2022 Progress Report to the Southern Region Small Fruits Consortium

Project Title: **Evaluation of Alternative Atmosphere Treatments to Extend Shelf-life of Georgia-grown Blackberries**

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Public abstract

Blackberries are an emerging, high-value crop in the State of Georgia whose acreage has been constantly increasing in the recent years. While the quality is excellent at harvest, blackberry shelf-life under cold storage is around 7 days under ideal conditions, due to their perishable nature. While cold storage is the most important step to ensure quality retention, new technologies can be used as add-ons to further extend the shelf-life of the crop. Controlled atmospheres are such an example that may extend the shelf-life of fresh fruits when used additionally to the traditional cold storage. Gaseous ozone has also been used to suppress microorganisms that proliferate during storage. While both technologies have shown promising results in other crops, little work has been done on newer blackberry varieties that have been established in the Southeastern US. Our team performed two sets of experiments during the Summer of 2022 using three popular varieties (Ponca, Osage and Ouachita) in order to investigate the effect of the above-mentioned technologies on fruit quality retention. While the experiments have been completed and the initial fresh quality data has been collected, we have not finished analyzing the frozen samples. Also, the statistical analysis of the data is pending. We are aiming to finish processing the frozen samples during this winter season, followed by data analysis and final report compilation in Spring of 2023.

Objectives

1. Continue the studies on the applicability of controlled atmospheres (CA) and the appropriateness of ozone (O_3) treatments during storage of fresh-market blackberries.
2. Evaluate the efficacy of the combination of CA and O_3 treatments in the suppression of postharvest disease incidence.
3. Investigate the phytotoxicity of ozonated air in blackberries.
4. Study the potential for blackberry shelf-life extension by using CA and O_3 treatments.

Justification and Description:

Blackberries (*Rubus fruticosus*) are highly perishable fruit due to their susceptibility to water loss, softening, mechanical injuries, and postharvest diseases. The shelf-life of blackberries is around 7 days when cooled immediately after harvest and stored at 2°C at 90–95% relative humidity (RH). While there is a high demand for fresh-market blackberries, often availability for extended periods of time is the limiting factor. Blackberry industry in Georgia has grown from 300 acres in 2009 to 800 acres in 2017 (USDA, 2021) focusing mainly on local sales. There is a high potential benefit to the local blackberry industry if postharvest storage could be improved, allowing for lower postharvest losses and new sales opportunities at more distant markets.

Blackberries can be stored only for a few days at 32-34ºF (0-1ºC) under high humidity conditions. Quality deterioration for blackberries is usually manifested in the form of loss of firmness, color reversion and in general the development of off-flavors. Furthermore, latent infections from the field result in the mycelial spread and occasional sporulation of numerous pathogens which occurs during cold storage.

Blackberry harvest periods vary widely, depending on spring temperatures, location, and cultivar selection. In South Georgia, blackberries are usually harvested between May 15th to June 15th while in the more northern parts of the State between June 1st and July 30th. Even when cooled down immediately after harvest at ideal temperature and relative humidity conditions, blackberry shelf-life is at best 7 days before fruit become soft, leaky, and unmarketable. It is of interest to local growers to extend the postharvest life of blackberries so that they can fill market niches later in the season and possibly be able to send their production to more distant markets.

Controlled atmosphere storage has been studied by scientists for years with Veazie and Collins (2002) reporting that 'Navaho' and 'Arapaho' blackberries stored for 7-days under CA showed reduce incidence of decayed fruit while consumer panels did not detect off-flavors in the treated blackberries. A more recent study from Brackman et. al (2016) found that CA storage of storage is 5 kPa O_2 with 15 kPa CO_2 was beneficial to the quality of 'Tupy' blackberries.

Ozone is a strong oxidizing agent (1.5 times stronger than chlorine) and is effective over a much wider spectrum of microorganisms. Ozone treatments can extend the shelf-life of many products as they can guard against mold and bacteria growth during cold storage at very low concentrations. Furthermore, ozone can oxidize ethylene, therefore delaying ripening, senescence, and the growth of molds in berries (Willis and Golding, 2015). On the other hand, exposure to ozone can trigger a stress response altering the fruit metabolism (Song et al., 2003) as well as changes in flavor in other small fruit such as blueberries (Giuggioli et al., 2015). Despite the use of ozone in many crops, the potential, and limitations of effective use of ozone for postharvest treatment of blackberries have not been fully documented and should be further studied.

Previous studies have shown that in 'Chester' blackberries, had no fungal decay following continuous exposure to ozone for 12 days at 0.1-0.3 $\mu L\ L^{-1}$, compared to 20%

fungal decay incidence for the untreated fruits (Barth et al., 1995). Furthermore, immersion of 'Tupy' blackberries in ozonated water (0.6 mg L^{-1} for 3 min.) was as effective as chlorine (200 mg L^{-1}) in reducing yeast and molds without affecting the fruit color, total phenolic content or antioxidant activity (Furlan et al., 2011).

A thorough investigation on the storability of Georgia-grown commercial varieties of blackberries (Ponca, Osage and Ouachita) stored under alternative atmosphere storage regimes such as controlled atmospheres (high carbon dioxide and low oxygen levels), as well as the use of ozone treatments would be of great benefit to the fresh market industry. Additionally, we would like to evaluate the effects of the above treatments on postharvest disease incidence during cold storage. The aim would be for the above technologies to be incorporated at current facilities using low-cost modifications, offering possible methods for extending the blackberry shelf-life.

Materials and Methods

Blackberries were hand harvested from a commercial farm (Paulk Vineyards) located in Wray, GA. The commercial cultivars Ponca, Osage and Ouachita were used for this experiment. 2 harvests per cultivar were performed in order to capture changes in fruit ripeness. Fruit were transported immediately to the Postharvest facility at the Vidalia Onion Research Laboratory, University of Georgia, Tifton Campus, and placed at 34ºF (1ºC) at 90-95% R.H..

Postharvest treatments

Postharvest and physiochemical attributes were measured initially (immediately after harvest) by evaluating berry size, weight, total soluble solids content (ºBrix), titratable acids content, for defects (bruises, pedicel separation/tears), and decay incidence. These same evaluations were performed after cold storage.

Firm blackberries of uniform color were stored in 6-oz vented polyethylene clamshells and held at 34ºF (1ºC) in closed cardboard boxes with polyethylene liners for up to 14 days. The experimental design was a randomized complete block, with three replications and four treatments:

1) Cold storage + [Control (no CA/ozone application)]
2) Cold storage + 1 ppm O_3 application
3) Cold storage + CA storage (10% CO_2/10% O_2)]
4) Cold storage + [CA (10% CO_2/10% O_2) plus 1 ppm O_3]

Boxes of blackberries held at 34ºF (1ºC) were subsampled every other day for weight loss, decay incidence, shriveling. Firmness was determined with a Firmtech 2 instrument, which is a sensitive equipment featuring a lever elevating mechanism. Three replicates of 15 blackberries were placed in jars at 68ºF (20ºC) and the headspace air was be sampled for presence of ethylene and respiration rate calculation using a gas chromatograph and a portable Bridge 900141 O_2/CO_2 analyzer. Berries free of decay were be frozen and held at -80ºC before and after storage treatments, for future compositional analysis.

Compositional analysis

Subsamples of fruit, consisting of 10 blackberries per sample, were juiced. The soluble solids content will be measured by placing approximately 1 mL of juice on a digital refractometer. The pH of the puree will be determined using a pH meter, and amount of acidity determined by a Mettler-Toledo titrator. Three to five mL of puree will be extracted with methanol for anthocyanin and phenolic determination using methods of Giusti and Wrolstad (1999) for total anthocyanins, and those of Singleton et al. (1999) for total phenolics.

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