**Minutes of NC-1023, USDA Multistate Project Meeting**

**October 16-18th, 2022**

**University of Illinois**

**Urbana-Champaign, Il**

### **Chair**: Ozan Ciftci ([ciftci@unl.edu](mailto:ciftci@unl.edu))

### **Chair-Elect**: Nitin Nitin ([nnitin@ucdavis.edu](mailto:nnitin@ucdavis.edu))

**Past chair:** Kirk Dolan ([dolank@msu.edu](mailto:dolank@msu.edu))

**Secretary:** Juliana Leite Nobrega de Moura Bell([jdemourabell@ucdavis.edu](mailto:jdemourabell@ucdavis.edu))

**Admin Advisor:** David Jackson ([djackson@nebraska.edu](mailto:djackson@nebraska.edu))

**Host:** Youngsoo Lee ([leeys@illinois.edu](mailto:leeys@illinois.edu)), Pawan Takhar ([ptakhar@illinois.edu](mailto:ptakhar@illinois.edu))

**Attendees (29):** Youngsoo Lee, Efren Delgado, Qingyang Wang, Ashim Datta, Deepti Salvi, Mohammed Kamruzzaman, Kasiviswanathan Muthukumarappan, Kirk Dolan, Barbara Chamberlin, Ali Ubeyitogullari, Buddhi Lamsal, Roger Ruan, Jiajia Chen, Gail M Bornhorst, Juliana M Leite Nobrega de Moura Bell, Rohan V. Tikekar, Wenbo Liu, Pawan Takhar, Mukund Karwe, David S Jackson, Yi-Cheng Wang, Kiruba Krishnaswamy, VM Balasubramaniam, Paulo Silva, Ilce G Medina-Meza, Fanbin Kong, Ozan Ciftci, Dharmendra Mishra.

**Oct 16, 2022**

6:00 – 8:00 PM - Dinner was held at the iHotel, Urbana-Champaign.

**Monday, Oct. 17, 2022**

**8:30** – Dr. Takhar welcomed attendees and Dr. Ciftci introduced the meeting goals. All members were asked to introduce themselves. The associate director of the Ag experimental station of Illinois Dr. Alex Winter-Nelson welcomed the group and showed his support for the collaborative mission of the multistate group.

**8:45-9:15 am**

Washington update – Dr. Hongda Chen (pre-recorded presentation)

Dr. Chen presented the USDA NIFA 2021 Partnership Award in Mission Integration of Research, Education, or Extension which was awarded for the NC 1023 multi-institutional seminar course. He highlighted the impact of covid on research and questioned what we learned through this time. He also mentioned that the Bridge showcased publications from food engineers highlighting the state of the art of nanotechnologies, among others. He provided an update with respect to the fiscal 2023 budget process, where he mentioned that a similar amount of funding had been allocated. The White House conference on hunger, nutrition, and health addressed 5 pillars supporting improved food access and affordability, integrating nutrition and health, empowering consumers to make and have access to healthy choices, supporting physical activity for all, and enhancing nutrition and food security research. He also mentioned the need to further deepen the definition of processed foods and educate the general population about the impact of processed foods on human health.

He also mentioned that the 2022-2026 USDA strategic priorities will focus on addressing climate change via climate-smart agriculture. How do science and research fit within the USDA strategic planning framework? AFRI RFA FY2022: postdoc applications are available (higher chance to be accepted due to few number of applications); A1731 Center of Excellence for meat and poultry processing and food safety research innovation (new) = funding amount $5M, project types: integrated (research and extension) project only, dealing Nov 3, 2022; A1343 Food and human health, funding amount $8M, budget up to $650,0000, research projects only, Sept 1st, 2022; and AFRI PD meetings: post-award activity-several meetings for different grants that were approved; happened in 2022.

Potential food safety threats, specifically related to the presence of nano plastics in foods were mentioned. There is a growing concern about nano plastics contamination from the environment into food. A key point of his presentation was that the lack of understanding of processed food classification systems is causing lots of problems due to inadequate consumer perception. Review trends in food science and technology are needed to better support consumer understanding. How processing changes the structure of foods and how those changes impact the absorption of the food compounds in the gastrointestinal system need to be better understood. That is important to help with the development of a more accurate classification system. He also mentioned the NIFA closer to zero opportunity: research and extension outreach to educate the population to reduce exposure to toxic elements in food products.

**9:15 am** **NC 1023 Administrator update** – **Dr. David Jackson** (10/01/2020-09/30/2025)

Dr. Jackson revised the major milestones and outcomes for the NC1023 project, as described below, and provided guidelines to help report the progress accomplishments with respect to the proposed milestones. We are in year 3 (10/01/22-09/30/2023).

Project objectives:

1. Characterize physical, chemical, and biological properties of raw and processed foods, by-products, and packaging materials.
2. Develop advanced and sustainable processing and packaging technologies to transform raw materials into safe, high-quality, health-promoting, and value-added foods.
3. Develop mechanistic and data-driven mathematical models to enhance understanding and optimization of processes and products that will ensure sustainable and agile food manufacturing for safe, high quality, and health-promoting foods.
4. Adapt pedagogical strategies involving novel educational approaches to enhance and assess student learning of food engineering.

The milestones proposed are listed below:

* **(2020):** Data generated from inter-laboratory testing of bioactive compound extraction will be analyzed. Two- or three-unit operations or food products that could be processed differently will be defined by members to focus on for future collaborations. Experimental work that could be utilized in multi-physics models will be identified. Develop one physical property teaching module (Module 1) and utilize at one station.
* **(2021):** Data from inter-laboratory comparisons of bioactive compound extraction will be published and presented at IFT. A novel thermo-physical property sensor under development will be shared for inter-laboratory testing. Utilize and assess effectiveness of teaching Module 1 at two or three stations; start work on Module 2 for a different physical property.
* **(2022):** Data will be collected on impact of processing technologies on product quality, safety, and nutrient availability. Data from sensing and property measurements will be presented at IFT or CoFE. Results from multi-physics models will be compared to experimental work. Revise teaching Module 1 based on assessment data, utilize and assess Module 2 at two or three stations, begin work on Module 3.
* **(2023):** Data on impact of various processing technologies on product quality, safety, and nutrient availability will be published and presented at IFT. Perform sensitivity analysis on the models to achieve optimum product and process parameters. Roll out teaching Module 1 for use and assessment at all stations, revise Module 2 based on assessment data, utilize and assess Module 3 at two or three stations, begin work on Module 4.
* **(2024):** A workshop or symposia on the use of processing to improve product quality and health benefits will be developed at IFT to present collaborative results. Results comparing modeling and experimental work will be published and presented at IFT or CoFE. Roll out teaching Module 2 for use and assessment at all stations, revise Module 3 based on assessment data, utilize and assess Module 4 at two or three stations, begin work on Module 5.

Overall, reports should describe the accomplishments since the project approval and provide a detailed overview of the accomplishments since the last project report. Provide additional information about outside funding sources that might have contributed to the accomplishment of the project objectives.

**10:15 am Dr. Ozan Ciftci \_ Review of the project’s objective and accomplishments**

Dr. Ciftci provided an overview of the specific activities proposed (described above) and accomplishments achieved. Dr. Bornhorst suggested having a champion to lead each project’s objective. Dr. Ciftci presented the methods developed by several stations for Objective 1 (new rapid-testing instrument; novel biosensors using nanostructure particles to serve as anti-microbial agents; isolation and characterization of plant-based protein using SDS-PAGE and spectrometry; the relationship between porosity and digestion of polysaccharides and their effect on gut health); for Objective 2 (packaging development; processing efficiency, industry collaboration to identify scale-up challenges), and Object 3 (high-pressure homogenization). Overall, the group suggested we develop a strategic plan to identify who is leading each area of research and which ideas will be pursued in each area and report the outcomes to Dr. Ciftci. It was also suggested to revise the milestones, identify if the stations listed are still involved in the specific milestone, and add a point person to each milestone. In addition, some context should be added for each milestone. This idea will be further discussed by the Ad hoc committee during the afternoon session.

**11:00 am Station reports 2021-2022 (5min for station)**

* **Arkansas Station (University of Arkansas):** - Station members (Dr. Ali Ubeyitogullari, Dr. Griffiths Atungulu, and Dr. Yanbin Li).

Collaborations with other stations: Dr. Li collaborated with MN and IA to develop a food safety monitoring and prediction system for poultry and pork supply chains. Dr. Ubeyitogullari delivered a seminar entitled “3D food printing for food processing and personalized nutrition) at the NC 1023- Food engineering seminar.

Areas seeking collaboration: Innovative packaging material and advanced packaging methods (Dr. Li); material science and modeling/biopolymer-based delivery systems using 3D printing and supercritical dioxide (Dr. Ubeyitogullari); electromagnetic-energy driven processing technology (Dr.Griffiths); Dr. Ubeyitogullari is planning to open an NC-1023 Food Engineering at the University of Arkansas.

* **California Station (University of California, Davis):** - Station members (Dr. Gail Bornhorst, Dr. Juliana Bell, Dr. Nitin Nitin)

Collaborations with other stations: Dr. Nitin collaborated with MD station to develop synergistic processing technologies (combination of food-grade compounds and low-intensity processing technologies such as light and ultrasound) to improve food quality and safety and reduce energy requirements; collaborated with NC station to develop a data-driven model for dosimetry of non-thermal plasma, and along with Dr. Simmons (UCD), collaborated with UMD station (Dr. Tikekar) in the development of teaching modules for food processing using virtual reality. Dr. Bornhorst collaborated with UMD-UNL et al. in the development of the Multi-Institutional Seminar Course (UCD hosted zoom seminars and videos).

Areas seeking collaboration: Multiscale imaging using MRI or other non-invasive technologies, multiscale breakdown and fluid flow during digestion (Dr. Barnhorst); mechanistic modeling during digestion and stability, scale up and modeling of ultrasound (Dr. Nitin); structural characterization of extracted compounds, target and untargeted metabolomics (Dr. Bell).

* **Illinois Station (University of Illinois):** - Station members (Dr. Mohammed Kamruzzaman, Dr. Pawan Takhar, Dr. Youngsoo Lee, Dr. Yi-Cheng Wang)

Collaborations with other stations: Dr. Takhar is collaborating with WSU (Dr. Tang) to combine microwave heating with conventional heating to develop fryers allowing improved control over pressure development and oil uptake in foods. Dr. Takhar collaborated with Penn State University (Dr. Anantheswaran) to perform CFD and FEM modeling of a commercial food slicer to improve sanitization and reduce cold spots. Dr. Kamruzzaman collaborated with Mississippi State University to develop data-driven optical sensing technology for sweet potatoes based on physical properties and other quality attributes. Dr. Lee collaborated with several stations to offer NC1023 multi-institutional course at U of Illinois (FSHN 598 in Spring 2022, 23 graduate students enrolled).

Areas seeking collaboration: modeling food-quality changes and intelligent packaging (Dr.Wang); Transport of species (solutes, nutrients, dissolved constituents, etc.) using Hybrid Mixture Theory (Dr. Pawan).

* **Indiana Station (Purdue University):** - Station members (Dr. Jen-Yi Huang, Dr. Carlos Corvalan, Dr. Jozef Kokini, Dr. Dharmendra Mishra)

Collaborations with other stations: Dr. Mishra collaborated with Dr. Dolan (MI) for the optimal design of a complementary experiment for the estimation of temperature-dependent thermal properties of food products in the range 20 - 140oC. This collaboration resulted in a publication: “Optimal Design of Complementary Experiments for Parameter Estimation at Elevated Temperature of Food Processing.” Foods 2022, 11, 26. Dr. Mishra continues to collaborate with MI to design and build advanced heaters for thermal properties measurement. Dr. Mishra collaborated with Dr. Vardhanabhuti (MO) to submit a United Soybean Proposal “Building Infrastructure and Connectivity for Small and Medium Scale Processing of Soy-Based Value-Added Products: A Multistate Approach” (funded) and is collaborating with Dr. Simunovic (NC) and Dr. Tang (WA) to submit a Department of Energy proposal for Electrify Manufacturing Innovation Institute. Dr. Huang continues collaboration with Dr. Barbosa-Carnovas (WA), Dr. Ciftci (NE), Dr. Chang (MS), Dr. Huang (VA), Dr. Kaletunc (OH), Dr. Lamsal (IA), Dr. Medina-Meza (MI), Dr. Wilson (IA), Dr. Zhao (OR) on comparative study on extraction of phenolic compounds from grape pomace, collaborated with Dr. Jung (OR) and Dr. Zhao (OR) to submit a 2022 USDA AFRI grant proposal, “Converting plant fiber-based biowastes from agricultural and food production to sustainable, hydrophobic, and economically viable molded pulp packaging products via eco-friendly and energy-saving technologies” (pending), and participated in the NC-1023 Multi-institutional Food Engineering course and offered a course “Emerging Food Technologies” at Purdue. Dr. Mishra collaborated with Dr. Dolan to submit a 2022 USDA AFRI grant proposal, “Advancing Use of Modeling Methods to Improve Low-Moisture Food Safety At Elevated Temperatures” (pending), and is planning to submit a paper in 2023 for inverse estimation of inactivation parameters of *Geobacillus stearothermophilus.* Dr. Mishra is also collaborating with Dr. Nair (AR) to develop machine-learning models to investigate different soybean varieties and their properties. Dr. Corvalan has an AFRI multistate collaborative grant with UMass Amherst (Dr. McClements) to study the fluid dynamics of short muscle fibers and flaky muscle alignment for realistic plant-based alternatives to seafood.

Areas seeking collaboration: measurement of thermal properties at elevated temperatures (Drs. Mishra and Dolan); digital twins for plant-based meat analogue (Dr. Mishra); and inverse problems and parameter estimation (Drs. Mishra and Dolan).

* **Iowa Station (Iowa State University):** - Station members (Dr. Buddhi Lamsal)

Collaborations with other stations: Dr. Lamsal has collaborated with USDA/ ARS, Peoria, IL (Plant Polymer Research Unit) in improving functional aspects of plant protein ingredients; collaborated in the Higher education challenge (HEC) grant, led by UMaine, where 6 universities participated (KY, ME, IA, VA, WA, ID). This effort focused on Enhancing Learning Outcomes in Food Engineering and Processing Courses for Non-Engineers Using Student-Centered Approaches and Implementing a few active learning tools. Its impact was evaluated through student surveys.

Areas seeking collaboration: Developing a mechanistic to understand how cold plasma inactivates microorganisms; removal of contaminants from materials and utilizing low-cost coproducts as fermentation media to produce high-value proteins, for example, antifreeze protein; using student-centered approaches; and graduate learning (Dr. Lamsal); extraction of phenolic compounds, pomace utilization and wine chemistry (Dr. Watrelot); sensor development for chemical compounds (Dr. Silva).

* **Maryland Station (University of Maryland):** - Station members (Prof. RohanTikekar)

Collaborations with other stations: Collaborated with Dr. Nitin at CA Station to develop ultrasound-assisted antimicrobial treatments for improved food safety and with Drs. Simmons and Nitin to develop virtual reality-based unit operations simulations (produce washing, lumped-system analysis, dehydration model, co and counter-current heat exchanger). Also collaborated with several stations to develop the NC-1023 multi-institutional online course.

Areas seeking collaboration: Monte Carlo simulation-based model to develop a mechanistic understanding of active packaging systems, validation study and engineering insights, and Extension education: FSMA PCQI training, Science of Food Safety short course.

* **Michigan State (University of Michigan):** - Station members (Prof. Ilce Medina)

Collaborations with other stations: Dr. Medina-Meza is collaborating with Dr. Balasubramanian (OH), in a study to evaluate the impacts of high-pressure processing on bioactive lipids (hormones, vitamins) from human breastmilk and with Dr. Ciftci (NE) in a study to evaluate the impact of CO2 supercritical extraction on phytochemicals from quinoa. Dr. Marks (MI) is collaborating with Drs. Sindelar and Glass (WI) to develop novel approaches for modeling Salmonella lethality on the surface of fully-cooked meat and poultry products, via a USDA AFRI CARE project, entitled Supporting small and very small meat/poultry processors in complying with USDA FSIS regulatory changes for fully-cooked products. Dr. Liu is collaborating with Dr. Datta (NY) on teaching FS students thermal processing using Datta’s simulation software.

Areas seeking collaboration: Seeking collaboration in food processing, food industry by-product, estimation of parameters in mathematical models using data, and evaluation of the nutritional value of fermented foods (Dr. Medina).

* **Minnesota Station (University of Minnesota):** - Station members (Dr. Roger Ruan)

Collaborations with other stations: described NMR research, intense pulsed light processes, and use of non-thermal processes to extract health-promoting compounds; valued added processes.

Areas seeking collaboration: the station is seeking collaborations in the above-described areas.

* **Missouri Station (University of Missouri):** - Station members (Dr. Krishnaswamy)

Areas seeking collaboration: Dr. Krishnaswamy is conducting research related to the development of sustainable processing methods, zero-waste food technologies, recovering macronutrient recovery and is seeking collaboration on topics related to upcycling of food loss/waste, mathematical modeling, food fortification with micronutrients, and sustainable development goals.

* **Mississippi Station (Mississippi State University):** - Station members (Dr. Yuzhen Lu, Dr. Wenbo Liu)

Collaborations with other stations: Dr. Lu is collaborating with the stations of UIUC, NCSU, and LSU to quantify/model/measure quality characteristics for grading and sorting of sweet potatoes using optical technologies; Dr. Liu is collaborating with Dr. Lu, Dr. Zhang, and Dr. Chang to realize automated fish processing operations.

Areas seeking collaboration: Dr. Lu has a project working on imaging-based quality assessment of poultry and meat and is looking for collaboration for characterizing and modeling microbiological quality and spoilage of meat and compositional analysis.

* **University of Nebraska:** - Station members (Dr. Ozan Ciftci)

Collaborations with other stations: Collaborated with MI station to characterize the physicochemical properties of quinoa seed lipids extracted with supercritical carbon dioxide; with OR, MI, WA, IN, VA, IA, and MS stations to determine the phenolic composition and the antioxidant properties of the grape pomace extract obtained by various conventional and unconventional extraction methods, and with OR, MI, WA, IN, VA, IA, and MS to determine the effect of different physical treatments assisting the extraction of bioactive compounds from a natural product. Collaborated with several stations to develop NC-1023 multi-institutional food engineering course.

Areas seeking collaboration: Seeking collaboration to understand microstructures in 3D printed foods during digestion, techno-economic analysis, modeling of supercritical fluid bioreactors (continuous packed bed immobilized enzyme reactor), modeling the bioactives diffusion in the porous bioaerogel matrix in supercritical carbon dioxide and organic solvent media and the flow of various food inks through nozzles during 3D food printing; and developing novel approaches to teaching food engineering unit operations to food science students.

* **New Mexico (New Mexico State University):** - Station members (Dr. Barbara Chamberlin, Dr. Efren Delgado, Dr. Pamela Martinez)

Collaborations with other stations: Dr. Delgadostarted a collaboration with Dr. Balasubramaniam (OSU) to analyze the effect of high-pressure treatment on the functional quality of cottonseed meal protein isolates. Dr. Chamberlin and Dr. Martinez (NMSU Innovative Media) recently completed the innovativemedia.nmsu.edu (Sanitization online learning modules (pre- and post-harvest) and animations describing different concepts and processes) and are currently developing “virtual reality for microbiomes”, “Game” for understanding complexity of water use issues, and “Game” for regulation of safety requirements for farmers markets.

Areas seeking collaboration: Dr. Delgado has a project working on aquaculture feed and is looking for collaboration to analyze the impact of a plant-based diet on the shrimp microflora, and outreach materials (virtual reality, animations). Dr. Chamberlin is seeking collaboration to develop outreach materials for education (animations, interactives, VR programs) and to communicate the impacts and values of our research to stakeholders.

* **New Jersey Station (Rutgers University):** - Station members (Dr. Mukund Karwe)

Collaborations with other stations: Dr. Karwe collaborated with NC station (Dr. Salvi) to evaluate the quality of sweet basil leaves that are grown hydroponically with plasma activated nutrient solution; with Dr. Rabinovich (Drexel University) to evaluate the properties of plasma activated water and plasma activated nutrient solution, with Dr. Nitin (CA) to develop a system to test the effect of shear stress on leafy fresh produce surface for bacterial detachment; and with Dr. Salvi (NC) to develop systems for applications of plasma activated water in sprouts and plasma activated mist in fresh produce.

Areas seeking collaboration: Drs. Karwe (NJ) and Tan (FAMU) are working on “Processing-Induced Changes in Carbohydrates and Proteins in Grains: Impact on Human Gut Microbiota”.   
They have submitted a proposal to NIFA on this topic. Dr. Karwe (NJ) and Dr. Tan (FAMU) are working on “Cleaning and Sanitation (C&S) of Food Contact Surfaces (FCS) in Food Manufacturing by Plasma-Activated Nanobubble Water (PMBW)”. They have submitted a joint proposal to NIFA. Seeking collaborations to gain a better understanding of the transport of plasma activated mist and its relevance in food safety, and plasma dosimetry (can we quantify the charge in plasma applications?).

**11:30 Annual report: providing research accomplishments for milestones**

Milestone 2020: data from inter-laboratory comparisons of bioactive compound extraction will be published and presented at IFT; Milestone 2021 and 2022: data will also be presented at IFt or CoFE; Milestone 2023 and 2024: data about the impact of various processing technologies on product quality and health benefits will be presented at IFT.

**Lunch 11:45-1:00 pm – provided at the meeting location**

**1:00 pm - station reports continuation**

* **Georgia Station (University of Georgia):** - Station members (Dr. Rakesh Singh, Dr. Fanbin Kong)

Collaborations with other stations: Dr. Kong collaborated with OR station (Dr. Zhao) to measure dielectric properties of hazelnuts and determine their characteristics with radio frequency heating and with ME station (Dr.Camire) to study surface modified cellulose nanocrystals for effective delivery of hydrophilic bioactive compounds in the gastrointestinal tract. Dr. Singh collaborated with TX station to study continuous high-pressure processing and quality parameters for pasteurization of grapefruit, watermelon, cantaloupe, and blueberry juices, as compared with HTST process. Dr. Kong collaborated with TN station (Dr. Chen) to model Radio Frequency heating of low moisture foods surrounded with different media.

Areas seeking collaboration: food digestion using dynamic GI models (e.g. evaluating microencapsulation, 3D-Printing, processing effects, etc.) (Dr. Kong), continuous high-pressure homogenization system, radio frequency heating system, and cold plasm.

* **North Carolina Station (North Carolina State University):** - Station members (Dr. Deepti Salvi)

Collaborations with other stations: NC Station (Dr. Salvi) collaborated with NJ station (Dr. Karwe) on the application of plasma-activated nutrition solution for enhancing the growth and yield of hydroponic basil, with CA station (Dr. Nitin) to develop a novel method for determining the dosimetry of plasma technologies, and participated in NC1023 seminar series in Spring 2021 and Spring 2022.

Areas seeking collaboration: novel thermal and non-thermal processing technologies, modeling and simulation of cold plasma processing, seminar series in spring 2023 (Dr. Salvi).

* **Ohio Station (The Ohio State University):** - Station members (Dr. Sudhir K. Sastry, Dr. Dennis Heldman, Dr. V.M.Balasubramaniam, Dr. Gonul Kaletunc, Dr. Osvaldo Campanella)

Collaborations with other stations: A Multistate educational effort was developed, involving presentations by participants from multiple stations. Presentations were made by various members from the OH Station. Students from Food Science and Technology, and Food Agricultural and Biological Engineering benefited from such efforts. The Conference of Food Engineering 2022 was held in Raleigh NC from September 18-21, 2022, and involved multiple stations. Mechanisms of contamination and infiltration into spinach leaves during vacuum cooling were investigated in a study involving the NY (Cornell) and OH Stations. The work involved modeling and experimental verification. Developed and validated a CFD model describing temperature and relative humidity distribution during superheated steam treatment in a simulated food processing environment (OSU & Cornell).

* **South Dakota Station (South Dakota State University):** - Station members (Dr. Kasiviswanathan Muthukumarappan, Dr. Lin Wei, and Dr. Mazhar Sher)

Areas seeking collaboration: Dr. Muthukumarappan and Dr. Lin have a project working on cold plasma activated water and are looking for collaboration in measuring chemical reactive species during treatment

* **Tennessee Station (University of Tennessee):** - Station members (Dr. Jiajia Chen, Dr. Qixin Zhong, Dr. Toni Wang, and Dr. Mark Morgan)

Collaborations with other stations: Dr. Toni Wang collaborated with Oak Ridge National Laboratory on an NSF grant to study the role of peptides in inhibiting ice crystal growth during frozen storage and Dr. Zhong studied processes leading to (A) formation of novel food biopolymeric emulsifiers with improved emulsifying properties, (B) incorporation of bioactive compounds in foods, (C) food antimicrobial intervention strategies improving microbiological safety, and (D) novel food colloidal systems with enhanced physical properties. Dr. Chen collaborated with AR and NE stations to develop an integrated radiofrequency and packaging technology in pasteurizing low-moisture food products and with TX station to model the drying process of sausages. A USDA proposal is under review. Drs. Chen, Morgan, and Wang worked on a USDA Research and Extension Experiences for Undergraduates (REEU) program on training more food engineers to advance food processing in the food industry

Areas seeking collaboration: Please continue to help share the program flyer with prospective students.

**1:30 pm Update on the NC-1023 Multi-institutional Food Engineering Course/Seminar series & Discussion (spring 2021, 2022, and beyond)**

Dr.Bornhorst and Dr. Tikekar presented the USDA NIFA 2021 Partnership Award in Mission Integration of Research, Education, or Extension that was awarded for the NC 1023 multi-institutional seminar course and provided some statistics related to the offering of the course in 2021 (Live attendance 86-163 people, 14h of videos recorded, > 527 hours of videos viewed, 12 universities offered the course and 3 major areas were covered: product utilization, engineering for health, engineering and processing for sustainable systems) and in 2022 (Live attendance 44-86 people, ~13.5 h of videos, >432 hours of video viewed, 10 universities participated and the following topics were covered: thermal processing, nonthermal processing, and sensing). Moderate Q&A and interaction time were included after each presentation.

As a group, we discussed the possibility of offering this course in 2023 and the logistics associated with its delivery. Should we continue to offer this course in 2023? Yes! Who is interested in offering the course? What is the major reason this effort had a strong impact? How to structure the class in the future? How do we know this effort is having a positive impact? How to assess this impact? Should seek feedback from students, are they interested in having the course again? How to create assessments? Access to wide research topics covered by different faculty. Youtube: with permission from the speakers, videos were uploaded to youtube. Nitin suggested the possibility of having a student committee from different universities help select speakers and topics for the meeting. The group decided to re-survey NC-1023 members to select seminar themes and to survey students from food science and food engineering programs for interest in specific topics. Student credit depends on the university, which must approve the course. Each university had access to the student feedback data.

**Stations interested in offering this course in 2023**: CA (EBS), NE, IA, MO, MI, NC, IL, NM, IN, OH, and TN.

**Action plan**:

1. Describe the research themes and ask students (graduate students) to rank their interest in the topics. The link was shared with undergraduates if they wanted to.
2. **Module topics**:

Development of analytic tools (sensing, methods)

Modeling (mechanistic, ML, numerical techniques, etc)

Alternative proteins, cellular AG, Novel foods

Waste, by-product Utilization, Biorefinery

Nanotechnology

Entrepreneurship

Diversity, Food Equality, social and career aspects in Food Systems (future careers, panel discussions, ethics, etc.)

Processing of underutilized products (grains, etc.)

Food and health interactions

Advanced food processing technologies

Advanced Packaging

Water and energy in food processing (sustainability, LCA, TEA, etc)

Future directions in food engineering

1. Which learning outcomes will be developed based a narrower list of topics?
2. Should we open it to speakers and or students outside of the NC-1023 groups? What should be the mechanism?

Faculty speakers only (2021)

Faculties from ¾ of talks, short talks for students (2022)

Faculty speakers, industry speakers, and graduate students’ presentations? Selected option: faulty and one industry speaker for each module?

1. How to involve students? Ask if students want to be part of a student committee to help select speakers.

**2:45 pm New York Station report (Cornell University) Dr. Ashim Datta (Collaborations in digital resources)**

Dr. Datta described research related to the development of a framework to predict texture, and the use of teaching modules in food puffing and food properties. The station is seeking collaboration in using, populating, and monitoring the knowledge base, developing mechanistic models involving food transformations, and sharing digital resources to make modeling more accessible to everyone. Dr. Datta shared with members the development of standalone modules covering food physics that are available for everyone. This web-based module was developed through the integration of properties knowledge base and a digital resource repository and includes modules covering applications, theory, and modeling. This project was funded by Dr. Chen for industry use, but it is available for everyone.

**3:30 pm Break**

**3:45 pm Ad Hoc Committees (round table discussions on current collaborative projects, planning new activities, and forming new ad hoc committees)**

In the past two years, only the “Extraction of Bioactive Compounds” and “Physical properties” committees were active. As a group, we discussed the formation of new Ad-hoc committees, and based on the group’s research interests new committees were formed. Chairs, co-chairs, and members were selected for each committee. Current and future topics and outcome activities were discussed for each committee.

**New Ad Hoc Committees 2022 & Onwards**

* Extraction of Bioactive Compounds
  + **Lead:** Dr. Ciftci
  + **Co-Lead**: Dr.Bell, Dr. Medina-Meza
  + Dr.Nitin
  + Dr.Delgado
  + Dr. Ruan
  + Dr. Bornhorst
* Food and Health
  + **Lead**: Dr. Medina-Meza
  + **Co-Lead**: Dr. Bornhorst, Dr. Ciftci
  + Dr. Lee
  + Dr. Karwe
  + Dr. Wang
  + Dr. Kong
  + Dr. Ubeyitogullari
  + Dr. Delgado
  + Dr. Krishnaswamy
  + Dr. Nitin
  + Dr. Lamsal
  + Dr. Bell
  + Dr. Balasubramaniam
  + Dr. Tikekar
* Multi-Institutional Seminar Course
  + **Lead**: Dr. Tikekar
  + **Co-Lead**: Dr.Bornhorst
  + Dr.Salvi
  + Dr. Medina-Meza
  + Dr. Krishnaswamy
  + Dr. Lee
  + Dr.Ciftci
  + Dr. Balasubramaniam
  + Dr. Delgado
  + Dr. Ubeyitogullari
  + Dr. Bell
* Modeling
  + **Lead**: Dr. Takhar
  + **Co-Lead**: Dr. Dolan
  + Dr. Salvi
  + Dr. Nitin
  + Dr. Karwe
  + Dr. Datta
  + Dr. Mishra
  + Dr. Chen
* Cold Plasma Processing
  + **Lead**: Dr. Salvi
  + **Co-Lead**: Sr. Muthukumarappan, Dr. Silva
  + Dr. Wang
  + Dr. Karwe
  + Dr. Ruan
  + Dr. Balasubramaniam
  + Dr. Lamsal
  + Dr. Nitin
  + Dr. Kong
* Use of Instructional Modules & Curriculum
  + **Lead**: Dr. Datta
  + **Co-Lead**: Dr. Chen
  + Dr. Lee
  + Dr. Karwe
  + Dr. Balasubramaniam
  + Dr. Nitin
  + Dr. Bornhorst
  + Dr. Krishnaswamy
  + Dr. Chamberlin
  + Dr. Salvi
  + Dr. Silva
  + Dr. Kong
  + Dr. Tikekar
* Industry Facing Groups and Extension
  + **Lead**: Dr. Mishra
  + **Co-Lead**: Dr. Rohan? Dr.Ganjyal?
  + Dr. Balasubramaniam
  + Dr. Kong
  + Dr. Dolan
  + Dr. Chen
  + Dr. Wang
  + Dr. Chamberlin
  + Dr. Padilla-Zakour

**4:45 pm Business meeting: Elect new secretary, locations for future meetings, CoFE/SoFE update**

The next meeting will happen in Davis, CA (October 2023) and Dr. Dharmendra Mishra from Purdue was elected secretary. The group decided to keep the same steering committee (Dr. Ramaswamy Anantheswaran, Dr. V.M. Balasubramaniam, Dr. Gail Bornhorst, Dr. Pawan Takhar, and Dr. Yanyun Zhao).

**5:30 pm Local tour - Pilot plant tours for Food Science and Integrated Bioprocessing Research Laboratory**

**6:30 pm -Dinner**

**Tuesday 10/18/2022**

**8:45 am** Ad-hoc committee reports and discussion related to new ad-hoc committees. Chair, co-chairs, and members were selected for each committee, and topics of interest and outcome activities were discussed for each committee.

* **Foods for health committee**

Each group member shared research interests to identify a common team for this group’s research (impact of extraction, encapsulation, and bioactive delivery, the impact of fiber-rich materials on gut health, extrusion, digestion models, use of metabolomics to guide process development, antioxidant compounds, toxicity and allergenicity of extracted compounds, upcycling of nutrients from food waste for using in fortification of foods). **Major topics selected**: extraction, encapsulation, digestion, and characterization. How to create an impact as a group? Review the existing literature and write a manuscript demonstrating the impact of food processing on structure, formation of new products (desirable or undesirable), functionality, nutrition, and the impact of these changes on health based on scientific evidence. Important to highlight that food safety should be considered not only from a microbial standpoint but also from a chemical standpoint.

**\***Impact of food process on health (**Drs.** **Nitin and Bornhorst leading**), and Food safety from a microbial and chemical standpoint (**Drs. Medina-Meza and Ciftci leading**)

* **Multi-Institutional seminar Course Ad hoc committee** (mostly offered as 1 credit)

The following action points were discussed in the meeting: 1)Update faculty and student survey (ask students topics of interest for lectures, ask faculty’s availability to present); 2) Upon results of the surveys, set up a meeting with the committee to look over the survey results to select the lecture topics and identify speakers; 3) Development of assessment questions to be given prior and after the offering of the course; and 4) Improve the website (**Drs. Lee and Youngsoo and** **Krishnaswamy will lead**). Lectures were offered at 2 pm (EST time) on Fridays. Ask students to introduce speakers, and moderate the Q&A.

**9:45 am** Strategic planning activity-Session 1 and 2 (*Round table discussions among station members to foster collaborations in consideration of the NC-1023 project’s objectives and accomplishments*)

During this session, the group brainstormed about current problems in food engineering. How to contribute to the objectives of the project? The strategic vision was discussed, and 4 groups were formed to discuss potential strategies to contribute to the project objectives. The results of this discussion were shared with all members and are listed below) and a word cloud was generated:

**Text

Description automatically generatedGroup 1**: Modernize the food engineering curriculum by introducing new technologies; joint contribution to curse development; changing the negative perception of food engineering/food processing; demonstrate the impact of processing on the production of healthier foods and upcycling of bioactive compounds to educate consumers and influence policymakers; integrating perspectives from food processing, nutrition, and health outcomes; data availability for the development of predictive models to describe the impact of processing on composition and functional aspects; developing simple and effective communication strategies to broadcast research impact; the impact of food texture, color, on happiness and mental health.

**Group 2:** Science communication and engagement to educate consumers and guide policymakers; Food and health aspects (inequity, mental impact), development of an integrated mechanistic understanding of foods to predict the impact of food processing on health and functionality; Curriculum development to engage the new generation of students in food engineering

**Group 3:** Food processing for personalized precision nutrition; diversification in grains and pulses processing; reduction of microplastic contaminants (how to measure and reduce contamination).

**Group 4:** improvement of methods to measure dielectric properties in low moisture foods; design of fish processing equipment; identify agencies where to get funding to support research (e.g., SBIR); development of workshops that can be shared to enhance outreach; entrepreneurship class development.

**Action plans:** Extensive literature review of grain sources to identify grains with reduced water and energy footprint while delivering nutrients; validate the accuracy of equipment measurements (small project); science communication (funding opportunity to support formal and non-formal education, USDA); outreach practices (share best practices through a seminar), literature review to demonstrate the impact of food processing on health).

**12:00 pm** Box lunch/adjourn