APPENDIX D

SAES-422

Project Number: S294

Project Title: QUALITY AND SAFETY OF FRESH-CUT VEGETABLES AND FRUITS

Period covered 10/01/2018 to 9/30/2019

Date of This Report: 12/01 / 2019

Annual Meeting Date: 06/12/2019

Participants attending:

Almenar, Eva (ealmenar@msu.edu) – MI
Brecht, Jeffrey (jkbrecht@ufl.edu) – FL
Houtz, Robert L. (rhoutz@uky.edu) - KY
Moore, Reuben (r.moore@msstate.edu) – MS
Nannapaneni, Ramakrishna (nannapaneni@fsnhp.mstate.edu) – MS
White, Shecoya (sw2323@msstate..edu) – MS
Woods, Floyd M. (woodsfm@auburn.edu) - AL

Non-attending participants also submitted reports:
Annous, Bassam (bassam.annous@ars.usda.gov) – USDA/ARS - PA
Fan, Xuetong (Xuetong.Fan@ars.usda.gov) – USDA/ARS- PA

Brief summary of minutes of annual meeting:

1. Welcome and Introduction, Jeff Brecht, Chair
    a. Attending Almenar, Brecht, Houtz, Moore, Nannapeni, White, and Woods.
2. Report form the Administrative Advisor, Ruben Moore (final year), Robert Houtz (incoming, new project advisor). Both presented current status of project and new perspectives of future participation
    a. Will send letter concerning this meeting to faculty / USDA participants and industry representatives concerning current meeting.
    b. Encouraged increased engagement and participation of future scientists.
    c. Need to expand efforts in areas of food production, food security, food safety and basic science arenas.
    d. Historical perspective(s) of S294, Rob Shewfelt (UGA), David Gombas, Jennifer McEntire and John Toner, detailing diverse activities, i.e., university showcase, poster sessions, scientific symposiums.

i. Ways to engage collaboration.
ii. Incentive base engagement.
iii. SAS, Sustainable Agricultural System,
iv. AFRI

New Business:

1. Need for creative means of increasing participation.
2. Discussion / Eva Almenar proposed creation of a collective effort of universities, government and industry web-based of information of specific individual(s) expertise. This would enable anyone to identify and contact researchers that could potentially collaborate with multi-state / multi-discipline areas.
    a. Development of podcast detailing expertise from all facets / representation of research,
3. Discussion of letter / e-mail from Dr. Jodi Williams-USDA-NIFA, National Program Leader, Food Safety (dated 04/16/2019), to S-294 members invitation in brief, extending an invitation to attend a funded a conference grant, entitled "Breeding Crops for Enhanced Food Safety at University of California, Davis convened on June 4-6, 2019. Additional information of the conference is located, https://ces.ucdavis.edu/confreg/?confid=1035. In essence, this conference was unique which identifies knowledge gaps and research priorities in the emerging field of breeding for food safety.
4. Discussion concerning possible submission of a four-page conference proposal to United Fresh convention for the next S-294 meeting in San Diego, CA, 2020.
    a. Need to address critical areas / topics of concern from a domestic and international perspective.
    b. Need to identify program title, i.e. Innovative Manufacturing Technologies for fresh-cut Fruit and Vegetables (suggested title, something creative). The title should encompass areas of safety, quality and nutritional aspects. Eva Almenar volunteered expertise and time to work with J. Brecht and F. Woods to provide a working title. An additional suggestion was to contact Dr. John Beaulieu, USDA-ARS- LA.

c. Further discussion concerning possible financial incentive(s) for program participants via United Fresh, i.e. membership fees (industry, government and academia).

d. Need to recruit international speakers and participation.

e. Identify someone from U.C. Davis, i.e., Dr. Linda Harris (Food Science and Technology) as a potential speaker.

f. Need to identify potential topics for conference.

g. Committee composed of Almenar, Brecht, Shaw and Woods will meet sometime early December 2019 to discuss the above possibility of conference.

h. No other business

i. Adjourn: Next meeting of S-294 meeting in San Diego, CA, 2020.

5. **Station Reports**:

a. Alabama – Floyd Woods, reporting.

Continuation of interdisciplinary, food quality & safety working group collaboration at Auburn. Whole-fresh nutritional value of banana, blueberries, lettuce, peach and strawberry research was reported. In particular, browning mechanisms and consumer quality determinants. Research was focused on carotenoid, phenolic and antioxidant activity and capacity of intact – whole fruit with future comparison of fresh-cut fruit and vegetables. In addition, determination of optimal maturity standards on short-season diverse banana cultivars adaptable for the southeastern U.S. and niche market development was reported.

Key areas of reporting included:

- Nutritional quality and consumer decision to purchase and repurchase fresh non-processed banana fruit, color and carotenoid content of banana peel and flesh is an important quality determinant.
- Five underutilized non-Cavendish short cycle banana were compared to traditional Cavendish banana. All non-Cavendish peel and pulp tissue contained higher total carotenoid content. Results indicate tetraploid bananas contained highest carotenoid content and therefore more desirable.
- Five familiar cultivars of rabbiteye blueberry were cultivated from two opposing geographic locations (North and South) AL and two growing seasons. Vitamin C, phenolic antioxidant content and antioxidant capacity were determined.
- Approximately 80% of the variability is accounted for by total phenolic content regardless of cultivar choice or season.
- Highest consumer nutritional quality traits among five cultivars of rabbiteye blueberry and antioxidant determinants occurred in northern location of AL.

- Highest anthocyanin content occurred in northern climate and therefore, may be the greatest contributing factor accounting for consumer visual selection and determinant.
- Collectively, these studies are designed to promote production and consumption of nutrient enriched underutilized banana and health benefits of rabbiteye blueberry.
- Future studies will expand our knowledge and understanding of fresh and minimally processed banana and blueberry functional food properties.

Florida – Jeff Brecht, reporting.

Key areas of reporting included:

- Challenges and advances in modification of food package (MAP), headspace gases, selective barrier film limitation and applications
- Revision of handbook No. 669 "Protecting perishable foods during transport by truck or rail". The updated edition reflects the dynamic changes and innovations in the handling and transportation of perishable foods.
- Vacuum infusion of PME and / or calcium to enhance strawberry postharvest storage.
- Report from five growing regions in FL, during three-year period (2013, 2014, and 2015) that focused on efficacy of fluming practices which are a part of FL Tomato Good Agriculture Practices (T-GAPs) regulation to evaluate the effects of postharvest processing on microbial load.
- Use of BreatheWay® membrane technology to enhance shelf life of ackee fruit.
- An in-depth / informative article reviews of challenges and potential solutions surrounding Salmonella contamination in tomatoes.
- Efficacy of 1-MCP and storage temperature on the physiology and postharvest preservation of camu-camu fruit.
- Food Recall Manual (Version 2) to assist food businesses, to encompass food chain system for learning to conduct rapid and effective product recalls.
- Quality evaluation of strawberry bruised by simulated drop heights.
- Survival and/or proliferation of Escherichia coli O157:H7 and Salmonella on the surface of artificially bruised and unbruised tomatoes at three ripeness stages (breaker, pink, and red) and two storage temperatures (10 and 20^{o}C).

Iowa- J. Brecht reporting for A. Shaw et. al,

Key areas of reporting included:

- Over the past year, the Iowa State University team focused on produce grower, harvester, processor, and distributer trainings and educational curriculum.
- Iowa State University collaborated with other states to produce specific educational materials to meet the produce industry need.

- Over 200 produce industry members in Iowa collaborated with ISU members to actively participate in outreach educational efforts for every produce conference.
- Assessment of knowledge and educational needs of produce growers in the north central region of the U.S. regarding Food Safety Modernization Act (FSMA) Produce Safety Rule, using a modified Delphi approach.
- Extension educators provided further outreach efforts to prepare farmers in the north central region of U.S. for Produce Safety Rule (PSR). Effective and diverse educational tools and materials were designed to meet needs of target audience(s).
- Development of food safety curriculum for use on prison farms in Iowa.
- Preharvest food safety intervention using lactic acid bacteria (LAB) electrostatically applied to soil and / or spinach leaf surface resulted in 3-log reduction of E. coli O157:H7.
- Development of web-based federal and state regulations on selling pickled vegetables.
- Development of web-based federal and state regulations on selling frozen and dehydrated foods.
- Development of web-based federal and state regulations on selling jams and jellies.
- Development of web-based federal and state regulations on selling fermented foods.
- Development of web-based information best practice for field workers: Bodily fluid clean up on the farm.
- FSMA Produce Safety Rule Summary for Midwest Orchards.
- Farm Stand and U-Pick Produce Operations Safety Best Practices.
- FSMA Compliant On-Farm Thermophilic compositing.
- Domesticated animals factsheet-FSMA Produce Safety Rule.
- FSMA Produce Safety Rule: Dealing with Wildlife.

Michigan – Eva Almenar, reporting.

Key areas of reporting included:

Demand for innovative active packaging technologies has rapidly grown in recent years due to new food market requirements in terms of shelf-life extension, quality improvement, safety, and waste reduction. Sensory evaluation of consumer acceptance of diced cantaloupe was determined and the impact of visible sachet inside package on the consumer acceptance of the package and product perception.

- Panelists evaluated freshness-related attributes including appearance, firmness, sweetness, flavor and overall acceptability of fresh-cut cantaloupe.
- Panelists preferred fresh-cut cantaloupe with sachets.
- Gender and age difference were apparent concerning preference for sachet presence.

Additional, research concerning factors that affect entrapment efficiency (EE) of β-cyclodextrins (β-CDs) using essential oils (EOs) of palmarosa and star anise as guest models of hydrophobic compounds was noted. The importance and implications of

these compounds as potential food preservative against several foodborne pathogens emphasized.

- The β-CD intramolecular water content was significantly affected EE of β-CDs.
- EE of β-CDs varied from 1.05 to 63.7% and from 9.84 to 70.7% for palmarosa and star anise EOs, respectively, depending on the changes made to internal factors evaluated.
- Basic physiochemical properties and kinetic properties were also noted.

Mississippi – Ramakrishna Nannapaneni and Shecoya White, reporting.

Key areas of reporting included

Mississippi Agricultural and Forestry Experiment Station (MAFES) in part, funded the research under the Strategic Research Initiative and Food Safety Initiative. There are limited data on the role of cantaloupe extracts on the growth and biofilm formation of *S. enterica* strains. The effect of strain, temperature, nutrient level and food-contact surface on the growth and biofilm formation by outbreak strains of S. Poona, *S. enterica* ser. Stanley and *S. enterica* ser. Montevideo in cantaloupe flesh and peel extracts was determined.

- The growth and biofilm formation by outbreak strains of S. enterica ser. Poona (S. Poona), S. *enterica* ser. Stanley (S. Stanley) and S. *enterica* ser. Montevideo (S. Montevideo) on different food-contact processing surfaces in cantaloupe flesh and peel extracts at 22 °C and 10 °C was determined.
- S. *enterica* strains grow rapidly and form biofilms on diverse cantaloupe processing surfaces in the presence of low concentrations of cantaloupe flesh or peel extracts.
- Determined differences in survival of heat stressed L. *monocytogenes* strains ScottA, NRRL B-33157 and F4260 in lethal levels of LAE (Lauric arginate), plant based essential oil (carvacol) and disinfectants when incubated at both 22^{o}C and 4^{o}C. Heat stressed cells of L. *monocytogenes* are not easily killed by LAE, carvacol and alkali-based antimicrobials.

- Reported increased heat tolerance of L. *monocytogenes* to lethal heating temperature when pre-exposed to sublethal heat stress conditions.
- Determined survival of L. *monocytogenes* EGD (Bug600) (serotype 1/2a) in various disinfectants and essential oils after sublethal heat stress at 48^{o}C.
- Heat stressed cells of L. *monocytogenes* are not easily killed by alkaline disinfectants, and in essential oils containing carvacol and bay oil.

USDA, ARS, Wyndmoor, PA- J. Brecht reporting for Xuetong Fan.

Key areas of reporting included

- Post-treatment rinsing with water on inactivation efficacy of acid treatments against *Salmonella* inoculated onto stem scar areas of two types of tomatoes and impact on fruit quality during 21-day post-treatment storage at 10^{o}C.
- Acid washes were more effective in inactivating *Salmonella* on large round tomatoes than on grape tomatoes, and water rinses following acid treatments eliminated the acidic odor without affecting the efficacy of the acids against *Salmonella*.

- Combinations of 4% citric acid, 3 or 4% ascorbic acid and 1.5 and 2% N-acetyl-L-cysteine (NAC) achieved more than 5-log reduction of L. *monocytogenes* in antibrowning solutions and maintained freshness of cut 'Granny Smith' apples.
- Development of new group of phenolic branched-chain fatty acids (*n*-PBC-FA), hybrid molecules of natural monophenols mixed with fatty acids products was characterized with the intent to replace known antimicrobials / antibiotics that are no longer effective against microorganisms.
- Non- chlorine-based intervention method or integrative technology, consisting of (organic wash, AW) followed by chitosan-allyl isothiocyanate (CT-AIT) capable of inactivating > 7.0 log reductions of inoculated *Salmonella enterica* per g of infected stem on grape tomato. In addition, no regrowth had occurred for 21 day refrigerated storage.
- Feasibility and characterization kinetics of waterless based intervention technology, gaseous chlorine dioxide ($gClO_2$) inactivation against virus-contaminated (Tulane virus; TV) blueberries.
- Enhanced storability and microbial safety against Salmonella contaminated grape tomatoes with minimal physico-chemical changes following treatment of dielectric barrier discharge atmospheric cold plasma (DACP).
- Demonstration of enhanced microbial safety and storability of strawberries with combinational treatment of antimicrobial washing (AW) and antimicrobial coating (AC) against inoculated pathogens (E. coli O157:H7), *Salmonella enterica* populations and native microflora during storage at 4^oC for 3 weeks.
- Announcement of scholarly review of natural and bio-based antimicrobials.
- Announcement of scholarly book citation of: Improving the microbial food safety of fresh fruits and vegetables with aqueous and vaporous essential oils.
- Announcement of scholarly book chapter of: New classes of antimicrobials: poly-phenolic branch-chained fatty acids.

Accomplishments:

Objective 1. Evaluate methods of sampling and measuring flavor and nutrition of fresh-cut products to facilitate comparison to traditional shelf life factors.

- Developing recommendations for minimum firmness for processing different mango cultivars in terms of sensory quality, with and without additives and MAP. (FL)

Objective 2. Develop new strategies to improve and maintain inherent fresh-cut product quality and nutrition.

- Approximately 3C temperature difference between open and closed displays for 12-24 h has not resulted in measurable differences in baby spinach, spring mix or Romaine physical, chemical, sensory or microbiological quality. (FL)
- Hydrocooling with sanitizer had no deleterious effect on peach quality; had lower microbial counts but did not effect shelf life. (FL)
- Hydrocooling with sanitizer had no deleterious effect on strawberry quality; reduced microbial counts; did not effect shelf life. Some cultivars may be susceptible to splitting during hydrocooling. (FL)

- Commercial hydrocooling operations were monitored for cooling efficiency and water quality. Trimming the shank of end of commercial sweet corn shows promise for facilitating packing without compromising quality and shelf life. (FL)
- Theodore M.Sc. Project. Two commercial cultivars of broccoli and one breeding line were cooled with slush ice or hydrocooling and stored with or without plastic film overwrap. (FL)
- Impact force necessary to induce bruises in freshly harvested strawberry was studied. Prototype handling systems were studied for effects on fruit bruising and shelf life. (FL)
- First assessment of consumer acceptance of active packaging with a drip-adsorbent visible sachet. (MI)
- Packages without sachets were rated higher by participants in sensory evaluation. (MI)
- Specific population segments within the panel had different opinions. (MI)
- No effect of a visible drip- absorbing sachet in a package on consumer perception of product. (MI)
- Majority would pay 2%–10% more for a pack that extends use life by multiple days. (MI)
- Identified main factors that affect the entrapment efficiency EE of β-cyclodextrins (β-CD) and their level of contribution. (MI)
- EE of β-CD can be enhanced if affecting factors are optimized. (MI)
- ICs of β-CD: palmarosa or star anise essential oils (Eos) were obtained for the first time. (MI)
- Different release of the two EOs from inclusion complex (ICs) obtained by manipulating temperature & RH. (MI)

Objective 3. Improve understanding of physiological mechanisms that affect fresh-cut product quality.

- In progress; Kargar Ph.D. project. Evaluating physiochemical properties and bioactive compounds of selected banana cultivars: Consumer demand, browning potential of fresh with intent to expand fresh-cut product. (AL).
- In progress; Shi, M.S. project. Evaluating impact of hydroponic production of lettuce on lettuce quality with emphasis on secondary metabolism. (AL).
- In progress; Evaluating interactive effects of environment, growing season and cultivar of blueberries destined for value-added consumer / homeowner quality. (AL).
- In progress; Evaluating combinational applications of labeled herbicides on hill and plasticulture for postharvest quality of selected cultivars destined for fresh-cut. (AL).
- In progress; Xia, M.S. project. Evaluating impact of hydroponic production of lettuce using nutrient film technique, incidence of tipburn and phenolic content. (AL).
- In progress; Belisle Ph.D. project. Evaluating progression of pink rib in romaine lettuce and pinking disorder in endive and escarole and potential inhibitors of pink pigment synthesis. (FL).

Objective 4. Determine critical factors in controlled inoculation studies with human pathogens and surrogates that influence the outcome of quantitative microbial risk assessments.

- Drs. Shaw and Mendonca have been working to identify potential surrogate microorganisms that can be used within a produce field setting and in a fresh-cut processing setting. To date, these two labs have been able to identify five strains that can be utilized for microbial risk assessment that mimic the attributes of Escherichia coli O157:H7. These results, as of December 1, 2018, these strains have been cited in 52 peer-reviewed journal articles as being used in other food safety research. With so few of options for surrogate available, this is a major contribution to the field of food safety. (IA)
- S. *enterica* strains can grow rapidly and form biofilms on different cantaloupe processing surfaces in the presence of low concentrations of cantaloupe flesh or peel extracts. (MS)
- Heat stressed cells of *L. monocytogenes* strains are not easily killed by lauric arginate, carvacol and alkali-based antimicrobials. (MS)
- Dry gaseous ozone treatments that achieved significant reductions of Salmonella populations caused deteriorations in the quality of grape tomatoes. (USDA/ARS-PA)
- Gaseous chlorine dioxide treatments that achieved more than 4 log reductions of Salmonella did not significantly affect sensory or nutritional quality of grape tomato (USDA/ARS-PA)
- Washing with organic acids was more effective in inactivating Salmonella on large round tomatoes than on grape tomatoes, and water rinses following acid treatments eliminated the acidic odor without affecting the efficacy of the acids against Salmonella. (USDA/ARS-PA)
- Combinations of citric acid, ascorbate and N-acetyl-l-cysteine in proper ratios can be used to enhance microbial safety of fresh-cut apples without compromising product quality. (USDA/ARS-PA)

Objective 5. Development and validation of novel diagnostic methods to determine presence of human pathogens and chemical hazards associated with fresh and fresh-cut products.

- Drs. Mendonca, Brehm-Stecher and Shaw have worked to develop need food safety intervention strategies, conduct on-farm observational research to determine the vectors of contamination, and improve the current detection methods for identifying the human pathogens in produce. (IA)
- Dr. Shaw focused efforts on how best to educate produce growers on the risk factors that impact the safety of the produce they grow, harvest, process, and distribute. In 2018, seven peer review articles were published, 11 peer- reviewed extension publications, and seven products (i.e. videos, checklist, spreadsheets) were released to add in education of produce growers. (IA)
- Additionally, there were 10 produce safety alliance grower trainings provided in Iowa to educate growers and 10 on-farm food safety visits to produce farms. All this research was presented at conferences through the U.S. Current estimates indicate that over 1,000 food industry, academics, and government agencies have been exposed to this research an extension publication. (IA)

- Knowledge assessments taken from the produce safety alliance grower trainings indicate a significant increase in knowledge related to the food safety modernization act produce safety rule ($p<0.001$) and changes in behavior were observed through on- farm visits at all 10 farms in 2018. These include adoption of new produce sanitizers, employee training, facility upgrades and technology. (IA)

Short-term Outcomes:

Outputs:
Inventions. N/A

Patents. N/A

Publications.

Abeysundara PD, N. Dhowlaghar, R. Nannapaneni, , M.W. Schilling, B. Mahmoud, C.S. Sharma, and D.P. Ma. 2018. *Salmonella enterica* growth and biofilm formation in flesh and peel cantaloupe extracts on four food-contact surfaces. International Journal of Food Microbiology. 280: 17-26.

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Boz, Z., B.A. Welt, J.K. Brecht, W. Pelletier, E. McLamore, G.A. Kiker, and J.E. Butler. 2018. Review of challenges and advances in modification of food package headspace gases. J. Applied Packaging Res. 10: 62-97.

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da Rocha Neto, A.C., A. B. de O. da Rocha, M., Maraschin, R. M. Di Piero, and Eva Almenar. 2018. Factors affecting the entrapment efficiency of β-cyclodextrins and their effects on the formation of inclusion complexes containing essential oils. Food Hydrocolloids: 77:509-523.

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Fan, X. Sokorai, K. and Gurtler, J. 2018. Type of tomatoes and water rinse affect efficacy of acid washes against Salmonella enterica inoculated on stem scar areas of tomatoes and on product quality. International Journal of Food Microbiology. 280: 57-65.

Fan, X., Sokorai, K.J.B., Phillips, J. 2018. Development of antibrowning and antimicrobial formulations to minimize Listeria monocytogenes contamination and inhibit browning of fresh-cut "Granny Smith" apples. Postharvest Biol. Technol. 143: 43-49.

Fan, X., H. Ngo, and C. Wu. 2018. Natural and bio-based antimicrobials: A review. p. 25-43. In: Fan, X., Ngo, H., Wu, C. (eds.), Natural and Bio-based Antimicrobials for Food Applications. ACS Symposium Series; American Chemical Society: Washington, DC.

Guo, M, Jin, T.Z., Gurtler, J., Fan, X., Yadav, M.P. 2018. Inactivation of E. coli O157: H7 and Salmonella on fresh strawberries by antimicrobial washing and coating. Journal of Food Protection.81: 1227-1235.

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Strohbehn, C. H., A.E. Enderton, A.M. Shaw, B.J. Perry, J. Overdiep and L. Naeve. 2018. Determining what growers need to comply with the food safety modernization act produce safety rule. Journal of Extension. 56:7RIB1

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Vorst, K, N. Shivalingaiah, B. A. Monges, S. Coleman, A. M. Mendonca, J. Brown, and A. Shaw. 2018. Effect of display case cooling technologies on shelf-life of beef and chicken. Food Control 94: 56-64.

Wang, F., A. Mendonca, B. Brehm-Stecher, J. Dickson, A. Dispirito and A. Shaw. 2018. Long-term-survival phase cells of Salmonella Typhimurium ATCC 14028 have significantly greater resistance to ultraviolet radiation in 0.85% saline and apple juice. *Foodborne Pathogens and Disease*: 15 (9):538-543.

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Activities:

Presentations.

Almenar, E. 2018. Avances en tecnologías para envases. Epicentro Cluser 2018. February 22, 2018. Cali, Valle del Cauca, Colombia. Oral.

Almenar, E. 2018. Novel packaging for baked goods. BakingTech 2018. February 26, 2018. Chicago, IL, USA. Oral.

Almenar, E.2018. Sustainable packaging alternatives to reduce food waste. Food Waste and Sustainability: Strategies to Improve Food Safety, Food Security, and Nutrition. September 27, 2018. Burr Ridge, IL, USA. Oral.

Belisle, C.E., S.A. Sargent, J.K. Brecht, and A.D. Berry. 2018. Trimming sweetcorn shanks maintains total sugars and water content in storage study. Florida State Horticultural Society Annual Meeting. June 12, 2018. Fort Lauderdale, FL. Oral.

Bhullar, M. and A. Shaw. Development of user-friendly E. coli water testing method for Iowa produce farmers to enhance food safety. International Association for Food Protection Annual Meeting. July 8-11th, 2018. Salt Lake City, Utah. Poster

Brecht. J.K. 2018. Modified atmospheres: Benefits and risks to fresh-cut produce. Fresh- Cut Products: The Science and Art of Quality and Safety. September 18-20, 2018. Davis, CA. Oral.

Brecht, J.K. 2018. Fresh- cut quality Issues regarding cell integrity, translucency & juice leakage. Fresh- Cut Products: The Science and Art of Quality and Safety. September 18-20, 2018. Davis, CA. Oral.

Brecht, J.K. 2018. Banana, mango, pineapple, citrus. Fresh- Cut Products: The Science and Art of Quality and Safety. September 18-20, 2018. Davis, CA. Oral.

Brecht, J.K. 2018. Sweet corn, cucumbers, squash. Fresh- Cut Products: The Science and Art of Quality and Safety. September 18-20, 2018. Davis, CA. Oral.

Danyluk, M., K. Schneider, R. Goodrich, and M. Ritenour. 2018. Produce safety alliance training: Produce Safety Rule (PSA) and the Preventive Controls (FSPCA) workshops. Courses taught 29 times. Various dates. Various locations in Florida. Oral.

De, J., B., Bertoldi, J. Brecht, S. Sargent, and K. Schneider. 2018. Evaluation of different postharvest cooling processes on the microbial quality and storage of Florida peaches. International Association for Food Protection. July 10, 2018. Salt Lake City, UT. Oral.

Dhowlaghar N., M.W. Schilling, and R. Nannapaneni. 2018. Strain differences of heat adapted L. monocytogenes cells exposed to carvacrol, alkali, H_2O_2, and lauric arginate (LAE). Mississippi Academy of Sciences Annual Meeting. February 22-23, 2018. University of Southern Mississippi, Hattiesburg, MS. Oral.

Dhowlaghar, N., Q. Shen, P.D. Abeysundara, A.U. Jadhav, R. Nannapaneni, M.W. Schilling, and C.S. Sharma. 2018. Differences in survival of heat stress adapted cells of L. monocytogenes EGD (BUG 600) in disinfectants and essential oils. Mississippi Academy of Sciences Annual Meeting. February 22-23, 2018. University of Southern Mississippi, Hattiesburg, MS. Oral.

Fan, X. 2018. Inactivation of foodborne pathogens in fresh produce by in-package aerosolization antimicrobials. International Association for Food Protection. July 10, 2018. Salt Lake City, UT. Oral.

Fan, X., J. Gurtler, and K.J.B. Sokorai. 2018. Washing tomato fruit with organic acids to reduce populations of Salmonella and preserve fruit quality. ACS Annual meeting. March 18-22, 2018. New Orleans, LA. Oral.

Fan, X. and K.J.B. Sokorai. 2018. Browning inhibition of fresh-cut "Granny Smith" apples and Listeria monocytogenes inactivation by the combinations of citric acid, ascorbic acid and acetylcysteine. American Chemical Society Annual Meeting. August 19-23, 2018. Boston, MA. Oral.

Fehlberg, J., C.L. Lee, L.M. Matuana, and E. Almenar. 2018. Converting agricultural waste into packages. The 2018 United Fresh University Showcase. June 25, 2018. Chicago, Illinois, USA. Poster

Friedrich, L., L. Dunn, B. Chapman, L. Strawn, and M. Danyluk. 2018. Survival of *Listeria monocytogenes* on cantaloupe field pack food contact surfaces. International Association for Food Protection. July 9, 2018. Salt Lake City, UT. Oral.

Friedrich, L., L. Dunn, and M. Danyluk. 2018. Salmonella infiltration into whole mangoes. International Association for Food Protection. July 9, 2018. Salt Lake City, UT. Oral.

Kargar, M., F.M. Woods, M.M. Wall, E.G. Fonsah, J.R. Kessler, K. Shetty, R.B. Jeganathan, and N. Larsen. 2018. Influence of maturity on physiochemical quality of genomically diverse banana (Musa spp.) cultivars. 82nd Annual Southern Region American Society for Horticultural Science. Feb 2-4, 2018. Jacksonville, FL. Oral.

Kargar, M., F.M. Woods, M.M. Wall, E.G. Fonsah, J.R. Kessler, K. Shetty, R.B. Jeganathan, and N. Larsen. 2018. Preliminary study of enzymatic browning susceptibility in banana peel and pulp tissues in relation to genotype and ripening. 115th Annual American Society for Horticultural Science. July 31 - August 3, 2018. Washington, D.C. Oral.

Perry, B., A. Enderton, C. Strohbehn, A. Shaw, and L. Naeve. 2018. Midwest Region Round Two Needs Assessment of FSMA Produce Safety Rule. International Association for Food Protection Annual Meeting. July 8-11th, 2018. Salt Lake City, Utah. Poster

Pfuntner, R., L. Truitt, M. Danyluk, B. Chapman, and L. Strawn. 2018. *Listeria monocytogenes* transfer potential during field-pack handling of cantaloupe. International Association for Food Protection. July 9, 2018. Salt Lake City, UT. Oral.

Sargent, S.A., A.D. Berry, T. Tamashiro and J.K. Brecht. 2018. Potential of programmed cooling to expand handling options for fresh-market strawberry. American Society for Horticultural Science. July 30-Aug. 3, 2018. Washington DC. Oral.

Shaw, A. Food Safety on Produce Farms. Dec. 9th-14th, 2018. St. Thomas. US Virgin Islands. Oral

Shaw, A**.** 2018. Food Safety on Produce Farms. Dec. 9th-14th, 2018. St. Croix. US Virgin Islands. Oral.

Shaw, A, J. Hannan, R. Rajagopal, A. Enderton, and E. Johnsen. Update for North Central

Regional Center for Training, Extension, and Technical Assistance. Southern Region Integrated Produce Safety Conference. Nov. 13-14th, 2018. Atlanta, Georgia. Oral

Shaw, A**,** J. Hannan, R. Rajagopal, A. Enderton, and E. Johnsen. Update for North Central Regional Center for Training, Extension, and Technical Assistance. Local Foods Conference. Nov. 1-2nd, 2018. Brookings, South Dakota. Oral
Shaw, A**,** J. Hannan, R. Rajagopal, A. Enderton, and E. Johnsen. Update for North Central Regional Center for Training, Extension, and Technical Assistance. USDA Food Safety Outreach Program Regional Director Meeting. August 20-22nd, 2018. Blacksburg, Virginia. Oral

Shaw, A., S. Ilic, and M. Ivey. Food Safety Hydroponic Fruits and Vegetables-What We Do and Don't Know. Symposia. International Association for Food Protection Annual Meeting. July 8-11th, 2018. Salt Lake City, Utah. Oral

Tamashiro, T., S.A. Sargent, A. D. Berry. 2018. Quality evaluation of strawberry bruised by simulated drop heights. Florida State Horticultural Society Annual Meeting. June 10-12, 2018. Ft. Lauderdale, FL. Oral.

Todd-Searle, J., M. Danyluk, and D.W. Schaffer. 2018. Modelling Salmonella contamination and survival on tomatoes at the farm and packinghouse. International Association for Food Protection. July 9, 2018. Salt Lake City, UT. Oral.

Wang, L., J. Sites, K. J.B. Sokorai, V. Wu, and X. Fan. 2018. Gaseous chlorine dioxide maintained sensorial and nutritional quality of grape tomatoes while significantly reducing populations of *Salmonella enterica serovar* Typhimurium. 2018. Institute of Food Technology Annual Meeting. July 15-18, 2018. Chicago, IL. Oral.

Woods, F.M., A. Gebrekidan, E. Coneva, E. Vinson, K. Shetty, D. Sarkar, B.D. Blasius and A. Caylor. 2018. Influence of cultivar, environment and growing season on phytochemical properties of Alabama-grown Rabbiteye blueberries (Vaccinium ashei Reade). 4th NDSU Annual Conference on Food for Health. July 8 - 11, 2018. Fargo, North Dakota. Oral.

Conference.

Agreement. N/A

Milestones:

Impacts:

- Maturity and physicochemical quality parameters for genomically diverse bananas was demonstrated. (AL).
- We demonstrated that browning susceptibility of banana is dependent on cultivar, tissue type, and genomic composition and related to Polyphenol oxidase (PPO), degree of browning (DOB), Peroxidase (POD), Phenylalanine ammonia lyase (PAL) activities and total phenolic content. (AL).
- We demonstrated that the relative health benefits of rabbiteye blueberries (functional properties) is directly related to primary and secondary metabolites and influenced by location of cultivation and season of fresh fruit. (AL).
- Methods to successfully process riper fresh-cut mango were tested and validated. (FL and ARS-FL).
- We demonstrated that variability among strawberry cultivars in wound ethylene production corresponds to bruising susceptibility. (FL).
- Although closed retail display cases were found to maintain lower (by 3°C) temperatures for leafy greens than open displays, exposure times were too short to result in measurable physical, chemical, sensory or microbiological quality differences. (FL).
- Trimming sweetcorn shanks shows potential to facilitate packing. (FL).
- Three peer review articles were published, 17 peer- reviewed extension publications, and 3 products (i.e. videos, checklist, spreadsheets) were released to add in education of produce growers. (IA).
- Additionally, there were 10 produce safety alliance grower trainings provided in Iowa to educate growers and 10 on-farm food safety visits to produce farms. (IA).
- Approximately, 1,000 food industry, academics, and government agencies have been exposed to safety alliance grower training topics as a result of research and extension publications. (IA).
- Development of active packaging materials for food shelf-life extension. (MI).
- Validation of new active packaging systems for fresh produce. (MI).
- Evaluation of strengths and limitations of conventional and novel scavengers for development of active packages. (MI).
- Understanding Salmonella biofilm formation in cantaloupe peel and flesh extract on four food-contact surfaces at two temperatures. (MS).
- Survival of heat stressed L. monocytogenes strains ScottA, NRRL B- 33157 and F4260 in lethal levels of lauric arginate or carvacrol. (MS).
- Differences in survival of L. monocytogenes EGD (Bug600) (serotype 1/2a) in various disinfectants and essential oils after sublethal heat stress. (MS).
- Novel antibrowning and antimicrobial formulation for cut apples. (USDA, ARS, Wyndmoor, PA).
- Development of non- chlorine-based intervention method or integrative technology effective in reducing *Salmonella* on large round tomatoes than on grape tomatoes. (USDA, ARS, Wyndmoor, PA).
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