen bound directly to carbon in biopolymers, such as starch and cellulose. Selectively measuring the NE hydrogen presents significant challenges which can be overcome using the UNIPREP online equilibration module prior to isotope ratio measurement by Elemental Analyser – Chromium Reduction - IRMS (EA-CR-IRMS). This widely used and accepted method for the accurate measurement of the NE hydrogen isotope ratios requires dual-water vapour equilibration with two waters of widely different but known isotopic composition, followed with the use of a zero blank autosampler to avoid uncontrolled hydrogen exchange with laboratory atmospheric water vapour during the analysis. Usually, this procedure is very time consuming due to the 5- days needed for offline water-equilibration of the sample, whereas the UNIPREP online equilibration unit utilized in FSCL allows equilibration in 2–hours, for each isotopically controlled water, followed by analysis from the same carousel autochanger used for the equilibration. The other project participants involved in FORESFA laboratory WG gave progress presentations on the use of carbon, nitrogen and oxygen stable isotope analysis of the excipients (Fondazione Edmund Mach, IT); and genomics to characterize the fragments of environmental DNA found within SF medicines; and Direct Analysis in Real Time – Mass Spectrometry (DART–MS) to characterize fake pharmaceuticals and give clues as to their origin (University of Edinburgh, UK). Currently, a database of maize starches of known geographical origin, and a repository of authentic and seized SF medicines are being compiled, with the help of the World Health Organization (WHO), pharmaceutical companies, medical and enforcement agencies in Southeast Asia and Africa before characterization and model building to test the reliability of the analytical procedures prior to enforcement and intervention work may begin.

17th Session of the Codex Committee on Contaminants in Foods.

Carl Michael Blackburn

The Codex Committee on Contaminants in Foods (CCCF) held its 17th Session in Panama City from 15–19 April 2024. The Food Safety and Control Section provided remarks and a written report on Joint FAO/IAEA programmatic work and activities relevant to the CCCF representatives in attendance from 54 Codex member countries, one member organization and 7 observer organizations.

The CCCF participants were interested in the Atoms4Food initiative announced in October 2023 by the Directors General of FAO and IAEA in their joint statement. The report to the CCCF also highlighted research activities related to chemicals and contaminants in food and in particular the coordinated research projects on “Integrated Radiometric and Complementary Techniques for Mixed Contaminants and Residues in Foods” (CRP D52041, that concluded in 2023) and “Nuclear techniques to support risk assessment of biotoxins and pathogen detection in food and related matrices (CRP D52044, on-going).

IAEA is responsible for international radiation safety standards and Codex is the international body for food standards. Therefore, the Joint FAO/IAEA Centre has a role in keeping Codex and the CCCF informed of a project concerning radioactivity in food and the development of international radiation safety guidance.

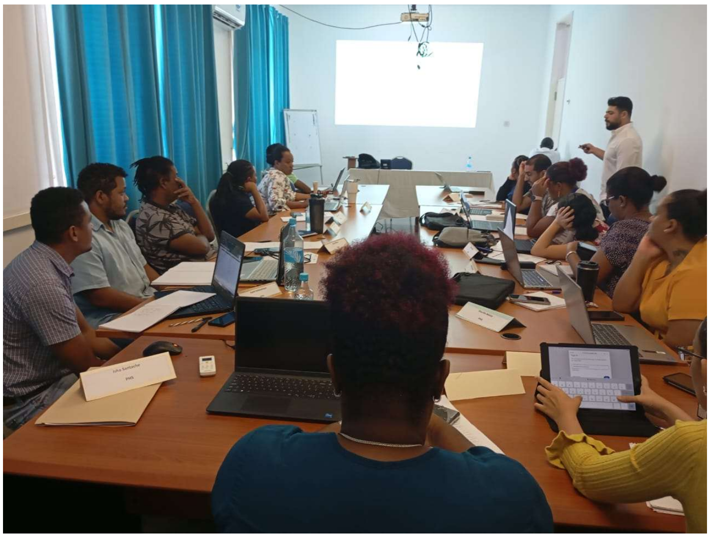
Readers will recall that at a previous Committee meeting the CCCF asked to be kept informed about this FAO, IAEA, WHO project and also welcomed the offer to elaborate an “informative document” for the food safety regulators community, providing the state of the art of natural radioactivity in food, feed and water.

This “informative document” on natural radioactivity in food, feed and water was subsequently drafted by the Joint FAO/IAEA Centre in collaboration with representatives from FAO, IAEA and WHO with input from the UNSCEAR. The Codex Alimentarius Commission Secretariat kindly circulated this for comment in February 2023 as CL 2023/17-CF.

It was agreed that the “informative document” will be re-drafted to take into consideration the responses received to CL 2023/17–CF and that it should also include the latest information available from the current UNSCEAR evaluation. Therefore, after UNSCEAR has produced its revised evaluation of public exposure to ionizing radiation which is expected to be published later this year (See the report on the 71st UNSCEAR).

Training on Risk Assessment in Seychelles

James Sasanya



A group of institutions receiving training on risk assessment from a food safety perspective, April 2024 (Photo courtesy of Ms S. Labrosse, Seychelles Public Health Laboratory)

A national training course on risk assessment was held in Mahe, Seychelles, on 22–26 April 2024 and was attended by 18 participants from Seychelles Public Health Authorities; Seychelles Bureau of Standards; Seychelles fishing Authority; Ministry of Agriculture, Climate Change and Environment, as well as the National Institute of Health and Social Studies (NIHSS)

The training covered a range of topics such as the: introduction to food safety and food control system; introduction to risk analysis and risk assessment in food safety; monitoring programmes for chemical residues and contaminants in food; dietary Exposure Assessment for chemical hazards in food (a case of pesticide residues and persistent organic pollutant – POPs); and microbial risk assessment in food. Others included the ecological risk assessment for chemical residue and contaminants, the role of Good Agricultural Practice and Good Manufacturer Practices in food safety. Some eco-friendly practices and applications for the remediation of organic and non-organic pollutants as well as the introduction to laboratory quality management system were also addressed.

The counterparts/country were encouraged to promote the One Health approach in tackling food safety issues in the country; to commission and fund at least one risk assessment study in the country; and to review and update the food safety regulations and policies to align with international food safety requirements. The development of a policy for a risk–based food control system with associated national monitoring and market surveillance plans and initiation of studies on locally produced and imported food for key hazards were also recommended. It is also important to conduct a qualitative (or a quantitative) risk assessment of the most pressing food safety issues in the country; and to enhance networking with other African countries for stronger food safety control systems.

A call was made to provide further support to the various institutions on: advanced risk assessment and risk management; proper sampling methods for risk assessment; data analysis; advanced ecological risk assessment, for selected representatives/professionals of national competent authorities of Seychelles; analytical equipment for chemical hazards.

Enhancing Food Safety Capabilities in Mozambique and Promoting the Atoms4Food Initiative

James Sasanya

Staff of the Institute of Agricultural Research (IIAM) of the Directorate of Animal Science (DCA) and IAEA Officer during a training, February, 2024 (Photo courtesy of Ms C. Menezes, DCA, Mozambique)

In February 2024, on–site technical support was provided by Mr Sasanya to the food safety-associated institutions in Mozambique namely, Institute of Agricultural Research (IIAM) of the Directorate of Animal Science (DCA) and National Institute of Fish Inspection (INIP) and the National Directorate of Plant and Animal Health and biosecurity (DNSAB), Ministry of Agriculture and Rural Development.

Training on the Inductively couple plasma mass spectrometer (ICP–MS) was provided by Mr Sasanya to IIAM staff after he installed a new water-chiller. Further training and guidance was provided to four scientists in IIAM's organic chemistry laboratory that hosts a radioreceptor assay instrument, high performance liquid chromatography and other instruments, to facilitate the testing of chemical residues and contaminants in food. The Officer shared a web platform of the African Food Safety Network (AFoSaN) which contains several analytical method protocols, including videos with the analysts to enhance their work. A needs-assessment was conducted and several missing items that could improve the laboratory's performance if provided, were identified.

At INIP, Mr Sasanya provided training to four laboratory staff on the principles and use of an ultra-high performance liquid chromatography mass spectrometer (UHPLC-MS/MS). The practical sessions were provided using two chemicals, cypermethrin and emamectin benzoate both used in crop and animal production. Mr Sasanya also provided INIP staff protocols, demonstration videos and a manual (book) of several standard operating procedures produced by the Food Safety and Control Section of the IAEA. Two such books were also provided to IIAM and DSAB. An additional manual, a product of a previous coordinated research project was also delivered to IIAM.

Mr Sasanya, the Director DNSAB and the focal point for IAEA's Agriculture projects at DNSAB met the Vice Minister of Agriculture and Rural Development to brief him about support provided to the country and which he was grateful for. He mentioned that the country wishes to access or maintain markets for various foods including maize, sesame, coffee and fish among others, but safety and quality must be improved. He called on the IAEA to provide further support.

Mr Sasanya also met the Director General of the IIAM to discuss various issues including the need for management-support for the laboratories at the IIAM so they can operate smoothly and sustainably. He also met the Director of Policy and Planning Services at the Technical Secretariat for Food and Nutritional Safety and discussed how to integrate food safety into relevant policy and intervention at the Ministry of Agriculture and Rural Development and the need for support in establishing a new food safety law.

The Permanent Secretary of the Ministry of Sea, Inland Waters and Fisheries appreciated the Agency for supporting the establishment of a UHPLC–MS/MS at INIP during discussions with Mr Sasanya and his hosts. She called for more support so that better testing services can be rendered in the country. The fisheries institute intends to strengthen regional laboratories since the country is a very long stretch and conducting tests close to the field is desired.

Mr Sasanya visited the FAO country office and met a number of staff, including the Technical Advisor to the FAO country representative, with whom he discussed how to collaborate to help Mozambique improve its food safety control system. This includes strengthening laboratories and the regulatory framework. The Atoms4Food Initiative was discussed, and it was agreed that a food safety project concept be jointly developed and resources mobilized under the initiative. Mr Sasanya prepared a draft and shared with the country office and counterparts for their input. The counterpart provided prompt inputs and we are waiting for the FAO country office to provide (additional) inputs.

Participation in the WHO Alliance for Food Safety Inception Meeting

Christina Vlachou

WHO Alliance for Food Safety Inception Meeting - group photo and "Thank you" message (Group photo courtesy of WHO)

On 6–8 May 2024, Ms Christina Vlachou participated in the inception meeting for the WHO Alliance for Food Safety, which was organized in Geneva, Switzerland, by the WHO Nutrition and Food Safety Department in collaboration with the Division of Foodborne, Waterborne, and Environmental Diseases (DFWED) of the Centres for Disease Control and Prevention (CDC) of the United States of America. This meeting brought together 100 participants from 64 WHO collaborating centres, international and European organizations including the World Organization for Animal Health (WOAH), United Nations International Children's Emergency Fund (UNICEF), World Food Programme (WFP), European Commission, European Food Safety Authority, European Centre for Disease Prevention and Control and other institutions including U.S. Food and Drug Administration (FDA) , Saudi Food and Drug Authority, the French Agency for Food, Environmental and Occupational Health and Safety, German's Federal Institute for Risk Assessment, Health Canada, Canadian Food Inspection Agency, Kenya Medical Research Institute (KEMRI), among others. These have demonstrated leadership and technical competency to support the implementation of the WHO Global Strategy for Food Safety 2022–2030, particularly in foodborne disease surveillance.

The inception meeting had the following objectives: (a) Development of the Terms of Reference (ToRs) of the WHO Alliance for Food Safety identifying its added value in the area of foodborne diseases surveillance and (b) Development of a draft work plan for 2023–2030 to help countries meet the WHO target of foodborne disease surveillance by 2030. To support countries in a coordinated way, WHO is exploring the reactivation of its Global foodborne infections network (GFN) and is tapping into its network of collaborating centres. The agenda of the meeting included presentations from WHO and officers from WHOs collaborating centres providing the necessary background and objectives. Group discussions and exchange of opinions and expertise on specific outcomes, actions, indicators and key stakeholders within working groups that were created were held.

As next steps, WHO will consolidate the inputs from the working groups and finalize the ToRs and the workplan of the Alliance and will call for participation of experts in future working groups that will be formed based on a multisectoral representation and networking.

United Nations Scientific Committee on the Effects of Atomic Radiation, Vienna International Centre.

Carl Michael Blackburn

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was established by the United Nations General Assembly in 1955. It has the mandate to evaluate and report on the levels and effects of exposure to ionizing radiation on human health and the environment. Its reports provide valuable information to the United Nations General Assembly, members of the public and policymakers.

The 71st session of UNSCEAR held in May 2024 involved discussions related to radiation exposure and scientific evaluations. The Joint FAO/IAEA Centre participated in the meeting and represented the FAO because UNSCEAR is considering natural radioactivity in food as part of its broader evaluation of public exposure to ionizing radiation. The latest version of this evaluation is nearing completion and was considered in session.

71st session of UNSCEAR from 20–24 May 2024 (Photo courtesy of C. Blackburn)

The committee concluded that the world-averaged annual effective dose to the public from natural radiation is estimated to be in the range 1–13 mSv (consistent with previous estimates). The annual average world-wide effective dose from natural sources was estimated as 3 mSv. Although this average dose estimate has changed from 2.4 mSv when compared to previous UNSCEAR reports, this does not reflect an actual change in public exposure but results from new data and revised calculation approaches. Food ingestion accounted for 0.5 mSv (13%) through the ingestion of potassium–40, uranium and thorium decay series radionuclides (chiefly polonium-210, lead–210, radium–226 and radium–228). The food ingestion dose evaluated for these latter four radionuclides was calculated based on data generated by the Food Safety and Control subprogramme and colleagues from the IAEA and WHO (recently published by the IAEA and jointly sponsored by FAO, IAEA and WHO). A detailed written report on public exposure is due to be available in early 2025 as an UNSCERA publication.

Qatar's Food Safety Laboratory (FSL) Assessed for a Collaborating Centre and is Now Ready to Share Capabilities with Other Countries

James Sasanya

One of the food safety testing laboratories at FSL in Qatar (Photo courtesy of Mr J. Sasanya, IAEA)

At the request of the Government of the State of Qatar, a mission was undertaken by Mr Sasanya to conduct a gap assessment at the FSL of the Ministry of Public Health (MoPH) from 21–25 April 2024. The assessment involved meetings with senior managers and staff of the FSL; presentations from the country representatives and Mr Sasanya and observations as well as interviews, among others. The FSL moved to its new modern facility in Feb 2023 from a previous facility built in 1965. In 1967 a pesticide poisoning incidence occurred triggering the initiation of food safety testing capabilities and hence the FSL which now consists of a chemistry; microbiology and molecular biology as well as radiochemistry laboratory sections. The FSL has a wide range of state–of–the–art analytical instrumentation; more than 50 scientists and is accredited since 2015 to ISO/IEC 17020:2012, Conformity assessment — Requirements for the operation of various types of bodies performing inspection. It is also accredited to ISO/IEC 17025 with nearly close to 100 methods accredited including those that are food safety related.

The laboratory has a bioengineering unit which supports different units in maintaining their equipment. There is also a dedicated quality management unit and an information management system.

The FSL is a well–established institution and was therefore found to be suitable for consideration as a new IAEA collaborating centre for food safety and control. This consideration of the laboratory as a collaborating centre was initiated promptly during the visit and subsequently on 30 May 2024 at the margins of the International Symposium for Food Safety and Control held in Vienna, Austria 27–31 May 2024, designation was granted by the IAEA. The country is also keen on supporting the Atoms4Food Initiative and has indicated that it is in discussions to determine details of how to participate.

Twelfth Meeting of The Representatives of Competent Authorities Identified Under the Convention on Early Notification of a Nuclear Accident and The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency

Carl Michael Blackburn

This twelfth "Competent Authorities Meeting" was held at the IAEA Headquarters in Vienna from 3 to 7 June. The Joint FAO/IAEA Centre participated because the FAO is a full signatory to both conventions.

The meeting brought together 268 participants from 113 countries and seven international organizations and was dedicated to discussing the future of nuclear and radiological emergency preparedness and response. It is a regular meeting held every few years to facilitate cooperation and information exchange among the specialists involved, with a view to improving national and international emergency arrangements.

Important upcoming activities were also highlighted, including the ConvEx–3, the largest global exercise in nuclear emergency preparedness which is scheduled for 2025 and an IAEA emergency preparedness and response conference that is scheduled for Autumn 2025.

Both conventions were adopted in 1986 following the Chernobyl nuclear plant accident. One provides an international mechanism for the prompt notification of nuclear accidents from which a release of radioactive material has or may significantly affect a neighbouring territory and the other establishes an international framework for the provision of timely assistance.

Coordinated Research Projects

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

Innovating the Radiation Processing of Food with Low Energy Beams from Machine Sources

Carl Michael Blackburn

This research effort is stimulating innovation and producing research outputs that will support the future use of low energy beam irradiation units "in-factory". The third research coordination meeting (RCM) of the above-named coordinated research project (reference CRP D61025) was very kindly hosted in April 2024 by the Comisión Nacional de Energía Atómica (CNEA), at Buenos Aires, Argentina.

Mr J. Pachado (Radiation Applications and Technology Management, CNEA) and Ms V. Vogt, (Radiation Processes Department, CNEA) provided opening remarks and welcomed everyone. Ms M. Lacroix and Ms U. Gryczka were appointed as chair and rapporteur respectively. On behalf of the meeting, the Chair expressed thanks for the generous extrabudgetary funding to Ms J. Elster and Mr R. Shwarz (both of Pacific Northwest National Laboratory) and asked them to convey this to their colleagues at the US funding organization.

Extrabudgetary funding from the U.S. National Nuclear Security Administration Office of Radiological Security supported most of the speakers and not only enabled this meeting to take place but helped extend it to include invited speakers and a special workshop on modelling and simulation.

The modelling workshop was provided in response to the recommendations of the previous RCM where researchers had recognized the importance of simulations and requested that this 3rd RCM include more on the subject of modelling electron beam and X ray interactions with food.

The first three days focused on CRP research and was held in the Dan Beninson Institute at the Ezeiza Atomic Center. The remaining 2 days were held at a venue in downtown Buenos Aires and included the modelling workshop plus keynote speakers, mostly from the region but also others from industry and research institutions world-wide. All were able to participate at both venues and in total, thirty-three different organizations from twenty-three countries and two international organizations took part. Although three research groups could not be represented in person the researchers from Tsinghua University (China), and Shiraz University (Iran) provided pre-recorded presentations.

Invited speakers were encouraged to share their experiences and invited to collaborate. Various equipment manufacturers, suppliers and others involved in radiation processing also took an active part and assisted with advice and technical information regarding both high- and low-energy beam irradiation.

Research is progressing well, and collaborative research efforts continue to develop and promote machine generated low energy radiation beams ("soft electrons" and "soft X rays") as alternative technologies for food irradiation and phytosanitary treatments.

Technical Cooperation Projects

Country/Region	Project No.	Title	Technical Officer
Barbados	BAF5001	Enhancing Capability for Food Safety and Surveillance through the Development of Nuclear, Isotopic and Complimentary Analytical Methods	J.J. Sasanya
Burundi	BDI5004	Enhancing Control of Chemical Residues and Related Contaminants in Food	J.J. Sasanya
Bangladesh	BGD5034	Enhancing Competence in Nuclear and Complementary Capabilities for Testing/Monitoring Veterinary Drug Residues and Other Contaminants in Foods	J.J. Sasanya A. M.V. M. Rodriguez y Baena
Bahamas	BHA5003	Strengthening Laboratory Capacity for Testing Microbial and Related Chemical Contaminants in Food Products	J.J. Sasanya
Bosnia and Herzegovina	BOH5003	Using Nuclear Technology in Enhancing Science Based Safety, Quality and Control Systems in Feed and Food Chains	H. Heinzen-Gonzalez J.J. Sasanya
Botswana	BOT5023	Enhancing Control of Food Hazards in Poultry Production and Products	J.J. Sasanya
Cameroon	CMR5025	Improving Laboratory Testing Capabilities to Enhance the Safety and Competitiveness of Agricultural Products - Phase I	J.J. Sasanya
Cameroon	CMR5028	Improving the Capacity for Food Safety Testing Using Nuclear and Complementary Techniques	J.J. Sasanya H. Heinzen-Gonzalez
Chile	CHI5053	National Reference System for Verification of Authenticity and Determination of Origin of Food using Nuclear Isotopic Techniques	S.D. Kelly
Chile	CHI5056	Strengthening of the National System for Verification of Authenticity and Determination of Origin of Food.	S.D. Kelly A.Mihailova
Chile	CHI0023	Building Capacity for Nuclear Science and Technology Applications	S.D. Kelly A.Mihailova B.M. Maestroni
Comoros	COI5001	Building a Food Safety Laboratory Capacity in Comoros — Phase I	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

Country/Region	Project No.	Title	Technical Officer
Cuba	CUB5025	Establishment of a National System for the Verification of the Authenticity and Determination of Food Origin	S.D. Kelly A.Mihailova
Djibouti	DJI5001	Developing Nuclear/Isotopic and Complementary Food Safety Testing Capabilities	J.J. Sasanya
Dominica	DMI5003	Strengthening a Nuclear Isotopic Laboratory and Complimentary Field Food Safety Surveillance Capabilities	J.J. Sasanya
Dominica	DMI5004	Establishing a National Food Safety Monitoring Surveillance Programme	J.J. Sasanya
Ecuador	ECU5030	Reducing Post-Harvest Losses of Native Potatoes and other Fresh Foods by Irradiation	C.M. Blackburn
Ecuador	ECU5033	Strengthening Laboratory Capacities for Monitoring Residues of Neonicotinoid Pesticides in Honey Bees and Honey	B.M. Maestroni
Eritrea	ERI5016	Strengthening the Capabilities of the National Plant and Animal Health Laboratory and Collaborating Institution(s) for Food and Feed Safety and Quality Testing	J.J. Sasanya
Eritrea	ERI5014	Enhancing Food Safety Analytical and Monitoring Capabilities	J.J. Sasanya
Fiji	FIJ5002	Increasing Trade and Export Capacities of Selected Value Chains within the Agro-Food Sector through the Adoption of an Appropriate Quality Infrastructure	C.M. Blackburn
Fiji	FIJ5005	Establishing a Food Safety Laboratory for Analysis of Pesticide Residues in Fresh Fruits, Vegetables and Root Crops — Phase II	B.M. Maestroni
Fiji	FIJ5006	Supporting the Establishment of an Irradiation Facility for the Treatment of Food and Agricultural Commodities against Exotic Pests and Diseases — Phase II	C.M. Blackburn
Fiji	FIJ5008	Improving the Capabilities of the Food Safety Laboratory for Analysis and Control of Biological Contaminants	B.M. Maestroni
Georgia	GEO5001	Enhancing National Programmes for Testing and Monitoring Food Contaminants and Residues	J.J. Sasanya
Honduras	HON5012	Strengthening Analytical Capabilities for the Detection of Residues, Contaminants and Microbiological Hazards in Food and Feed	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Indonesia	INS5045	Strengthening Food Security Through Improvement of Food Safety for Exports Using Gamma Irradiators and Electron Beams	C.M. Blackburn B. S. Han
Indonesia	INS5046	Strengthening Food Security through the Improvement of Food Safety for Exports using Gamma Irradiators and Electron Beams	C.M. Blackburn
Iran, Islamic Republic of	IRA1011	Building Capacity for the Development of Stable Isotope Techniques in Medicine, the Environment, Agriculture, and Sciences	S. D. Kelly U.D. Sarvana Kumar O. Kracht J.A. Miller
Cote d'Ivoire	IVC5042	Improving Testing and Monitoring of Food Hazards Using Nuclear and Isotopic Techniques	J.J. Sasanya
Cote d'Ivoire	IVC5045	Strengthening National Analytical Capacities for Food Safety Testing and Assessing Micronutrient Bioavailability in Local Diets	J.J. Sasanya V.O. Owino
Cambodia	KAM5004	Strengthening National Capability for Food and Feed Safety	J.J. Sasanya
Kazakhstan	KAZ5005	Building Capacities in Effectively Irradiating Food	C.M. Blackburn
Kenya	KEN9007	Establishing a National Standard Laboratory for Individual Monitoring, Radioanalysis, and Calibration of Neutron and Surface Contamination Services	C.M. Blackburn J.J. Sasanya
Kyrgyzstan	KIG5001	Establishing Effective Testing and Systematic Monitoring of Residues and Food Contaminants and of Transboundary Animal Diseases	J.J. Sasanya I. Naletoski
Lebanon	LEB0010	Strengthening the Nuclear and Complementary Analytical Techniques of the Lebanese Atomic Energy Commission to Meet Forensic Needs for Materials Investigation and Characterization	S. D. Kelly
Lebanon	LEB5016	Strengthening Capacity for Exposure Assessment of Residues and Contaminants in the National Diet	J.J. Sasanya
Lebanon	LEB5017	Strengthening Technical Capabilities by Introducing Metal Speciation Techniques to Support Health and Environmental Safety	S. D. Kelly
Lesotho	LES5011	Strengthening Nuclear and Related Food Safety Laboratory Capabilities to Control Veterinary Drug Residues and Related Contaminants	J.J. Sasanya
Madagascar	MAG5028	Developing Food Safety Laboratory Capabilities	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
North Macedonia	MAK5009	Enhancing National Capacities to Standardize Nuclear Based and Related Techniques for Food Safety and Detection of Irradiated Food	B. S. Han A. Mihailova C.I. Horak
Malaysia	MAL5032	Strengthening National Capacity in Improving the Production of Rice and Fodder Crops and Authenticity of Local Honey Using Nuclear and Related Technologies	A. Mihailova S.D. Kelly J. J. Adu-Gyamfi E. Fulajtar C. Zorrilla
Malaysia	MAL5033	Strengthening Analytical Capabilities for Food Safety and Food Security	J.J. Sasanya H. Heinzen-Gonzalez
Malaysia	MAL5035	Strengthening National Capacities in Nuclear and Related Techniques to Improve Halal Meat Authentication for Food Safety and Security	S.D. Kelly A.Mihailova
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
Mauritania	MAU5011	Enhancing Intersectoral Food Safety Testing and Surveillance of Chemical and Biological Hazards	J.J. Sasanya H. Heinzen-Gonzalez
Marshall Islands	MHL5002	Building Core Capacities to Control Contaminants and Other Residues in Food — Phase I	J.J. Sasanya
Marshall Islands	MHL5004	Strengthening Capacities for the Detection and Control of Contaminants and Residues in Food	J.J. Sasanya
Mali	MLI5032	Improving Laboratory and Monitoring Capabilities for Contaminants in Cereals and Nuts	J.J. Sasanya H. Heinzen-Gonzalez
Malawi	MLW5007	Enhancing Capabilities to Test, Monitor and Control Contaminants and Chemical Residues in Foods	J.J. Sasanya
Mongolia	MON5024	Enhancing Food Safety Analytical Capabilities for Veterinary Drug Residues and Related Contaminants Using Isotopic Techniques	J.J. Sasanya
Mozambique	MOZ5012	Enhancing Food Safety Testing and Monitoring of Hazards Using Nuclear and Related Techniques	J.J. Sasanya
Myanmar	MYA5031	Strengthening Food Safety Chemical Hazard Testing and Monitoring Capabilities	J.J. Sasanya
Namibia	NAM5019	Enhancing National Capacity for Contaminant and Adulteration Monitoring of Marine and Other Food Products for Consumer Protection	J.J. Sasanya A. Mihailova M. H. T. Metian

Country/Region	Project No.	Title	Technical Officer
Namibia	NAM5021	Enhancing National Food Safety and Aquatic Contaminant Monitoring Programmes	B.M. Maestroni C.Vlachou
Nepal	NEP5007	Supporting Analysis of Pesticide Residues in Agricultural Products	B.M. Maestroni
Niger	NER5025	Improving Food and Biological Hazard Detection, Food Preservation and Mutation Breeding	J.J. Sasanya C.M. Blackburn S. Sivasankar
Niger	NER5026	Enhancing Food Production, Preservation, Safety and Quality	J.J. Sasanya C.M. Blackburn H. Heinzen-Gonzalez I.K.K. Bimpong
Oman	OMA5010	Building Capabilities in Food Safety and for Monitoring Irradiated and Contaminated Food and Consumer Products	C.M. Blackburn S.D. Kelly
Vanuatu	NHE5004	Strengthening Agro-Food Laboratory Quality Infrastructure — Phase II	J.J. Sasanya
Vanuatu	NHE5005	Strengthening Food Safety Laboratory and Surveillance Capabilities of the Vanuatu Bureau of Standards — Phase III	J.J. Sasanya
Nicaragua	NIC5012	Strengthening the Monitoring and Control System for Food Contaminants	J.J. Sasanya
Pakistan	PAK5053	Strengthening and Enhancing National Capabilities for the Development of Climate Smart Crops, Improvement in Animal Productivity and Management of Soil, Water, and Nutrient Resources Using Nuclear and Related Techniques	J.J. Sasanya H. Heinzen-Gonzalez
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	PAN5030	Strengthening Laboratory Capacity in Monitoring Veterinary Drug Residues and Contaminants in Milk and Honey Using Nuclear/Isotopic Techniques	J.J. Sasanya H. Heinzen-Gonzalez
Panama	PAN5032	Strengthening Monitoring Capabilities for Chemical Residues and Contaminants in Aquaculture using Nuclear and Isotopic Techniques	J.J. Sasanya H. Heinzen-Gonzalez
Philippines	PHI5035	Advancing Laboratory Capabilities to Monitor Veterinary Drug Residues and Related Contaminants in Foods	J.J. Sasanya
Papua New Guinea	PAP5005	Strengthening National Infrastructure to Control Contaminants and Other Residues in Food — Phase I	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Paraguay	PAR5013	Strengthening Analytical Capacities in the Control of Residues and Contaminants in Primary Foods for Human Consumption	B.M. Maestroni C.Vlachou
Palau	PLW5005	Building Core Capacities to Control Contaminants and Other Residues in Food — Phase I	J.J. Sasanya
Qatar	QAT5009	Enhancing National Food Safety Capacity to Test and Monitor Residues/Contaminants Using Nuclear and Related Isotopic Techniques	J.J. Sasanya C.M. Blackburn H. Heinzen-Gonzalez
Romania	ROM5010	Enhancing Food Safety and Quality of Consumer Protection	C.M. Blackburn J.J. Sasanya
Rwanda	RWA5003	Strengthening Laboratory Capacity of the Standards Board to Analyse and Monitor Chemicals (Veterinary Drug Residues and Related Contaminants) in Foods — Phase II	J.J. Sasanya A. M.V. M. Rodriguez y Baena
Saint Kitts and Nevis	STK7001	Building National Capacity for the Application of Nuclear Science and Technology	C.Zorrilla H. Heinzen-Gonzalez J.J. Sasanya
South Africa	SAF5018	Establishing National Capacities for Monitoring and Control of Pesticide Residues in Agricultural Produce	B.M. Maestroni
Seychelles	SEY5014	Developing Toxicological Analytical Capability for Monitoring and Biomonitoring Exposure to Toxic Agents in Biological and Environmental, as well as Food and Water Matrices	J.J. Sasanya
Senegal	SEN5043	Developing Capacity to Conduct an Assessment of Exposure to Chemical Hazards in Food, and to Evaluate the Nutritional Composition of Local Dishes	J.J. Sasanya V.O. Owino
Singapore	SIN5001	Enhancing Food Safety	C.M. Blackburn J.J. Sasanya
Sri Lanka	SRL5048	Strengthening National Capability for Food and Feed Safety	A. Mihailova
Sri Lanka	SRL1011	Expanding the Capacities and Capabilities of the Sri Lanka Atomic Energy Board, including Irradiation and Related Services in the Sri Lanka Gamma Centre, to Achieve Self-Sustainability with Increased Customer Satisfaction	S.D. Kelly
Sudan	SUD5040	Strengthening the Evaluation of Quality, Monitoring and Control Programmes for Food Contaminants	J.J. Sasanya
Thailand	THA5058	Applying Nuclear Technology to Assure Food Quality and Safety	C.M. Blackburn J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Togo	TOG5007	Developing Laboratory Capacities for the Quality Control of Food and Pharmaceutical Products	A. Mihailova J.J. Sasanya H. Heinzen-Gonzalez
Tunisia	TUN5033	Strengthening Food Safety Capabilities	J.J. Sasanya H. Heinzen-Gonzalez
Uganda	UGA5042	Strengthening Capabilities of Two Central Food Safety Laboratories and Selected Regional Veterinary Centres of Public Health	J.J. Sasanya
Samoa	WSM5001	Building Core Laboratory Capacities to Control Chemical Contaminants and Residues in Food	J.J. Sasanya
Democratic Rep. of the Congo	ZAI5028	Controlling Food and Feed Contaminants in Fish Production	J.J. Sasanya
Zambia	ZAM5032	Strengthening and Expanding Analytical Capacity to Monitor Food Contaminants using Nuclear/Isotopic and Complementary Tools	J.J. Sasanya
Zambia	ZAM5034	Expanding the Scope of Food Safety Testing and Surveillance of Hazards in Foods and Related Matrices	J.J. Sasanya
Africa	RAF5084	Strengthening Food Contaminant Monitoring and Control Systems and Enhancing Competitiveness of Agricultural Exports using Nuclear and Isotopic Techniques (AFRA)	J.J. Sasanya
Africa	RAF5091	Enhancing Human and Analytical Capacities for Food Safety Standards (AFRA)	J.J. Sasanya
Africa	RAF5088	Building Capacity for Food Irradiation by Facilitating the Commercial Application of Irradiation Technologies — Phase II (AFRA)	C.M.Blackburn B. S. Han
Asia/ Pacific	RAS5087	Promoting Food Irradiation by Electron Beam and X ray Technology to Enhance Food Safety, Security and Trade (RCA)	C.M. Blackburn
Asia/ Pacific	RAS5096	Strengthening Multi-Stakeholder Food Safety Monitoring Programmes for Chemical Contaminants and Residues in Plant and Animal Products Using Nuclear/Isotopic Techniques	J.J. Sasanya
Asia/ Pacific	RAS5099	Developing Climate Smart Crop Production including Improvement and Enhancement of Crop Productivity, Soil and Irrigation Management, and Food Safety Using Nuclear Techniques (ARASIA)	J.J. Sasanya M. Zaman H. Heinzen-Gonzalez
Europe	RER5029	Improving Food Safety Through the Early Detection of Microbial Pathogens	J.J. Sasanya

Country/Region	Project No.	Title	Technical Officer
Latin America/ Caribbean	RLA5091	Strengthening the Monitoring Programmes of Pesticide Residues and Mycotoxins in Food Through the Establishment of a Proficiency Test Programme in Official Laboratories (ARCAL CXCV)	B.M. Maestroni
Latin America/ Caribbean	RLA5079	Applying Radio-Analytical and Complementary Techniques to Monitor Contaminants in Aquaculture (ARCAL CLXXI)	J.J. Sasanya
Latin America/ Caribbean	RLA5084	Developing Human Resources and Building Capacity of Member States in the Application of Nuclear Technology to Agriculture	J. J. Adu-Gyamfi I. Naletoski W.R.E. Hoeflich C. Zorilla J.J. Sasanya A. Mihailova
Latin America/ Caribbean	RLA7027	Applying Nuclear Technology in Agriculture, Water Resource Management and the Environment in Caribbean Member States (CARICOM)	K.I. Bimpong M. Metian W.R. Enkerlin C. Vlachou

Supporting Madagascar to Strengthen Food Safety Capabilities

James Sasanya

Training at LNDV on screening of chemical hazards in food, Jan 2024 (Photo courtesy of LNDV)

The Laboratoire National de Diagnostic Vétérinaire (LNDV) and Institut National des Sciences et Techniques Nucléaires (INSTN) are two institutions endeavoring to improve their capabilities to ensure that Madagascar consumes safe and quality food. Through an IAEA technical cooperation project MAG5028 "Developing Food Safety Laboratory Capabilities", relevant instrumentation and human resource development assistance have been provided. This was augmented in January this year through a visit by Mr Sasanya to provide on–site technical support. He delivered a talk to six INSTN and LNDV scientists on food safety support so far rendered to the country; past projects and a new regional project. He also reviewed INSTN's (food–related lab) quality infrastructure; assessed and identified gaps; and noted that the laboratory needed at least one biosafety cabinet and safety facilities to protect analysts etc. A microwave digestion system and water purification system were immediately identified as urgent needs for the INSTN in order to facilitate elemental analysis.

Mr Sasanya delivered two presentations to six INSTN and LNDV staff, on laboratory quality management system and sampling, and provided relevant material, including protocols. He also trained three LNDV staff on effective use of a radioreceptor assay instrument for screening various chemical hazards in foods, enhancing staff capabilities and boosting confidence. He also assessed the installation-site for a UHPLC instrument recently delivered. Awareness of the support these two institutions could provide to the national food safety standards was created through an interaction with the national Codex contact.

Sustainability of operational laboratories requires extensive management support and partnership. In this regard, Mr Sasanya and his counterparts met the Director General of the Livestock fund to discuss national plans to strengthen food safety and animal health testing capacity; and attaining of accreditation. A new laboratory is under construction thanks to the fund. This is complementary to the support provided by the IAEA.

With the support provided thus far, LNDV staff have now improved their capabilities and confidence in testing certain chemical hazards in food using radioreceptor assay techniques. A major challenge the INSTN faced for many years in the lack of an operational microwave digestion system has been resolved following Mr Sasanya's visit and intervention. A new system would otherwise cost the institution or IAEA ~ 20,000 Euros. The knowledge of several staff of the INSTN and LNDV in quality management and sample was enhanced following the training and information provided by the Officer. Nevertheless, gaps in INSTN's quality management system were identified and support could be provided, including procurement and setup of biosafety cabinet(s); appointing a quality manager or establishing a team and preparation of a quality manual. A laboratory information management system could also be considered for both institutions.

Reporting Activities of the Food Safety and Control Section at the Codex Committee on Pesticide Residues (CCPR55)

James Sasanya

Participants (some sponsored by an IAEA regional TC project RAS5096) at the 55th CCPR in China, June 2024 (Photo courtesy of CCPR Secretariat)

The Section reported its activities to the 55th Session of the CCPR since the last meeting in 2023. The event was held in Chengdu, Sichuan Province, People's Republic of China, from 3–8 June 2024. Mr Sasanya introduced the agenda item through a video presentation and recalled that member countries have been participating in a number of international research activities with the aim of supporting the establishment of maximum residues levels (MRLs) for certain compounds, including dual–use compounds relevant to CCPR and related committees. The research findings could also benefit interests and discussions on residues in offal. The meeting was informed about several capacity building projects needed to address a critical gap in food safety systems among member countries, and to establish or contribute to the setting of national, regional, and international (Codex) standards and guidelines. Mr Sasanya also reported that member countries in such projects have been receiving support to build capacities required to generate reliable scientific data that would be used for setting MRLs for a range of chemical hazards including pesticides. The beneficiaries included routine testing and research laboratories, as well as regulators that had a clear role to play in standards setting, risk assessment and risk management. Mr Sasanya thanked the CCPR and Codex family in general for supporting the recently concluded international symposium on food safety and control held in Vienna, Austria. Notable representation included the Chairperson of the Codex Alimentarius Commission, the Codex Secretariat, and several member countries. The committee was reminded about the call for countries to actively participate in the generation of reliable scientific data to facilitate Codex standard setting and risk management decisions. Mr Sasanya also discussed the Atoms4Food Initiative, drawing the meeting's attention to food safety and control service and the need for partnerships. The meeting commended the Joint FAO/IAEA Centre for its capacity building and other activities concerning the safety of pesticides, and chemicals in general, in food and feed, using nuclear and related techniques. The appreciation of this support by member countries was noted and further cooperation between Codex, Member countries and the Joint FAO/IAEA encouraged.

Applying Nuclear Technology towards Capacity Building in the Area of Food Safety and Control in Caribbean Member States

Christina Vlachou and Saskia Frater–Smith

Participants of the first virtual coordination meeting of the regional RLA7027 TCP (Photo courtesy of Mr M. Islam, IAEA).

The first coordination meeting for the regional IAEA project "Applying Nuclear Technology in Agriculture, Water Resource Management and the Environment in Caribbean Member States (CARICOM)" was held in a hybrid — in–person and virtual format — from 4 to 8 March 2024 at the IAEA Headquarters in Vienna.

Antigua and Barbuda, Bahamas, Barbados, Belize, Dominica, Grenada, Guyana, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago are the Member States participating in this regional project. They will contribute to awareness and capacity building in the region related to applications of nuclear technology in different areas, including food safety and control.

During the coordination meeting, the IAEA technical officers and representatives from the Member States provided presentations and the project workplan was reviewed and updated. According to the planned activities, equipment will be procured for food safety laboratories in the region and techniques for food authenticity testing and food traceability procedures will be introduced to food safety specialists, followed by training of personnel in the use of these new techniques.

Currently, there is an ongoing assessment of the existing resources and capabilities in the participating countries' laboratories to gather feedback regarding their needs in instrumentation and analytical methods for food safety and food authenticity assessments. The project is in line with the Regional Strategic Framework for Technical Cooperation with the IAEA–CARICOM Member States (2020–2026).

Participants of the first virtual coordination meeting of the regional RLA7027 TCP (Photo courtesy of Mr M. Islam, IAEA)

Strengthening the Monitoring Programmes of Pesticide Residues and Mycotoxins in Food Through the Establishment of a Proficiency Test Programme in Official Laboratories in Latin America and the Caribbean (ARCAL CXCV, RLA/5/091)

Britt Maestroni and Nicola Schloegl

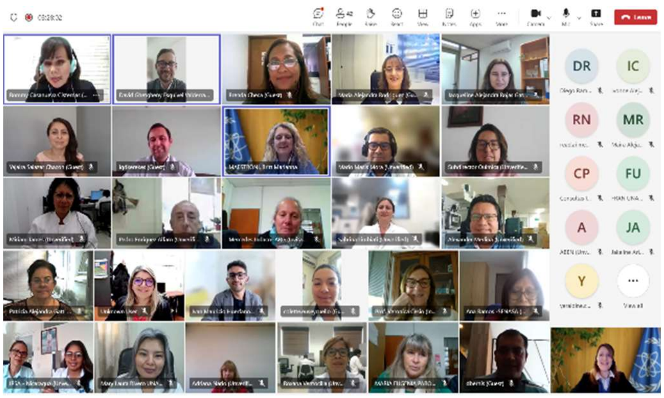


Figure 1: Participants of the first virtual coordination meeting of project ARCAL CXCV, RLA/5/091 (Photo courtesy of Ms B. Maestroni, IAEA)

The Regional Cooperation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL) provides a framework for Member State collaboration with the support of the IAEA and other international sources of cooperation. A new project on "Strengthening the Monitoring Programmes of Pesticide Residues and Mycotoxins in Food Through the Establishment of a Proficiency Test Programme in Official Laboratories in Latin America and the Caribbean" has been initiated starting in 2024. The participating countries so far include Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, Venezuela as participating countries (Figure 1).

The aim of the regional project is to strengthen the analytical capacities of the official food safety laboratories in the region, thus contributing to the improvement of surveillance and monitoring programmes, specifically about pesticide residues and mycotoxins in food of plant origin. The project will additionally contribute to the development of test items for the proficiency schemes which are necessary to ensure confidence of institutional testing capacities. More specifically, the project will assist participating countries in: (i) the development of selected test items tailored for the region; (ii) training in isotope dilution mass spectrometry techniques; (iii) the implementation of regional intercomparison tests; (iv) the strengthening of quality management systems; and (v) cooperation activities through a network of analytical laboratories under the Regional Network of Analytical Laboratories (RALACA) framework. The project builds on results of previous national and regional projects (RLA5081, RLA5080) that assisted countries in the region in strengthening their analytical capacities, as well as in the establishment of a regional data sharing network under the RALACA framework. The project will contribute to the generation of scientific regional and local data that are accurate and reliable for use by decision makers in the formulation of food safety policies and strategies, especially those associated with the implementation of international standards of food quality and safety. The first coordination meeting took place in April 2024 using the virtual modality and helped framing the project workplan. A regional meeting on inter-laboratory comparison programme for food safety laboratories is currently (June 2024) ongoing in Colombia with the aim to prepare a roadmap for the identification of current regional needs, and the establishment of a regional interlaboratory programme, that will contribute to enhanced technological independence of the Latin American and Caribbean region in terms of proficiency and interlaboratory tests.

Developments at the Food Safety and Control Laboratory (FSCL)

Investigation into the Regional Discrimination of Paw San Rice Cultivated in Two Different Geographical Locations of Myanmar Using Carbon and Oxygen Stable Isotope Analysis.

Aiman Abrahim, Susana Fiadey, Islam Hamed and Simon Kelly

Rice, as a staple food and a vital agricultural commodity, plays a pivotal role in sustaining global food security. Myanmar, renowned for its diverse agroecological regions, has emerged as an increasingly significant contributor to the global rice market. Among the myriad varieties cultivated, Paw San rice stands out, characterized by its distinct aroma, texture, and culinary versatility. Myanmar's agricultural landscape is marked by its geographical diversity, contributing to the unique qualities of various rice varieties. Paw San rice, celebrated for its exceptional fragrance and cooking properties, is cultivated in the Schwe Bo District and Ayeyarwaddy Division or region, each imparting their own bio–geoclimatic nuances, or terroir, to the crop. Schwe Bo, situated in the northern part of Myanmar, experiences a different climatic and soil profile compared to the Ayeyarwaddy region in the southwest. These distinct agroecological conditions can influence the chemical and isotopic composition and quality of Paw San rice, making it important to explore and understand potential bio-geoclimatic variations. While both regions contribute significantly to the production of Paw San rice, anecdotal evidence suggests subtle yet discernible differences in the rice's sensory attributes, such as aroma, taste, and grain texture. Understanding these quality differences is crucial not only for consumers seeking a specific culinary experience but also for stakeholders involved in the rice trade and distribution networks. The economic implications of Paw San rice production extend beyond quality considerations. The market value of Paw San rice is influenced not only by its inherent qualities but also by its perceived geographic origin influence. Accordingly, the distinction between rice cultivated in Schwe Bo District and Ayeyarwaddy Division carries economic significance, as consumers often associate specific characteristics with each location. This association has created economic motivations for fraudulent mislabeling, where Paw San rice from the Ayeyarwaddy region may be misrepresented as originating from Schwe Bo District to command a higher market price. Consequently, the objective of this FSCL study was to develop a total carbon and total oxygen stable isotope measurement method to investigate its efficacy to verify the claimed origin of premium Paw San rice, cultivated in these two distinct geographical locations in Myanmar. This work was undertaken to support Myanmar's Technological University's participation in Coordinated Research Project "Implementation of Nuclear Techniques for Authentication of Foods with High–Value Labelling Claims" (CRP D52042). There are currently over 20 publications dating back to the early 2000's using stable isotope and/or trace element (SITE) analysis combined with chemometrics to confirm the origin of rice on a regional and international scale. SITE analyses permit the integration of various environmental factors, such as climate, water sources, and soil composition. These factors collectively contribute to the overall 'fingerprint' of the geographical origin. SITE and chemometrics can offer a robust and hypothesis-driven methodology for confirming the geographical origin of rice. This integrated approach leverages the complementary strengths of each technique, providing a more comprehensive and reliable assessment of the geographical provenance of agricultural products and has the potential to be fused with other orthogonal techniques such as vibrational spectroscopy.

A total of 87 Paw San rice samples were collected in 2020 and used in this feasibility study: Seventy from the Ayeyarwady Division (Pyapon, Bogalay, Dedaye, Kyaiklat, Pathein, Myaungmya), and 16 from the Shwe Bo District. The Rice samples were milled to a fine powder in a multifunctional high-speed grinder and a 0.5 mg of the rice powder was weighed into a silver capsule before being thermochemically degraded (pyrolyzed) to hydrogen (H_2) nitrogen (N^2) and carbon monoxide (CO) gasses at 1300 °C in a molybdenum foil lined ceramic reactor mounted in a high temperature elemental analyser (TC/EA) that was connected to an isotope ratio mass spectrometer (IRMS). The gases were swept by a flow of helium carrier gas through a bed of glassy carbon granules. The pyrolysis gases then passed through a packed GC column filled with molecular sieve 5Å heated to 40 °C, which separated H_2, N_2 and CO gases. A small portion of the effluent flowed from an interface into the ion source of the IRMS. The m/z 30 (12C18O), m/z 29 (13C16O) and m/z 28 (12C16O) ion beams of carbon monoxide isotopologues entering the source were simultaneously integrated over time to measure carbon and oxygen stable isotope ratios, 13C/12C and 18O/16O, respectively. Certified reference materials (CRMs) USGS90 millet flour from Tuscany, Italy, and USGS91 rice flour from tropical Vietnam were selected as matrix–matched cereals with similar carbohydrate/protein compositions to the rice samples with assigned oxygen isotope delta–values (δ18O) vs Vienna Standard Mean Ocean Water (V–SMOW) and assigned carbon isotope delta-values (δ13C) vs Vienna Pee Dee Belemnite (V–PDB). This permitted a two-point oxygen–18 and carbon–13 delta-scale calibration of the rice samples. Spruce wood powder was selected as suitable carbohydrate quality control material with assigned δ13C and δ18O values to assess the accuracy of measurements.

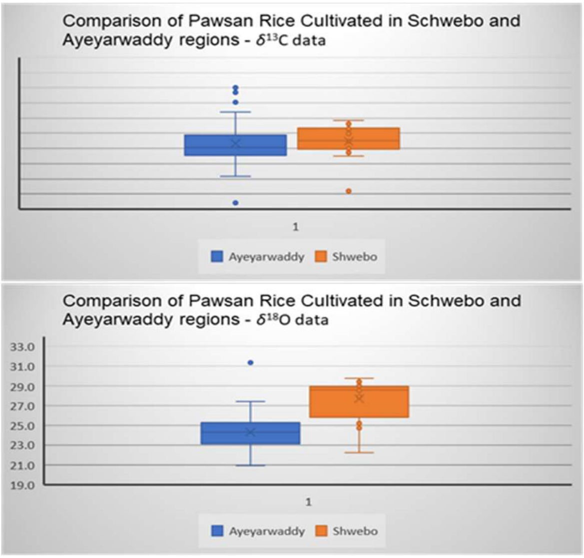


Figure 1: Box and whisker diagrams calculated from the individual δ13C and δ18O stable isotope measurements of ground Paw San rice cultivated in 2020 in Shwe Bo District (n = 16) and Ayeyarwaddy Division (n = 70) of Myanmar

Figure 1 above shows the box and whisker diagrams calculated from the individual δ13C and δ18O stable isotope measurements of the Paw San rice samples cultivated in Schwe Bo District (orange) and Ayeyarwaddy Division (blue) during 2020. The box in the middle of the diagram represents the middle 50% of the data. The top and bottom of the box mark the upper and lower quartiles, respectively. In other words, the box contains the central 50% of the data. The "whiskers" extend from the box and show the range of the data. They reach out to the smallest and largest values within a certain range, often 1.5 times the interquartile range (the range covered by the box). Any data points beyond the whiskers are considered outliers. The line inside the box represents the median, which is the middle value when the data is ordered. It divides the data into two equal halves. The box represents where the majority of the data points lie. If the box is shifted to one side, it suggests skewness in the data, which is more apparent in the Schwe Bo Paw San rice δ18O data, with a skew to lower δ18O values. The length of the whiskers indicates the spread or variability of the δ18O data and show the overlap in some of the δ18O data, which reflects the variability in the oxygen isotopes in the input water. All of the δ13C data overlaps and this is unsurprising as the dominant fractionation of carbon isotopes is dictated by the Calvin (C3) cycle used by all rice plants to fix carbon dioxide during photosynthesis and is affected to a much smaller extent by environmental factors, such as temperature, humidity, altitude, etc. and the corresponding effect on stomatal opening and CO_2 conductance limiting or enhancing fractionation. Outliers beyond the whiskers are individual data points that are significantly different from the rest of the data, and these are generally limited.

In order to statistically assess the differences in the measured δ13C and δ18O values of the Paw San rice samples cultivated in Schwe Bo and Ayeyarwaddy regions A two-sided t–test was conducted. This is a statistical method used to determine if there's a significant difference between the means of the two groups. A two–sided t–test with unequal variances was performed to establish if there was a meaningful difference between the two groups, considering that the variability in one group might not be the same as in the other. From the t–Test of the oxygen isotope data, the critical value was found to be 2.09. Since the calculated absolute value of t was 5.81 and found to be greater than the critical value the null hypothesis was rejected, and it was concluded that there was a statistically significant difference between the average δ18O values of rice grown in the Schwe Bo District and Ayeyarwaddy region. The possibility of this result occurring by chance was insignificant. It is likely that this difference is derived from geo-spatial differences in δ18O values of the source of irrigation water used in the two locations, which is incorporated into the rice during photosynthesis and metabolism of the plant components including the rice seeds. From the carbon isotope data, the critical value from the t–Test was calculated as 1.97. Since the observed absolute value of t was 0.55 and smaller than the critical value the null hypothesis was accepted, and it was concluded that there was not a statistically significant difference between the average δ13C values of rice cultivated in the Schwe Bo District and Ayeyarwaddy regions. This result was expected, as the overriding carbon isotope fractionation in rice plants is biochemical (C3 photosynthesis) and not geo-climatic factors related to the place of cultivation.

In order to visualize the data in two dimensions whilst making some meaningful statistical assessment of the separation of the two production zones δ13C and δ18O values were plotted on an X-Y scatter plot and bivariate prediction ellipses calculated. Bivariate prediction ellipses are a graphical representation of the uncertainty associated with predicting a new data point in a bivariate dataset. It is constructed based on the existing data distribution and is typically calculated at a specific confidence level. The δ13C data is not completely normal in distribution and so the ellipse calculation must be interpreted with some care.

To calculate a bivariate prediction ellipse, the mean and covariance matrix of the data is computed. This equation is often expressed in terms of the standard deviation and correlation between the two variables. The resulting prediction ellipses, shown in Figure 2 above, represents an area in the bivariate space within which a new data point is likely to fall with a certain level of confidence. In this case, the ellipse was calculated at the 95% confidence interval, meaning that there is a 95% probability that a new data point will fall within the ellipse. When considering if new data belongs to the same population, it is straightforward to compare the location of the new data point with the prediction ellipse. If the new data point falls within the ellipse, it suggests that the new data is consistent with the existing data distribution, providing evidence that it belongs to the same rice population. On the other hand, if the new data point falls outside the ellipse, it suggests that the new data may represent a different population or that there might be an error in the prediction. Similarly, in this case it can be clearly seen that there is significant overlap in the δ13C and δ18O values. Overall, it is clear that there is some value in measuring the oxygen isotope composition of the Paw San rice to discriminate its origin of production within Myanmar as expected, but a larger number of samples is required to understand the extent of variances and inter-annual stability of samples. However, within the scope of the CRP D52042 and the commitment to develop a usable stable isotope method and demonstrate the feasibility of the approach through a limited database, this requirement has been accomplished. Furthermore, fusion of the δ18O data with stable isotope data such as δ15N, reflecting agricultural practice/nitrogen fertilization, as a confirmatory technique, and orthogonal screening data such as that provided by FT-NIR may prove to be valuable.

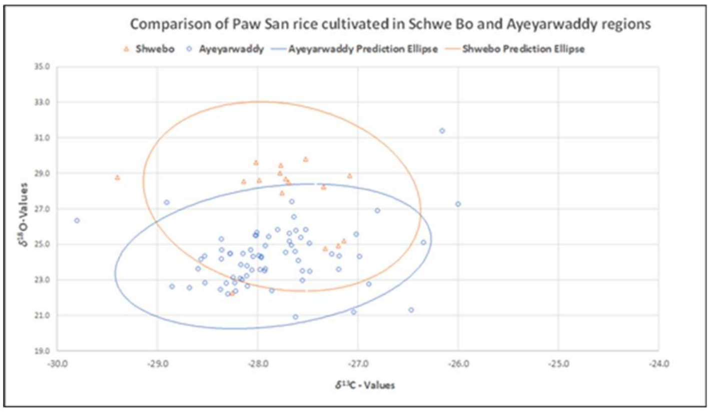


Figure 2: Prediction ellipses for the discrimination of ground Paw San rice cultivated in 2020 in Shwe Bo (n = 16) and Ayeyarwaddy (n = 70) regions of Myanmar based on δ13C (X-axis) and δ18O (Y-axis) stable isotope measurements

New handheld Near-infrared Spectrometer for Rapid Food Safety and Authenticity Screening at FSCL

Alina Mihailova

Near–infrared (NIR) spectroscopy is a non-destructive analytical technique which measures the absorption of light from a sample in the near–infrared region of the electromagnetic spectrum from 4000 to 12500 cm^{-1} (2500 nm to 800 nm). The recorded NIR spectrum consists of overtones and combinations of fundamental vibrations of molecules that contain C–H, O–H, and N–H bonds, which provide information about the molecular structure of the sample. This makes NIR spectroscopy suitable for the identification of raw materials, composition analysis, conformity testing and process monitoring.

NIR spectroscopy offers both targeted and non-targeted screening capability as well as low operational costs. This analytical technique allows rapid analysis and high sample throughput, requires little or no sample preparation and does not involve the use of chemicals or specialized laboratory facilities. NIR spectroscopy has been used for a wide range of applications in the areas of chemistry, petrochemistry, pharma, food and feed, agriculture, materials science and medicine. In the field of food safety and control, NIR spectroscopy has been applied for the verification of safety and authenticity and the determination of geographical, botanical and production origins of various commodities, e.g., edible oils, spices, honey, milk, meat, fish, wine etc. When combined with chemometrics and machine learning, this analytical approach allows fingerprinting of authentic samples and rapid monitoring of subtle compositional changes that would highlight atypical (fraudulent) samples. Some examples of the food safety and authenticity applications using benchtop NIR spectroscopy, include the species authenticity and adulteration in seafood and meat products, the detection of melamine adulteration in milk and milk powder, detection of adulteration of black pepper, oregano and turmeric with cheaper bulk materials, detection of pulp wash in orange juice, differentiation of wines according to geographical origin and grape variety.

Over the past decade, there has been an increasing interest in the development of miniaturized portable NIR spectrometers which can be used for on-site measurements outside the laboratory. The main advantages of handheld spectrometers include small size, portability, low cost and ease of use. This allows bringing the spectrometer to the sample, as opposed to bringing the sample to the spectrometer, and thus can significantly enhance the efficiency of the testing process. The development of robust analytical approaches using such portable devices can facilitate the detection and tackling of food safety and authenticity issues at different stages of the food supply chain.

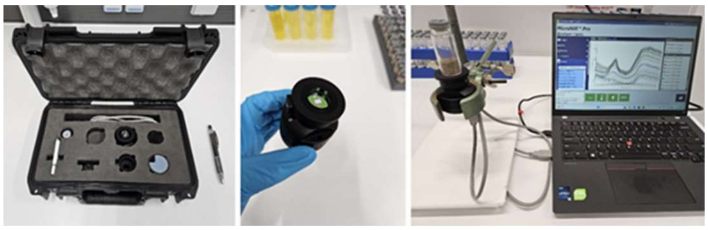


FIG. 1. Portable NIR spectrometer microNIR 1700ES at FSCL (Photo courtesy of Ms A. Mihailova, IAEA)

To complement existing benchtop IR spectrometers that are being used for rapid screening at the FSCL, a portable NIR spectrometer, microNIR ES 1700ES from VIAVI Solutions (USA), was obtained in March 2024 (Figure 1). FSCL staff received training on the use of the microNIR 1700ES and microNIR Pro software (Figure 2).

FIG. 2. Mr Jonas Altnöder (Analyticon Instruments GmbH) delivering the training on the use of the portable NIR spectrometer microNIR 1700ES at FSCL (Photo courtesy of Ms A. Mihailova, IAEA).

MicroNIR 1700ES is a portable and lightweight NIR spectrometer that combines high-precision optical coating technology with innovation in optical system design and miniaturization. The microNIR 1700ES spectrometer has a light source, collection optics, electronics, and linear variable filter (LVF) in a miniature housing which has the size of 45 × 50 mm and weighs only 64 g. The spectrometer is USB powered and can be used in diffuse reflection, transmission, or transfection modes. The VIAVI microNIR Pro software suite includes features for data acquisition, calibration, method development, chemometric modelling and real-time prediction. The users can process data and build chemometric models using regression and classification algorithms including PCA, PLS, Spectral Match Value and Moving Block analyses.

NIR spectroscopy analysis using microNIR 1700ES can be used for rapid cost–effective tier one food safety and authenticity screening before committing to more sophisticated tier 2 techniques (e.g., stable isotope analysis, high resolution mass spectrometry) that may require more time, for confirmatory or orthogonal analysis. The use of portable NIR spectrometer will complement other analytical approaches that are being developed and used at FSCL under CRP D52042 “Implementation of Nuclear Techniques for Authentication of Foods with High–Value Labelling Claims” and transferred to the Member State laboratories.

FSCL is currently in the process of using the microNIR 1700ES to develop methods for the geographical discrimination of rice and the verification of authenticity of black pepper. Future applications will include verification of authenticity and determination of geographical and production origin of other spices, fish, meat, wine and other high added–value commodities. Some of this research work will be presented in the future editions of the FSC newsletter. Visiting scientists, fellows and interns will have the opportunity to be trained in the operation of the microNIR 1700ES thereby supporting Member State efforts to improve their food safety and authenticity control systems and raising awareness of this highly accessible and novel rapid screening technology.

Verification of Black Pepper Authenticity Using Near-infrared Spectroscopy and Chemometrics

Alina Mihailova, Marivil Islam, Simon Kelly, Horacio Heinzen

Black pepper (*Piper nigrum L.*) is economically the most important and the most widely used spice crop worldwide. Having a high added value and being a part of a complex and vulnerable supply chain, black pepper has become a frequent target for economically motivated adulteration. The addition of cheaper bulk materials, which resemble black pepper, provides an easy route to commit fraud. Papaya seeds are commonly used as adulterants in black pepper due to their structural resemblance, low cost and availability. Other common adulterants include chilli, millet, buckwheat, wheat and corn flour, beans, Juniper berry, starch, mineral oil and ash. In addition, the stem and chaff of black pepper as well as berries from different pepper species (e.g., *Piper attenuatum, Piper longum, Piper galeatum*) can often be mixed with whole peppercorns and sold as authentic black pepper for financial gain. For consumer confidence and to protect the supply chain, it is therefore highly important to develop robust analytical methods that can provide an objective verification of the authenticity of black pepper.

Infrared spectroscopy is a rapid, non-destructive technique that offers high sample throughput and low operation costs, requires little or no sample preparation and does not involve the use of chemicals or specialized laboratory facilities. Several studies have applied mid–infrared (MIR) and NIR spectroscopy for the authenticity testing of black pepper. Coupled with chemometric modelling, this analytical approach allows obtaining a fingerprint of authentic samples and rapid monitoring of subtle compositional changes that would highlight atypical (fraudulent) samples. In addition, the fast development and growing popularity of portable handheld NIR spectrometers enables rapid authenticity screening of samples outside the laboratory which can be applied at different stages of the supply chain.

In an ongoing study t at the FSCL conducted jointly with the IAEA Collaborating Centre “Aerial” (France), high- and low–field nuclear magnetic resonance (NMR) spectroscopy as well as MIR and NIR spectroscopy are applied, compared and assessed for their suitability to discriminate ground black pepper (*P. nigrum*) and various adulterants of plant origin as well as to detect and predict the adulteration of black pepper in a simulated adulteration experiment. In addition, a comparison of the performance of benchtop NIR and two portable NIR instruments is ongoing. Principal component analysis (PCA), orthogonal partial least squares discriminant analysis (OPLS–DA), orthogonal partial least squares regression (OPLSR) and data-driven soft independent modelling of class analogy (DD-SIMCA) are used for chemometric modelling. This article will focus on the preliminary NIR spectroscopy results.

The PCA of the FT–NIR data, revealed a tendency of *P. nigrum* samples to group in accordance with their type, i.e., black, white and red pepper. OPLS-DA was used to discriminate different types of *P. nigrum* samples (black, white and red) as well as their geographical regions (Africa, Asia and South America). The scores plot of the 7-fold cross-validated OPLS–DA model for the discrimination of three types of *P. nigrum* is shown in Figure 1. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values of the OPLS–DA model were 0.975, 0.853 and 0.798, respectively.

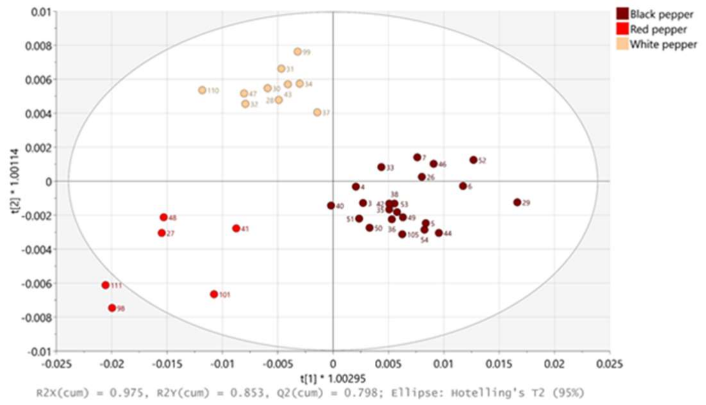


FIG. 1. The scores plot of the OPLS-DA model for the discrimination of black, white and red P. nigrum samples using benchtop FT-NIR spectroscopy.

Similarly, to the benchtop FT–NIR, it was possible to differentiate black, white and red P. nigrum using two portable NIR spectrometers. The comparison of the performance indicators of the OPLS–DA models for the differentiation of three types of P. nigrum using benchtop FT–NIR and two portable NIR spectrometers is shown in Table 1.

The OPLS-DA model, built using FT–NIR data, allowed discriminating *P. nigrum*, non–*P. nigrum* and adulterant samples. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values of the OPLS–DA model for the discrimination of the three classes were 0.987, 0.780 and 0.474, respectively. Further, OPLS–DA was used to discriminate each of the two classes as follows: i) *P. nigrum* and the adulterants, ii) non–*P. nigrum* and the adulterants, iii) *P. nigrum* and non–*P. nigrum*. The scores plot of the 7-fold cross-validated OPLS–DA model for the discrimination of *P. nigrum* and the adulterants is shown in Figure 2A. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values of the OPLS-DA model were 0.976, 0.897 and 0.775, respectively.

For the validation of the above-mentioned OPLS–DA model, the full dataset comprising *P. nigrum* and the adulterant samples (n=67) was split in a randomised manner into a training set (n=44), which was used for the generation of the model, and the test set (n=23) which was used for model validation. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values of the OPLS–DA model, built using the training set, were 0.978, 0.905 and 0.727, respectively. The model was able to correctly classify all samples from the test set (Table 2).

TABLE 1. PERFORMANCE INDICATORS OF OPLS-DA MODEL FOR THE DISCRIMINATION OF BLACK, WHITE AND RED PIPER NIGRUM.

Analytical technique	**Spectral range, cm^{-1}**	**OPLS-DA model (n = 38)**		
		R2X (cum)	**R2Y (cum)**	**Q2 (cum)**
Benchtop FT–NIR	11550 – 3950	0.975	0.853	0.798
Portable NIR 1	10526 – 6060	0.993	0.828	0.763
Portable NIR 2	13514 – 9346	1.000	0.744	0.658

TABLE 2. PERFORMANCE INDICATORS OF OPLS-DA MODEL FOR THE DISCRIMINATION OF *PIPER NIGRUM* AND THE ADULTERANTS.

Analytical technique	**OPLS-DA model (training set, n = 44)**			**Correct classification rate of the test set, %**		
	R2X (cum)	**R2Y (cum)**	**Q2 (cum)**	***Piper nigrum* (n =14)**	**Adulterants (n = 9)**	**Total (n = 23)**
FT-NIR	0.978	0.905	0.727	100	100	**100**

Non-*P.nigrum* and adulterant samples were also successfully discriminated. The scores plot of the 7–fold cross–validated OPLS–DA models for the discrimination of non–*P. nigrum* and the adulterant class is shown in Figure 2B. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values of the OPLS–DA model were 0.975, 0.896 and 0.638, respectively. In addition, OPLS–DA was able to successfully discriminate *P. nigrum* and non-P. nigrum samples (Figure 2C). The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) values of the OPLS-DA model for the discrimination of *P. nigrum* and non–*P. nigrum* were 0.983, 0.941 and 0.827, respectively.

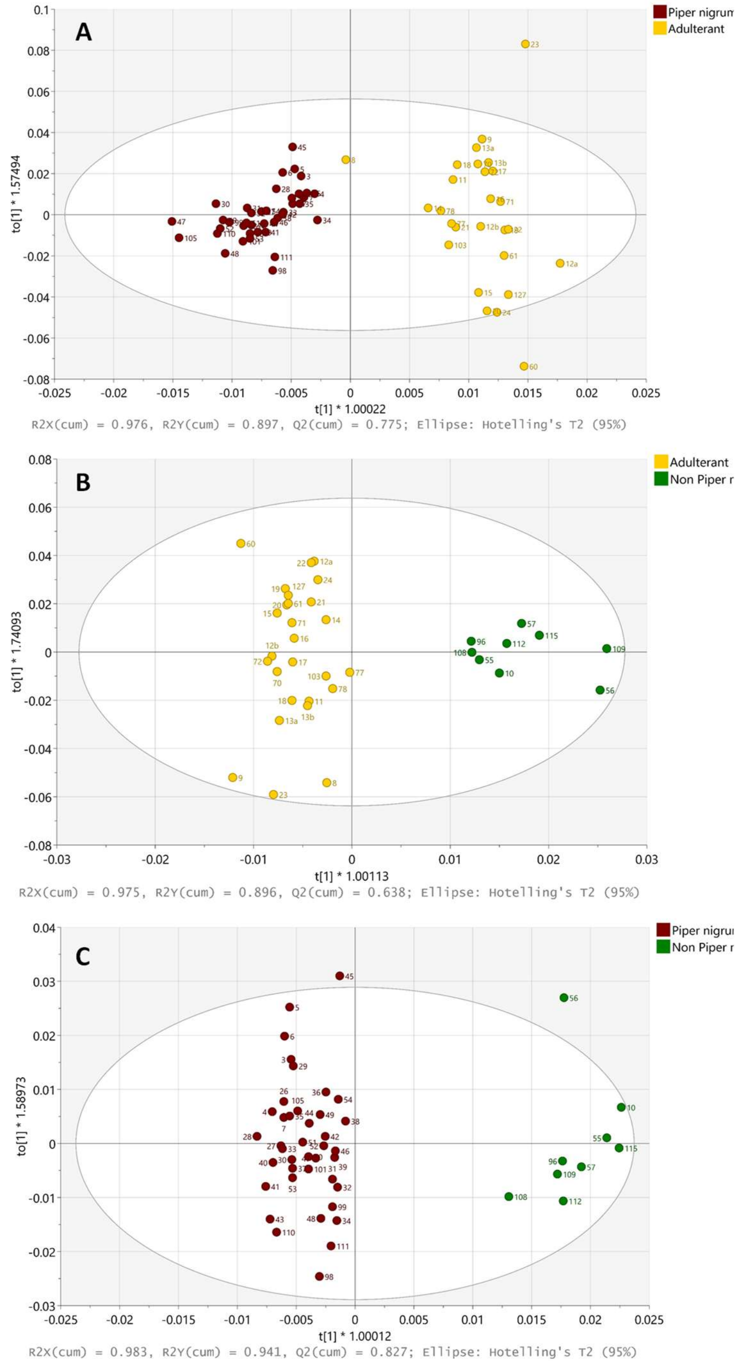


FIG. 2. The scores plots of OPLS-DA models for the discrimination of P. nigrum and adulterants (A), non-P. nigrum and adulterants (B) and P. nigrum and non-P. nigrum (C) using benchtop FT–NIR spectroscopy.

To assess, how well NIR spectroscopy could predict the adulteration of *P. nigrum* with different types of adulterants, a simulated adulteration experiment was conducted. *P. nigrum* was adulterated with six different adulterants (black pepper distilling grains (dreche), black pepper pinheads, papaya seeds, sesame, millet, black mustard, corn flour). The following spiking levels were used for the initial experiment: 0%, 5%, 25%, 50%, 75%, 95% and 100% (w/w). OPLSR models were used to predict the adulteration levels of *P. nigrum* with each of the selected adulterants. The models were built using the training dataset (n = 42) and validated using a test set (n = 28).

An example of the OPLSR model for the prediction of *P. nigrum* adulteration with sesame is shown in Figure 3. The goodness of fit (R2X(cum), R2Y(cum)) and the predictive ability (Q2(cum)) of the OPLSR model for the detection of adulteration of *P. nigrum* with sesame were 0.999, 0.998, and 0.997, respectively. The coefficient of determination (R^2), root mean square error of estimation (RMSEE) and root mean square error of cross validation (RMSECV) of the OPLSR model for the training dataset were 0.998, 1.949 and 2.162, respectively (Figure 3A). The R^2 and root mean square error of prediction (RMSEP) for the test dataset were 0.998 and 2.745, respectively (Figure 3B).

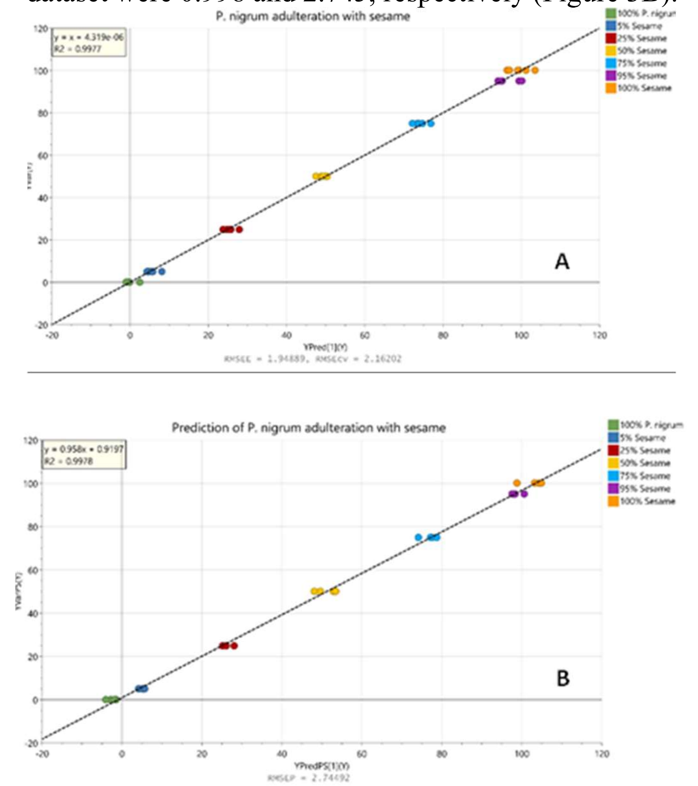


FIG. 3. OPLSR models of the P. nigrum adulteration with sesame: A - training dataset (n = 42), B - test dataset (n = 28).

In addition to discriminant analysis, a one–class model for the verification of authenticity of black pepper was generated using DD–SIMCA add–on in MS Excel using. The DD–SIMCA model, which was generated using FT–NIR data, achieved 95% sensitivity and 99% specificity. The acceptance plots of the DD-SIMCA model are shown in Figure 4. The only sample, which was misclassified as the authentic *P. nigrum,* was *P. nigrum* adulterated with black pepper dreche at 5%.

These are the first results from this collaborative study and the analysis of a larger number of samples is currently underway. The preliminary results show a great potential of NIR spectroscopy for the discrimination of black pepper and various adulterants of plant origin as well as predicting the adulteration rate of black pepper over 5%. Further findings will be reported in the future issues of the FSC Newsletter.

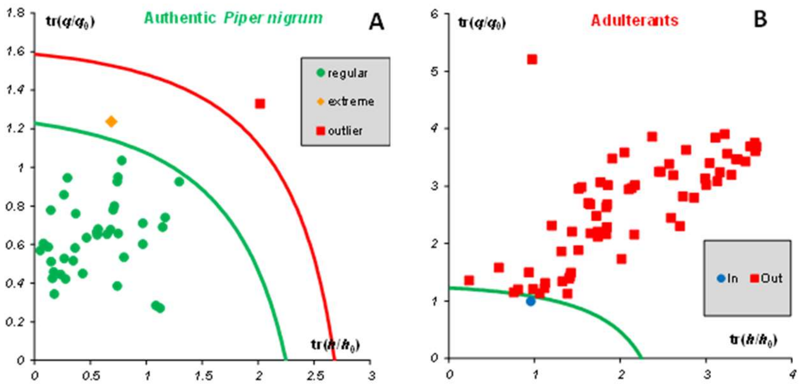


FIG. 4. The acceptance plots of the DD-SIMCA model for the authentic black pepper population (A) and adulterants (B). The green line indicates the acceptance boundary (95% confidence) of authentic black pepper. Blue circles are the adulterant samples misclassified as black pepper. The red squares are the adulterant samples correctly classified as outliers.

A comprehensive Approach for Evaluating the Impact of Climate Change on Food Safety in Dryland Crops

Supporting Member States to Address and Mitigate the Impact of Climate Change on Food Safety and Food Security

Christina Vlachou, Britt Maestroni

Climate change is one of the most complex global issues of concern. Worldwide alterations in temperature, drought and CO_2 patterns are expected to have significant effects on food safety and food security, threatening food supply through exacerbating foodborne diseases caused by micro–organisms, compromising food safety due to increased food contamination with mycotoxins and heavy metals and creating environments conducive to further emerging hazards in the food chain. Climate change has profound impacts on dryland crops, not only adversely impacting the crop yields posing threat to food security, but also diminishing the nutritional quality of food and presenting increased contamination risks.

IAEA promotes R&D in this area of work through nuclear science and applications to devise and deploy strategies that make dryland staples resilient to deal with the anticipated effects. This is in conjunction with work on nuclear and complementary methods to detect, monitor, and control contaminants, safeguarding public health and ensuring compliance with food and feed safety standards for market access. Millet, cassava and groundnuts represent cereal, root and legume crops that are crucial for food security. The impact of climate change on these crops has not been adequately investigated. To support Member States to better address and mitigate the impact of changing climate conditions, three laboratories of the Joint FAO/IAEA Centre of Nuclear Techniques on Food and Agriculture, the FSCL, the Plant Breeding and Genetics Laboratory (PBGL) and the Soil and Water Management and Crops Nutrition Laboratory (SWMCNL) conduct research jointly under the project "*Ensuring food security and safety by future-proofing dryland crops under climate change*". The project is funded by the Government of the United Kingdom of Great Britain and Northern Ireland, via the Department for Energy Security and Net Zero.

FSCL is currently developing and validating analytical methods for multi-analyte mycotoxins (aflatoxins and fumonisins) determination in millet, cassava and groundnut. The tools used include liquid chromatography – tandem mass spectrometry and rapid screening sensors. Additionally elemental profiling of essential and toxic elements in these crops is conducted with the energy dispersive X ray fluorescence technique in collaboration with Queens University Belfast (IAEA Collaborating Centre) as a R&D partner.

Future activities under this joint project include a workshop to identify research gaps and needs, building networks with global partners, and preparing a pilot project for long–term R&D in the security and safety of dryland crops under challenging climate conditions for targeted Least Developed Countries.

The expected outcome is improved understanding of the potential to use new nuclear techniques to support Member States in addressing the impacts of climate change on food safety and food security.

Preparation of cassava root samples for analysis of mycotoxins with LC–MS/MS at FSCL (photo courtesy of Ms B. Maestroni, IAEA)

Sample Processing for Laboratory Samples from Dry Land Crops

Sofia Bussalino, Maria Veronica Cesio, Carlotta Cozzani, Chang Xu, Yuzhu Han and Britt Maestroni

The very first step in any analytical determination is the comminution of the laboratory sample. The homogenization, grinding, and comminution of the sample need to be implemented for homogeneous distribution of the analyte (s) under investigation. The FSCL validated the homogenization process for cassava, millet, and groundnut samples.

Fresh cassava roots

The cassava roots were peeled with stainless steel knives. The edible part of the fresh cassava roots was then diced into small cubes and grinded in a Retsch GM200 sample homogenizer, applying a first homogenization at maximum speed, while covering the sample with a space reducer device (Figure 1).

The homogenized fresh cassava was weighed, then placed in a freeze dryer for 48 hours. Finally, the dried cassava was milled into a smooth powder in the sample homogenizer and weighed again, applying a 30–second homogenization at maximum speed (Figure 2).

Figure 1: Processing of the fresh cassava roots (Photo courtesy of Ms B. Maestroni, IAEA)

Figure 2: Second processing of the freeze-dried cassava roots in a sample homogenizer (Photo courtesy of Ms B. Maestroni)

Millets

Dry millets were grinded in a sample homogenizer, applying a thirty second homogenization twice while covering the sample with a space reducer device. The sample was transferred into a coffee grinder and grinded for an additional amount of time (Figure 3).

Figure 3: Processing of the dry millet samples (Photo courtesy of Ms B. Maestroni, IAEA)

Groundnuts

Samples of groundnuts were homogenized 'in shell'. Both the edible part and the inedible shell were grinded in a sample homogenizer applying two times a 10–second homogenization twice while covering the sample with a space reducer device (Figure 4).

Figure 4: Processing of the dry groundnut samples (Photo courtesy of Ms B. Maestroni, IAEA)

The weight of the kernel (edible part) in the sample was estimated after establishing a suitable factor for the proportion of shell to kernel in whole groundnuts. This proportion is used to ascertain the amount of kernel in the sample taken through the sample preparation and method of analysis.

The proportion of shell/kernel was estimated by considering approximately 100 whole groundnuts, taken randomly from the laboratory sample, weighing the whole nuts, and then the shell and the kernel parts separately (Figure 5).

Figure 5: Establishment of a suitable factor for the proportion of shell to kernel in whole groundnut samples (Photo courtesy of Ms B. Maestroni, IAEA)

Rapid Screening of Aflatoxins Using Surface Enhanced Raman Scattering

Chang Xu, Yuzhu Han and Britt Maestroni

Climate change has a huge impact on mycotoxin occurrence, not only in southern Europe, Africa, and Southeast Asia but increasingly in other regions such as Central Europe and other northern countries. A recent study from the University of Exeter in the United Kingdom showed that crop pests and fungi, which are responsible for mycotoxin–formation, have been migrating northwards at a rate of several kilometers per year since the 1960s. According to the Food and Agriculture Organization of the United Nations (FAO), an estimated 25% of grain worldwide is contaminated with mycotoxins. However, this figure may greatly underestimate the number of mycotoxin contamination occurrences found above detectable levels, and, therefore, immediate action is required. This includes, among other interventions, testing more samples and implementing preventative measures to help avoid or reduce the formation of mycotoxins. The problem of mycotoxin contamination has reached a global scale and a global solution is also required more so in the face of climate change. The FSCL started a new line of work using a portable instrument for performing Surface Enhanced Raman Scattering (SERS) measurements, which permits detection and identification of analytes at low concentrations. The Raman effect derives from light interacting with chemical bonds of a molecule. Due to vibrations of the chemical bonds, the interaction with photons causes specific energy shifts in the scattered light appearing in a Raman spectrum. This specific study aims at validating a rapid screening method to detect aflatoxins (AFs), at parts per million level, in food commodities such as grains, root tubers and legumes.

The initial work involved the optimization of the measurement parameters. Test samples/standards were prepared by pipetting 0.05 mL of AFs at a concentration of 20, 15, 10 and 5 mg/L into measurement vials containing 0.4 mL of colloidal nanoparticles and 0.05 mL of 0.5 M NaCl solution. After thorough mixing, samples were inserted into the specific vial holder for the acquisition of the SERS spectra of the samples.

Several parameters including: laser power, auto integration, integration time, averaging and the raster were tested. An example of the optimization is presented in Figure 1. Results show that gold colloid provides a higher signal compared to the silver colloid along the entire spectra and was therefore considered more suitable for the testing of AFs in food samples.

This work is ongoing and simulated testing of AFs will be conducted by spiking food extracts with a range of AFs concentrations and comparing the region of interest in relation to the blank matrices. Chemometric approaches will be applied to interpret the data.

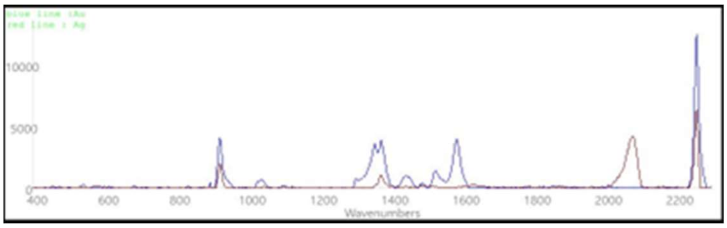


Figure 1: Comparison of the Silver (red line) and Gold (blue line) nanoparticles for the acquisition of AFs spectra at a concentration of 2 mg/L.

Confirmatory Approach for the Analysis of Aflatoxins in Dry Land Crops

Britt Maestroni, Carlotta Cozzani, Sofia Bussalino, Maria Veronica Cesio

The aflatoxins are a group of mycotoxins produced by two species of the fungus Aspergillus. Aflatoxins can occur in foods such as cereals, root tubers and legumes, because of fungal contamination before and after harvest. Several types of aflatoxins are produced naturally. Aflatoxin B1 (AFB1) is the most common in food and among the most potent genotoxic and carcinogenic aflatoxins with AFB1 reported as a cause of hepatocellular carcinomas (HCCs) in humans. To help control these hazards, maximum limits of aflatoxins are laid down in the Codex Alimentarius general standard for contaminants and toxins in food and feed (CXS 193–1995, rev. 2023) and individual countries. The chemical structure of some aflatoxins is shown in Figure 1. They are slightly soluble in water (10–20 µg/mL) and freely soluble in moderately polar organic solvents.

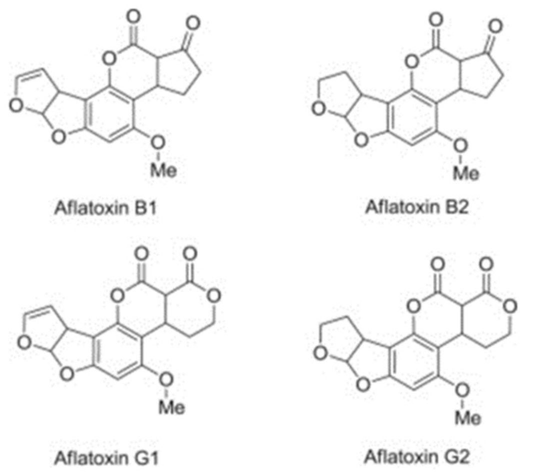


Figure 1: Chemical structure of aflatoxins B1 (AFB1), B2 (AFB2), G1 (AFG1) and G2 (AFG2)

The analysis of AFs in representative root crops and cereals in FSCL was implemented by liquid chromatography coupled to tandem mass spectrometry (LC–MS/MS) using a dilute and shoot approach. Samples were extracted using a solvent mixture consisting of acetonitrile, water and acetic acid. The extracts were diluted with water and acetonitrile to achieve a final injection solution. Within-laboratory method validation was carried to ensure that the method is suitable for the analysis of AFB1, AFB2, AFG1 and AFG2 in millet and cassava samples. The method performance parameters investigated include its scope, specificity, accuracy, sensitivity, repeatability and within laboratory reproducibility according to the Codex standard CXS 193–1995, rev. 2023. Millet and cassava samples were used on three different days to establish within laboratory reproducibility and repeatability values. In each study 6 replicate analytical portions were spiked at each concentration level (4 levels). Figure 2 shows the average recovery data obtained for AFs in millet and cassava at 4 different spiking concentrations, namely 0.4, 2, 4 and 10 µg/kg for each aflatoxin.

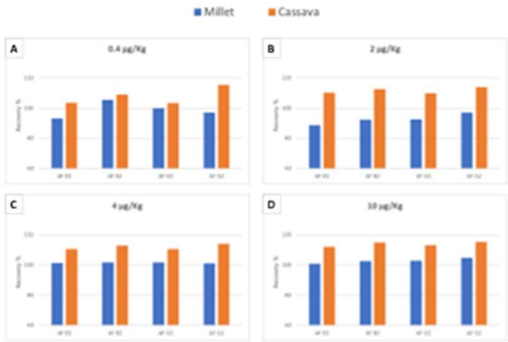


Figure 2: The recovery values for aflatoxin B1, B2, G1 and G2 in millet and cassava at spiking levels of 0.4 (A), 2 (B), 4 (C) and 10 (D) µg/kg for each aflatoxin

Aflatoxins B1, B2 and G1 showed recoveries within the acceptable limits of 70-110%, except for AFG2, which had recovery values slightly higher than 110% but with good precision values. In this case the higher recovery values were exceptionally accepted. The repeatability and within–laboratory–reproducibility values were within the accepted criteria for method performance according to the Codex standard. The method protocol is currently being prepared and will be available in due course. Future method development and validation studies will address the determination of AFs in groundnuts (peanuts).

FSCL Staff

Ms Beatriz Pérez–Fernandez, who had joined FSCL in September 2022 as a consultant, completed her work in March 2024. Beatriz holds a BSc in Chemistry and a MSc in Analytical and Bioanalytical Sciences. She made an excellent contribution to FSCL's research, focussing on the development and optimisation of electrochemical immunosensors for the rapid screening of aflatoxins in pistachio and fumonisins in maize products, along with the development of protocols and standard operating procedures and drafting of manuscripts for publication in scientific journals. We wish Beatriz all the very best for her future career and look forward to future collaborations.

Ms Sofia Bussalino joined FSCL in March 2024, to work for three months as a consultant on the project "*Ensuring food security and safety by future–proofing dryland crops under climate change*". Sofia holds a Diploma in Chemical Engineering from the Universidad Nacional del Comahue in Argentina, has over seven years of hands-on experience at the Chromatography Laboratory (LCR) of the Centro de Investigaciones Agrobiología y Toxicología Ambiental del Comahue (CITTAC), and had completed a 12-month internship at FSCL in 2023. She is currently contributing to the development and validation of analytical methods for the determination of aflatoxins and fumonisins in millet, cassava and groundnut samples.

Ms Joanna Mletzko, who was supporting FSCL and APHL as a team assistant, took advantage of the Agency's staff mobility mechanism to move to the Office of Procurement Services on a development reassignment as a procurement officer. We thank Joanna for her support and wish her all the very best on her new assignment.

Ms Martina Domanik joined the FSCL team in April 2024 on a temporary assignment, taking over Joanna's duties as a team assistant. Martina has experience in administrative support duties, with her most recent assignment being at the International Organization for Migration. She has quickly integrated with the team and made a very good start in Seibersdorf, supporting the FSC and APH laboratories.

Ms Chang Xu joined FSCL as an intern in December 2023. Chang holds a BSc in Bioengineering from the China Agricultural University and a MSc in Food Technology from the KU Leuven Ghent University. Ms Yuzhu Han joined FSCL as an intern in February 2024. Yuzhu holds a BSc in Marine Resources Development Technology from the Shandong University and a MSc in Zoology from the Institute of Hydrobiology of the Chinese Academy of Sciences. Chang and Yuzhu are contributing to FSCL's work assisting in sample preparation, literature review and in a feasibility study for mycotoxins detection by Raman Spectroscopy, while taking advantage of training opportunities in analytical methodologies for safety assessment in food.

Announcements

Food Safety and Control E-Learning Courses

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

The open courses available are:

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

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

How to enroll:

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

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Codex Committee on Contaminants in Foods (CCCF17), Panama City, Panama, 15–19 April 2024

https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-735-17%252FWorking%2Bdocuments%252Fcf17_04x.pdf

Codex Committee on Pesticide Residues, Chengdu, Sichuan Province, P.R. China, 03–08 June 2024

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2023

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https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-735-16%252FWDs%252Fcf16_04e.pdf

Codex Committee on Veterinary Drug Residues in Foods, Portland, USA, 13–17 Feb 2023

https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252Fmeetings%252FCX-730-26%252FREPORT%252Ffinal%252FREP23_RVDF26e.pdf

Codex Committee on Pesticide Residues, Beijing, P.R. China, 26 June–1 July 2023

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