2023 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 recent years. While harvest quality is excellent, blackberry shelf-life in cold storage is around seven days under ideal conditions, due to their perishable nature. While cold storage is the most important step towards quality retention, new technologies create additions to further extend the fruit's shelf-life. Controlled atmospheres are an example of a technology that may extend the shelf-life of fresh fruit when paired with cold storage. Gaseous ozone has also been used to suppress microorganisms that proliferate during storage. Both technologies have shown promising results in other crops, though little work has been done on newer blackberry cultivars that have been established in the Southeastern US. An experiment was conducted during the 2023 blackberry season using four popular cultivars (Caddo, Osage, Ouachita, and Ponca) in order to investigate the above-mentioned technologies on fruit quality retention. Three harvests were conducted at the beginning, middle, and end of season respectively follow by three weeks of cold storage under varied conditions. Various postharvest quality attributes were measured such as: visual quality, weight loss, respiration rates, decay incidence, red drupelet reversion presence, titratable acidity, total soluble solid content, anthocyanin content, and aroma volatile composition. Aroma volatile samples are currently being analyzed using a Gas chromatography system paired with Mass Spectrometry (GCMS). Samples are expected to be completed before the next upcoming blackberry harvest season in 2024. The methodology requires finetuning as the number of identify volatiles for each cultivar is lower than previous literature states. Some of the current prominent compounds across all cultivars are Hexanal, Butanoic Acid, 2-Hexenal, 2-Hexen-1-ol, 1- Pentanol, 4-methyl-, 2-Heptanol, Camphene, Hexanoic acid, O-Cymene, D-Limonene, linalool, Nonanal, and Octanoic acid. All listed volatile compounds are above a 75% purity percentage. 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 data analysis followed by a final report in 2024.

Preliminary results

RDR Presence Ouachita		
Harvest #	Day 0	Day 21
Harvest 1	87 % a	78 % a
Harvest 2	97 % a	40 % b
Harvest 3	87 % a	48 % b
P Value	0.1094	0.00003

Table 1. Percentage of red drupelet reversion (RDR) presence in Ouachita blackberries over three harvest dates. The statistical difference comparing RDR presence initially after harvest and after 21 days of storage. Means with different letters for each harvest are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

RDR Presence Osage		
Harvest #	Day 0	Day 21
Harvest 1	32 % a	60 % ab
Harvest 2	52 % a	68 % a
Harvest 3	32 % a	42 % b
P Value	0.0336	0.0101

Table 2. Percentage of red drupelet reversion (RDR) presence in Osage blackberries over three harvest dates. The statistical difference comparing RDR presence initially after harvest and after 21 days of storage. Means with different letters for each harvest are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

RDR Presence Ponca		
Harvest #	Day 0	Day 21
Harvest 1	57 % a	43 % b
Harvest 2	57 % a	75 % a
Harvest 3	57 % a	52 % b
P Value	0.2497	0.0007

Table 3. Percentage of red drupelet reversion (RDR) presence in Ponca blackberries over three harvest dates. The statistical difference comparing RDR presence initially after harvest and after 21 days of storage. Means with different letters for each harvest are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

RDR Presence Caddo		
Harvest #	Day 0	Day 21
Harvest 1	35 % a	55 % b
Harvest 2	38 % a	78 % a
Harvest 3	35 % a	57 % b
P Value	0.9095	0.0121

Table 4. Percentage of red drupelet reversion (RDR) presence in Caddo blackberries over three harvest dates. The statistical difference comparing RDR presence initially after harvest and after 21 days of storage. Means with different letters for each harvest are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Compositional Attributes 'Ponca' Harvest 1						
	Day 7		Day 14		Day 21	
	TA	TSS	TA	TSS	TA	TSS
Control	2.49 a	8.3 a	2.41 a	6.03 a	2.49 a	7.1 a
CA	1.97 a	7.63 a	2.18 a	8 a	2.39 a	7.63 a
Ozone	1.9 b	6 a	1.78 b	8.6 a	1.95 b	8.03 a
P-Value	0.0887	0.2169	0.0265	0.3461	0.0306	0.6133

Table 1. Compositional attributes titratable acidity and total soluble solids in harvest 1 of 'Ponca' blackberries stored for 21 days under varied storage conditions. The statistical difference comparing the treatment effects on TA/TSS values within x number of days after storage. Means with different letters for each measurement day are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Compositional Attributes 'Ponca' Harvest 2						
	Day 7		Day 14		Day 21	
	TA	TSS	TA	TSS	TA	TSS
Control	2.31 a	7.03 a	2.49 a	6.77 a	2.54 a	7.43 a
CA	2.25 a	7.33 a	2.21 a	7.4 a	2.58 a	8.6 a
Ozone	1.98 b	8.37 a	2.32 a	7.7 a	2.63 a	7.43 a
P-Value	0.3544	0.4633	0.5054	0.7017	0.9719	0.4523

Table 1. Compositional attributes titratable acidity and total soluble solids in harvest 2 of 'Ponca' blackberries stored for 21 days under varied storage conditions. The statistical difference comparing the treatment effects on TA/TSS values within x number of days after storage. Means with different letters for each measurement day are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Compositional Attributes 'Ponca' Harvest 3						
	Day 7		Day 14		Day 21	
	TA	TSS	TA	TSS	TA	TSS
Control	2.83 a	7.87 a	2.58 a	7.8 a	2.18 a	7.13 a
CA	2.06 b	7.47 a	2.44 a	7.9 a	1.9 a	8.37 a
Ozone	2.30 b	7.77 a	2.3 a	7.67 a	1.97 a	7.6 a
P-Value	0.0054	0.927	0.6964	0.9856	0.4426	0.4873

Table 1. Compositional attributes titratable acidity and total soluble solids in harvest 3 of 'Ponca' blackberries stored for 21 days under varied storage conditions. The statistical difference comparing the treatment effects on TA/TSS values within x number of days after storage. Means with different letters for each measurement day are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Compositional Attributes 'Caddo' Harvest 1						
	Day 7		Day 14		Day 21	
	TA	TSS	TA	TSS	TA	TSS
Control	2.46 a	7.33 a	2.46 a	7.83 a	2.26 a	8.77 a
CA	1.87 a	9.03 a	2.29 a	9.47 a	2.37 a	8.9 a
Ozone	0.22 b	9.3 a	0.35 b	9 a	0.18 b	8.43 a
P-Value	0.0003	0.3851	0.0003	0.4187	0.00002	0.9542

Table 1. Compositional attributes titratable acidity and total soluble solids in harvest 1 of 'Caddo' blackberries stored for 21 days under varied storage conditions. The statistical difference comparing the treatment effects on TA/TSS values within x number of days after storage. Means with different letters for each measurement day are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Compositional Attributes 'Caddo' Harvest 2						
	Day 7		Day 14		Day 21	
	TA	TSS	TA	TSS	TA	TSS
Control	2.34 a	7.27 a	2.24 a	7.97 a	2.33 a	9 a
CA	1.63 a	9 a	1.33 ab	8.27 a	2.44 a	7.87 a
Ozone	0.24 b	10 a	0.2 b	7.4 a	0.19 a	9.33 a
P-Value	0.0006	0.2968	0.0176	0.838	0.0657	0.4139

Table 1. Compositional attributes titratable acidity and total soluble solids in harvest 2 of 'Caddo' blackberries stored for 21 days under varied storage conditions. The statistical difference comparing the treatment effects on TA/TSS values within x number of days after storage. Means with different letters for each measurement day are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Compositional Attributes 'Caddo' Harvest 3						
	Day 7		Day 14		Day 21	
	TA	TSS	TA	TSS	TA	TSS
Control	2.46 a	7.57 a	2.09 a	8.67 a	2.21 a	7.13 a
CA	1.35 a	7.7 a	0.23 b	9.53 a	0.41 b	8.73 a
Ozone	0.19 a	9.6 a	0.23 b	8.53 a	0.20 b	10 a
P-Value	0.0674	0.4235	0.00007	0.7074	0.00003	0.3608

Table 1. Compositional attributes titratable acidity and total soluble solids in harvest 3 of 'Caddo' blackberries stored for 21 days under varied storage conditions. The statistical difference comparing the treatment effects on TA/TSS values within x number of days after storage. Means with different letters for each measurement day are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

Harvest Date: June 8th, 2023

Sensory Evaluation I							
Cultivar	Overall Appearance	Overall Flavor	Color	Firmness	Size/Shape	Sourness	Sweetness
Caddo	8.4 a	7 a	8.4 a	8 a	8.6 a	5.6 a	6.8 a
Ouachita	6.9 b	5.1 b	7.5 a	7 a	6.6 c	4.7 a	4.8 b
Osage	7.6 ab	6.7 a	8 a	7.2 a	7.7 ab	5.2 a	6.2 a
Ponca	7.2 b	6.7 a	7.9 a	7.2 a	6.7 bc	5.6 a	6.1 ab
P Value	0.0004	0.0006	0.0959	0.1223	0.0000009	0.2947	0.0020

Table 1. Sensory attributes of four blackberry cultivars evaluated using a 9-point hedonic scale. 1= dislike extremely, 9= like extremely, 5= neither like nor dislike. Means with different letters for each attribute are significantly different ($P \leq 0.05$) using Tukey's significant different test.

Harvest Date: June 14th, 2023

Sensory Evaluation II							
Cultivar	Overall Appearance	Overall Flavor	Color	Firmness	Size/Shape	Sourness	Sweetness
Caddo	8.2 a	6.9 a	8.3 a	7.6 a	8 a	5.4 a	6.8 a
Ouachita	7.8 ab	6.5 a	8.4 a	7.5 a	7.5 a	5 a	5.8 a
Osage	7 b	6.2 a	7.6 a	7 a	6.6 a	5.5 a	6.5 a
Ponca	7.6 b	6.9 a	8 a	7.4 a	7.5 a	5.2 a	6.7 a
P Value	0.1268	0.6157	0.2254	0.6471	0.0793	0.9385	0.3283

Table 1. Sensory attributes of four blackberry cultivars evaluated using a 9-point hedonic scale. 1= dislike extremely, 9= like extremely, 5= neither like nor dislike. Means with different letters for each attribute are significantly different ($P \leq 0.05$) using Tukey's significant different test.

Harvest Date: June 22nd, 2023

Sensory Evaluation III							
Cultivar	Overall Appearance	Overall Flavor	Color	Firmness	Size/Shape	Sourness	Sweetness
Caddo	7.3 ab	6.7 ab	7.7 a	6.9 a	7 b	5.6 a	6.3 ab
Ouachita	6.9 b	5.7 b	7.8 a	7 a	6.9 b	5.3 a	5.2 b
Osage	8 a	7.2 a	8.1 a	7.7 a	8.2 a	6.2 a	6.8 a
Ponca	7.6 ab	6.2 ab	7.9 a	6.9 a	7 b	5.7 a	5.9 ab
P Value	0.0639	0.0072	0.6154	0.2370	0.0104	0.5141	0.0358

Table 1. Sensory attributes of four blackberry cultivars evaluated using a 9-point hedonic scale. 1= dislike extremely, 9= like extremely, 5= neither like nor dislike. Means with different letters for each attribute are significantly different ($P \leq 0.05$) using Tukey's significant different test.