

Institution: University of Florida

Participants: Food Science & Human Nutrition: Schneider, K. R.; Sims, C. A.; Talcott, S. T. Horticultural Sciences: Brecht, J. K.; Huber, D. J.; Sargent, S. A., Plant Pathology: Bartz, J. A.

Activities

Food Science & Human Nutrition

Objective 2: Develop new strategies to maintain fresh-cut product quality.

APPROACH: Methods to inhibit degradation or to promote biosynthesis of phytochemical components of fruits and vegetables will be investigated. This will include the utilization of compounds isolated from natural sources as antioxidants and enzyme inhibitors and evaluating postharvest storage methods that enhance phytochemical production and retention. Emphasis will be placed on polyphenolic and carotenoid retention as a means to improve antioxidant capacity and overall quality. Commodities for investigation may include: tomatoes, carrots, potatoes, grapes, grape seeds, blueberries, and peppers.

PROGRESS: 2004/10 to 2005/09

Dense phase-CO₂ processing (DP-CO₂) is a promising pasteurization technology and may lessen detrimental effects to thermolabile phytochemicals such as anthocyanins. Similarly, the formation of intermolecular copigments by the addition of purified polyphenolics will assert a protective effect against anthocyanin and ascorbic acid (AA) degradation. To enhance anthocyanin stability, this study evaluated exogenously added polyphenolic cofactors from thyme (*Thymus vulgaris*) on the phytochemical and sensory attributed of AA-fortified muscadine grape juice model system following thermal and DP-CO₂ processing. Copigmentation along with DP-CO₂ processing was demonstrated to be effective in preventing phytochemical and quality deterioration in muscadine grape juice during processing and storage. Dense phase-CO₂ processing can also reduce microbial loads without adverse affects on phytochemicals or sensory characteristics. Micrographic observation aided understanding of microbial inactivation and similar microbial stability was observed between DP-CO₂ and thermally pasteurized juices during storage. DP-CO₂ served to protect phytochemical and antioxidant levels throughout processing and storage without comprising microbial stability or sensory attributes of the juices. Glucosidase and tannin acyl hydrolase are also commonly used as a processing aid for foods and beverages and is often associated with quality improvement such as releasing aroma components or removing undesirable compounds. Polyphenolic isolates from muscadine grape juice were prepared and evaluated for changes in the presence of these enzymes. Incubation with tannase revealed no specific activity for the ellagic acid glycosides or HHDP units of ellagitannins. However, free gallic acid significantly increased in the presence of tannase (17.8-fold increase) indicating the presence of gallotannins or gallic acid esterified to ellagitannins. A book

chapter is in progress to highlight the nutrient and non-nutrient losses associated with fresh-cut fruits and vegetables as an ending to this research project.

IMPACT - 2004/10 to 2005/09: Information on phytochemical content, stability, and antioxidant capacity during processing and storage were evaluated. By monitoring these factors under actual food processing and storage conditions, a better understanding of food quality and potential health promoting properties were assessed.

PUBLICATIONS - 2004/10 TO 2005/09:

- Allen, R.L., B.R. Warren, D.L. Archer, S.A. Sargent, and K.R. Schneider. 2005. Survival of *Salmonella* spp. on the surfaces of fresh tomatoes and selected packing line materials. *HortTechnology* 15:831-836.
- Brenes, C.H., Del Pozo-Insfran, D., Talcott, S.T. 2005. Stability of copigmented anthocyanins and ascorbic acid in a grape juice model system. *Journal of Agricultural and Food Chemistry*. 53, 49-56.
- Del Pozo-Insfran, D. Percival, S.S., Talcott, S.T. 2006. Acai (*Euterpe oleracea*) polyphenolics in their glycoside and aglycone forms induce apoptosis of HL-60 leukemia cells. *Journal of Agricultural and Food Chemistry* 54(4),1222-1229.
- Del Pozo-Insfran, D. Duncan, C.E., Yu, K.C. Chandler, C.K. Talcott. S.T. 2006. Polyphenolics, ascorbic acid, and soluble solids concentrations of strawberry cultivars and selections grown in a winter annual hill production system. *J. Amer. Soc. Hort. Sci.* 131:89-96.
- Lee, J.H., Johnson, J.V., Talcott, S.T. 2005. Identification of Ellagic Acid Conjugates and Other Polyphenolics in Muscadine Grapes by HPLC-ESI-MS. *Journal of Agricultural and Food Chemistry*, 53, 6003-6010.
- Fox, A.J., Del Pozo-Insfran, D., Lee, J.H., Sargent, S.A., Talcott, S.T. 2005. Ripening Induced Chemical and Antioxidant Changes in Red Bell Peppers Affected by Ethylene Degreening and Time of Harvest. *Hortscience*. 2005. 40(3), 732-736.
- Mertens-Talcott, S.U., Bomser, J.A., Romero, C., Talcott, S.T., Percival, S.S. 2005. Ellagic acid potentiates the effect of quercetin on p21waf1/cip1, p53, and MAP-kinases without affecting intracellular generation of reactive oxygen species in Vitro. *Journal of Nutrition*, 135, 609-614.
- Talcott, S.T., Peele, J.E., Brenes, C.H. 2005. Red Clover Isoflavonoids as Anthocyanin Color Enhancing Agents in Muscadine Wine and Juice. *Food Research International*, 10, 1205-1212.
- Warren, B.R., M.E. Parish and K.R. Schneider. 2005. Comparison of chromogenic *Shigella* spp. plating medium with standard media for the recovery of *Shigella boydii* and *Shigella sonnei* from tomato surfaces. *J. Food Protection* 68:621-624.
- Yuk, H.-G., Bartz, J. A., and Schneider, K. R. 2005. The effectiveness of individual or combined sanitizer treatments for inactivating *Salmonella* spp. on smooth surface, stem scar, and wounds of tomatoes. *J. Food Sci.* 70:M409-M414.

Horticultural Sciences

Objective 3: Improve understanding of biochemical, physiological and molecular mechanisms that affect fresh-cut product quality.

APPROACH: This project will focus on the effects of fresh-cut preparation and handling, including techniques and technology, on the physiology, biochemistry, and quality of fresh-cut vegetables and fruits. Technology to be evaluated will include modified atmosphere packaging, application of novel food grade GRAS chemicals, and use of temperature-control regimes as alternatives to application of chemical compounds. We will also investigate the physiological and biochemical causes of quality changes, especially aroma, color (including browning), and textural changes, in fresh-cut vegetables and fruits. These studies will include the role of ethylene and the respiratory response and recovery or re-equilibration of fresh-cut vegetables and fruits following wounding and fluctuating temperatures. As one means of assessing the role of ethylene, commodities will be treated with the ethylene-action inhibitor 1-methylcyclopropene prior to processing into fresh cut. We will investigate textural changes associated with wounding during preparation and storage of fresh-cut vegetables and fruits. We will investigate the physiology of fresh-cut tropical and subtropical species when exposed to low temperatures in terms of the tissue response to chilling stress such as textural alterations, and aroma volatile production. Fresh-cut vegetables and fruits that will be studied include sweet corn kernels, lettuce, mango, papaya, peaches, and watermelon. Selection of intact items for cutting will include studies on initial product quality, identification of appropriate cultivars, and optimum maturity at harvest.

PROGRESS - 2004/10 to 2005/09: Methods of pretreating whole fruit for improvement of fresh-cut quality and shelf life were developed. Whole apples and mangoes were pretreated with 1-MCP, heat or ethanol. Heat and ethanol pretreatments resulted in extended shelf life for cut apple, and ethanol treatment enhanced appearance and reduced decay in mango, although some off flavor was associated with the higher level ethanol treatments. Correlation of total sensory (appearance, texture, flavor, odor), compositional, and microbiological quality changes in fresh-cut zucchini in MAP with machine vision and electronic nose measurements were done. Coatings on apple, peaches and mango showed some promising results for inhibition of browning and maintenance of flavor volatiles (mango) that warrant further research. 1-MCP treatment can help to reduce chilling injury of papaya fruit and the shelf life extended from 2 to 6 days. Slices from whole light red or red tomatoes pretreated with 1-MCP maintained greater pericarp firmness and developed less watersoaking (senescence) symptoms. Nonmelting-flesh (NMF) peach cultivars are better suited for fresh-cut processing than melting-flesh (MF) cultivars because their firmer texture allows the use of riper fruit with better flavor than the less ripe fruit that must be used for fresh-cut MF peaches. Fresh-cut sweetcorn kernels shelf life is limited by flavor loss and after-cooking browning. The latter increases with advanced maturity and higher storage temperature. Reduced O₂ plus elevated CO₂ (2% O₂ + 10% CO₂) is very beneficial in maintaining visual quality (preventing after-cooking browning) and reduced sugar and flavor losses during 10 days storage at 5C compared to storage in air. The effects of cutting on the firmness, activities of cell wall and membrane hydrolases, and ethylene biosynthetic enzymes in fresh-cut versus intact papaya fruit during storage at 5C were studied. The data suggest that the increase in the activities of enzymes targeting cell walls and membranes, and changes in the apoplastic environment of fresh-cut tissue as a result of membrane damage, contribute to the rapid deterioration of fresh-cut tissue. The comparison of mRNA transcripts

between intact and fresh-cut papaya fruit revealed that 12 genes were differentially expressed in response to cutting.

IMPACT - 2004/10 to 2005/09: Fresh-cut produce can help increase the consumption of fresh produce due to its convenience and attractive appearance and flavor. Development of novel approaches for assuring the quality and safety of fresh-cut produce depends on a better understanding of fresh-cut vegetable and fruit physiology, including nutrients and other functional components as affected by storage and handling.

PUBLICATIONS - 2004/10 to 2005/09:

- Boynton, B.B., B.A. Welt, C.A. Sims, M.O. Balaban, J.K. Brecht, and M.R. Marshall. 2006. Effects of low-dose electron beam irradiation on respiration, microbiology, texture, color, and sensory characteristics of fresh-cut cantaloupe stored in modified atmosphere packages. *J. Food Sci.* 71:S149-S155.
- Boynton, B.B., B.A. Welt, C.A. Sims, J.K. Brecht, M.O. Balaban, and M.R. Marshall. 2005. Effects of low dose electron beam irradiation on respiration, microbiology, color and texture of fresh-cut cantaloupe. *HortTechnology* 15:802-807.
- Fonseca, S.C., F.A.R. Oliveira, J.K. Brecht, and K.V. Chau. 2005. Influence of low oxygen and high carbon dioxide on shredded Galega kale quality for development of modified atmosphere packages. *Postharvest Biol. Technol.* 35:279-292.
- Ergun, M., D.J. Huber, J. Jeong, and J.A. Bartz. 2006. Extended shelf life and quality of fresh-cut papaya derived from ripe fruit treated with the ethylene antagonist 1-methylcyclopropene. *J. Amer. Soc. Hort. Sci.* 131:97-103.
- Nunes, M.C.N., J.K. Brecht, A.M.M.B. Morais, and S.A. Sargent. 2005. Possible influences of water loss and polyphenol oxidase activity on anthocyanin content and discoloration in fresh ripe strawberry (cv. Oso Grande) during storage at 1 °C. *J. Food Sci.* 70:79-84.
- Plotto, A., J. Bai, J.A. Narciso, J.K. Brecht, and E.A. Baldwin. 2006. Ethanol vapor prior to processing extends fresh-cut mango shelf-life by decreasing spoilage, but does not always delay ripening. *Postharvest Biol. Technol.* 39:134-145.

Plant Pathology

Objective 5: Evaluate and control unintentional and intentional microbial contamination of intact and fresh-cut produce.

APPROACH: Compare standard chlorine solutions to other oxidative solutions for ability to inactivate microbes on the cut surfaces of various products. Attention will be paid to recovery of microbes from oxidative damage. Recovery of microbes on growth media will be compared to recovery of microbes on plant tissues to determine how well the media models plant tissues. Common chemicals such as ethanol will be added to heated water at low concentrations to determine if efficacy can be improved without increasing the phytotoxicity.

PROGRESS - 2004/10 to 2005/09: Chlorine dioxide gas generated from either a mixture of dry ingredients or by off-gassing from a solution was used to inactivate soft rot bacteria in wounds on tomato fruit. At a ratio of approximately 2.0 mg chlorine dioxide to 1 kg of tomato fruit, soft rot was prevented or greatly reduced at 6 x 1 sq cm wounds on green tomato fruit. Tomato box material reacts with chlorine dioxide and, is an irreversible sink. Free moisture absorbs chlorine dioxide but is a reversible sink since the gas comes back out of the solution as the headspace concentrations decrease. Water channels in the surface of tomato fruit enable water soluble dyes or bacterial suspensions to readily internalize.

IMPACT - 2004/10 to 2005/09: Chlorine dioxide gas has potential to eliminate gram negative bacteria from fresh wounds on tomato fruit. Processes that lead to water congestion of openings in a tomato fruit surface enable ready internalization of particular matter including bacteria.

PUBLICATIONS - 2004/10 to 2005/09:

- Bartz, J.A. and J.W. Scott. 2005. Water infiltration and postharvest problems in tomato fruit. Florida Tomato Institute Proceedings pp. 20-23. (Gilreath and W.M. Stall, eds.) PRO 522. University of Florida/IFAS Extension and Citrus & Vegetable Magazine.
- Bartz, J. A., Mahovic, M., and Tenney, J. 2005. Chlorine dioxide as a postharvest sanitizer: Reversible in irreversible sinks. (Abstr) Phytopathology 95:S7.
- Mahovic, M., Bartz, J. A., and Schneider, K. 2005. Some factors affecting infiltration of water into tomato fruit. (Abstr.) Phytopathology 95:S64.
- Bartz, J. A. 2006. Internalization and infiltration. pp. 75-94. In: Microbiology of Fruits and Vegetables. G. M Sapers, J. R. Gorny, and A. E. Yousef, (eds). CRC Taylor and Francis LLC, Boca Raton, FL
- Nunes, M. C. N., Morais, A.M.M.B., Brecht, J. K., Sargent, S. A., and Bartz, J. A. 2005. Prompt cooling reduces the incidence and severity of decay caused by *Botrytis cinerea* and *Rhizopus stolonifer* in strawberry. HortTechnology 15:153-156.