

2021 Progress Report to the Southern Region Small Fruits Consortium

Project Title: Alternative Atmosphere Treatments to Extend Shelf Life and Control Postharvest Decay in Muscadine Grapes

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Public abstract:

Muscadine marketing is hindered by a brief harvest window which is exacerbated by a relatively short storability. This project aims to find ways to extend the storability of muscadine fruit so that they can be marketed more successfully and reach consumers throughout the nation. This project is aiming to expand the knowledge regarding the applicability of controlled atmosphere (CA) and ozone treatments for muscadine storage. It investigates the efficacy of the application of each individual technology as well as the combination of both while it also studies the potential phytotoxicity of ozonated air on muscadine grapes. The research project started later in the Fall of 2021, due to issues with the O₃ generator setup in the cold rooms. Two muscadine grape varieties (Supreme and Hall) that were stored in four different atmosphere regimes. All muscadines were stored at 40°F and 85% relative humidity plus the following atmospheres: Air, CA (6% O₂ plus 14% CO₂), O₃ (9 ppm) CA (6% O₂ plus 14% CO₂) + O₃ (2 ppm). Unfortunately, due to a cold room malfunction the control treatment (Air storage at 40°F) froze in November of 2021 when it was too late to find fresh fruit. We continued the experiment with the rest of the treatments and we will be processing the data this month. However, since the control treatment is crucial in the comparisons we would like to make between the treatments, we plan to repeat the set of experiments in 2022.

Objectives

1. Expand our knowledge on the applicability of controlled atmospheres (CA) and the appropriateness of ozone (O₃) treatments during storage of muscadine berries.
2. Investigate and evaluate the efficacy of the combination of CA and O₃ treatments in the suppression of postharvest disease incidence.
3. Investigate the phytotoxicity of ozonated air on muscadine grapes.
4. Study the potential for muscadine grape shelf-life extension by using CA and O₃ treatments at a higher, non-chilling storage temperature

Justification and Description

There is an increasing interest by consumers in the consumption of fruits which are good sources of antioxidants. Muscadines (*Vitis rotundifolia*) are rich repositories of high antioxidants such as flavonoids in peel, flesh, and seed, as well as ellagic acid and resveratrol in their juice they are also a good source of potassium, magnesium and calcium (Ector, 2001). Additionally, unlike some other antioxidant fruits such as Aronia, muscadines actually have a wonderful flavor. Muscadines are thus positioned to become a new superfood if they can be successfully introduced to consumers not familiar with this product. Unfortunately, muscadine marketing is hindered by a brief harvest window which is exacerbated by a relatively short storage ability. This project aims to find ways to lengthen the storage ability of muscadine fruit so that it can be marketed more successfully and reach consumers throughout the nation.

Muscadine grapes while similar to bunch grapes (*Vitis vinifera*) differ in that their fruit are larger, seeded, thick skinned and usually borne in small clusters of 2-10 berries, and picked as individual berries.

Vegetative growth is abundant and fruit generally grow within the thick canopy, rather than hanging down from the vine like bunch grapes, hindering fungicide application for disease control. The southeastern production region also has greater rainfall and humidity, increasing the prevalence of disease, causing fungi growth on the fruit.

Muscadine harvest season is relatively short and limited to about a 45-day window in late summer while its timing can vary widely, depending on summer temperatures and cultivar selection. South Georgia muscadine production usually begins in late July, peaks in mid-August, and ends in mid-September. Northern Georgia, Arkansas, and North Carolina generally have their harvest window shifted back a month later. Improved postharvest storage techniques would increase sales by lengthening the time fruit could be sold and facilitating transport of fruit to regions outside of the production areas.

Muscadine grapes can be stored for a few weeks at 32-40°F (0-4°C) under high relative humidity (RH) conditions. However, chilling injury is a common problem at such low temperatures which becomes visible in the form of brown or black discoloration in the grape surface upon transfer to ambient conditions. On the other hand, storing fruit at higher temperatures results in rapid quality losses which are usually manifested in the form of weight, firmness and flavor losses and the development of off-flavors. Additionally, latent infections from the field result in the mycelial spread and occasional sporulation of numerous pathogens during storage, hastening fruit deterioration.

Even when cooled down immediately after harvest at ideal temperature and relative humidity conditions, muscadine shelf life is at best two to three weeks before fruit become soft, shriveled, and unmarketable. It is of interest to muscadine growers to extend the postharvest life of fruit so that they can fill market niches later in the season potentially as late as Thanksgiving. Thus, the target is to achieve storage periods of 12-16 weeks, ensuring high-quality fruit for sale after storage.

It would be of great benefit to the fresh market industry a thorough investigation on the performance of commercial varieties of muscadines [Supreme (black) and Fry or Hall (bronze)] when it comes to their storability under controlled atmospheres (high carbon dioxide and low oxygen) and the potential of ozone treatments to suppress pathogens.

Sulfur dioxide has been used for years as an effective way to control decay during storage of muscadines, often causing bleaching damage, which further reduces the marketability of the product (Ballinger and Nesbitt, 1982). An alternative approach is the use of high carbon dioxide (15%), low oxygen (5%) which has been reported to extend muscadine shelf life to 6 weeks at 34°F (1°C) (Mercer and Smittle, 1990). In this case, chilling injury could be induced in fruit held below 41°F (5°C), in the form of increased decay incident upon transfer to room temperature conditions after 4 weeks storage at 34°F (1°C) (Saunders et al., 1981). Previous studies (Perkins-Veazie et al., 1999) found that muscadines held at 36°F (2°C) with 15% CO₂ and 10% O₂ reduced decay incidence but increased incidence of brown lesions which could be either a chilling injury symptom or due to expression of impact damage as these fruits were collected by shaking rather than hand harvest.

In the past years there has been an increased interest in the utilization of ozone (O₃) as an alternative to traditional sanitizers in many crops including grapes (Sarig et al., 1996). 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. Despite the use of ozone in many crops, the potential and limitations of effective use of ozone for postharvest treatment of muscadines have not been fully documented and should be further studied.

In this work we are investigating the effects of controlled atmosphere (high CO₂ and low O₂) with the addition of ozone (O₃) during cold storage on the overall fruit quality as well as their potential to shelf-life extension. Additionally, we are evaluating the effects of the above treatments on postharvest disease incidence during cold storage and after the transfer of muscadines in ambient conditions. The aim would be for the methods to be incorporated at current facilities using low-cost modifications, offering possible methods for extending the muscadine shelf life to 12-16 weeks.

Materials and Methods

Muscadines were obtained from a commercial cooperator near Griffin, GA. The grapes were collected after the fruit have passed through the commercial cooling, grading and packing lines to ensure that standard industry procedures have been followed. The common commercial cultivars Supreme (black) and Hall (bronze) were used for this experiment. Fruit was transported immediately to the Postharvest facility at the Vidalia Onion Research Laboratory, University of Georgia, Tifton Campus, and placed at 40°F (4°C) and 85% R.H.

Postharvest treatments

Samples of the fruit have been frozen and will be analyzed in the coming weeks. We will be measuring total soluble solids content (° Brix), titratable acids content, pH. Additionally, we have recorded the physiochemical attributes of fruits initially (immediately after harvest) by evaluating berry size, weight, for defects (bruises, pedicel separation/tears), and decay incidence.

Firm muscadine berries of uniform color were stored in one-pint polyethylene clamshells and held at 40°F (4°C) with high R.H. in closed cardboard boxes with vented polyethylene liners for up to 16 weeks. The experimental design was a randomized complete block, with three replications (with 3 clamshells per replication) and four treatments:

- 1) Cold storage [Control (no CA/ozone application)]
- 2) Cold storage + CA storage (6% O₂ plus 14% CO₂)
- 3) Cold storage + 9 ppm O₃
- 4) Cold storage + [CA (6% O₂ plus 14% CO₂) plus 2 ppm O₃]

Fruits were subsampled every week for weight loss, and presence or absence of decay, shriveling, and firmness determined with an advance force gauge, which is a sensitive equipment featuring a lever elevating mechanism. Three replicates of 10 muscadine berries were placed in jars at 68°F (20°C) and headspace sampled for presence of ethylene and to measure their respiration rates using a gas chromatograph and a portable Bridge 900141 O₂/CO₂ analyzer. Berries free of decay have been frozen and held at -80°C before and after storage treatments, for future compositional analysis.

Compositional analysis

Subsamples of fruit, consisting of 10 grapes per sample, will be 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.

Expected Results

This study will determine the efficacy of controlled atmosphere storage along with efficacy of ozone treatments in controlling the primary postharvest fungal pathogens of Muscadine grapes. It is anticipated that the CA/ozone application will have a positive effect on the shelf life and post storage quality of the fruit without the undesirable effects (bleaching and off-odors) of traditional storage extension methods.

This could result in a significant extension in the cold storage and marketing window for the grapes. The preliminary results (without the control treatment since this was damaged by the freezing temperatures) have been collected and will be analyzed. We are planning on repeating the set of experiments in 2022 in order to be able to perform the comparisons with the standard industry practices as planned.

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