Title: Postharvest Quality and Volatile Composition of Blackberry Cultivars Grown in South Georgia.

Ramsey Corn
Master Student
Department of Horticulture
University of Georgia-Tifton
2360 Rainwater Road
Tifton, GA 31793
Ramsey.Corn@uga.edu

PI: Co-PI
Zilfina Rubio Ames   Angelos Deltsitis
Assistant Professor   Assistant Professor
Department of Horticulture   Department of Horticulture
University of Georgia- Tifton   University of Georgia- Tifton
2360 Rainwater Road   2360 Rainwater Road
Tifton, GA 31793   Tifton, GA 31793
zilfina.rubioames@uga.edu   adeltsidis@uga.edu

Summary

The postharvest quality, sensory attributes, and volatile composition of four blackberry cultivars: 'Ouachita,' 'Caddo,' 'Ponca,' and 'Osage' grown in South Georgia were evaluated. Understanding cultivar performance under Georgia's unique climate conditions is critical as blackberry production expands in the state. The four blackberry cultivars were assessed for physicochemical characteristics and sensory attributes. Quality parameters, including weight, firmness, total soluble solids, titratable acidity, red drupelet reversion (RDR), and volatile compound profiles, were analyzed at harvest and during a 21-day storage period. Sensory evaluations identified 'Caddo' as the most preferred cultivar for its superior size, flavor, and low RDR, while 'Ouachita' showed lower firmness and higher RDR presence.

Introduction

Blackberry production and consumption have increased in the United States over the past decade. Similarly, blackberry production acreage in Georgia has increased from 300 acres in 2009 to 1,858 acres in 2024 (USDA-NASSA,2024). Blackberries are harvested in Georgia from June to mid-July, and the main producing area in the state is South Georgia. Arkansas-bred cultivars are mainly grown in South Georgia. However, no information on fruit quality characteristics of Arkansas cultivars grown under Georgia conditions was previously reported. Fruit quality and sensory characteristics were only reported under Arkansas weather conditions (Threlfall et al., 2021). Environmental factors affect plant's biochemical and physiological processes, consequently affecting fruit quality (Baldwin, 2002). Furthermore, geographic location, climate, the type of soil, and cultural practices influence physicochemical and sensory attributes (Di Vittori et al., 2018). South Georgia and Arkansas have a humid subtropical climate; however, the two locations differ in the minimum and maximum temperatures. The average temperature in Arkansas (from the central to the south of the state) during June

fluctuates from ~79.8°F to 78.2°F, while in South Georgia it fluctuates from 81.9°F to 80.6°F. Furthermore, precipitation patterns differ from May to July in both states, with Arkansas having an average of 3.62 inches and Georgia 4.61 inches (Climate.org, accessed October 2022). Indeed, differences in weather patterns during fruit development and harvest season can affect fruit quality attributes (Stafne et al., 2017) and may also affect sensory characteristics and volatile profile, which can impact consumer preferences. Consumer preferences are based on different aspects of blackberry fruit quality, such as appearance, firmness, flavor, and nutritional value (Threlfall et al., 2021). However, even though consumers prefer unblemished fruit, repeat purchases depend on flavor. Flavor includes taste and other sensations humans perceive while eating (Klee and Tieman, 2018). Generally, the sugar/acid ratio in the fruit is not the only attribute determining consumer preferences. A diverse group of chemical compounds, such as amino acids, aroma volatiles, and phenolic compounds, influences consumer preference. In this project, the physicochemical and sensory attributes of four Arkansas-bred cultivars: 'Ouachita,' 'Caddo,' 'Ponca,' and 'Osage,' grown in South Georgia were evaluated.

Experimental Procedure

The four cultivars were hand-harvested and field-packed four times from a commercial farm located in Irwin County, GA, with 60 clamshells per cultivar, each harvest (Fig. 2, 3). Blackberries were transported to the Vidalia Onion Research Laboratory at the UGA-Tifton Campus and hand-sorted to remove any damaged or diseased berries before storage. The berries were stored overnight at 34°F (1°C) at 90-95% relative humidity. Physiochemical attributes were analyzed at four stages: immediately after harvest (initial evaluation), 7 days of storage, 14 days of storage, and 21 days of storage. The sensory evaluation was conducted using an untrained panel. Twenty participants rated each cultivar using a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, and 9 = like extremely). The parameters assessed included overall flavor, appearance, color, size, firmness, sweetness, and sourness. Volatile collection/sample preparation was analyzed 24 hours after harvest. Additionally, volatile collection and sample preparation occurred after every seventh day of storage. The quality characteristics measured include berry weight, firmness (Fig.4), total soluble solids, titratable acidity, red drupelet reversion (RDR) presence, and volatile compound content.

Red drupelet reversion assessments were conducted around three hours after harvest and after removal of the clamshell from cold storage. Twenty berries per clamshell were scored (a total of 60 berries) for RDR severity based on a predetermined scale (Fig. 1).
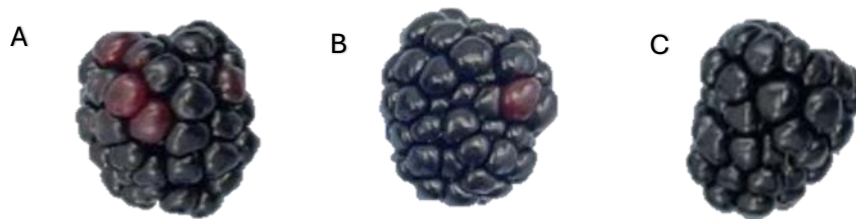

Figure 1. Severity of Red Drupelet Reversion (RDR) in blackberry drupelets. High RDR with 3 or more affected drupelets (A), Low RDR with 1–2 affected drupelets (B), and No RDR with 0 affected drupelets (C).

Outcomes

Red Drupelet Reversion (RDR) Red Drupelet Reversion (RDR) was observed within hours after harvest and tended to decrease over the storage period. 'Ouachita' had the highest presence of RDR across all three harvests (Tables 1-3). This high susceptibility to RDR persisted through the storage period, particularly in the first harvest (Table 1), marking 'Ouachita' as particularly vulnerable compared to the other cultivars. In the second harvest (Table 2), 'Ouachita' had more berries with RDR presence at harvest, but the incidence decreased after 21 days of storage. Notably, the only distinguishing factor between the second and the other two harvests was a significant rainfall event (29 mm = 1.1 in) occurring the day before and the morning of the harvest, which may have influenced these outcomes. Conversely, 'Caddo' and 'Osage' exhibited the lowest initial incidence of RDR and maintained consistently low levels of RDR throughout the storage period. In comparison, 'Ponca' exhibited high levels of RDR both at harvest and after 21 days of storage, with particularly elevated RDR observed in the second harvest following the storage period. Significant differences in RDR incidence among cultivars were observed at each harvest; however, by the third harvest, these differences in RDR severity among cultivars were no longer statistically significant after 21 days of storage. These results highlight the importance of selecting RDR-resistant cultivars, such as 'Caddo' and 'Osage', for extended storage periods. In contrast, cultivars like 'Ouachita' and 'Ponca' may require specific handling practices to minimize the occurrence of RDR. In 2024, there were significant differences in RDR among the cultivars, particularly after 21 days of storage. In the first harvest, the cultivars were not significantly different in RDR presence at harvest. At 21 days of storage, 'Ouachita' and 'Ponca' had higher RDR. In general, at 21 days of storage, 'Ouachita' and 'Ponca' had higher RDR present in all three harvests. In 2024, there were significant differences in the first harvest and the second harvest, in which 'Ouachita' had a higher RDR present compared to the other cultivars, but statistically significant differences were not always found (Tables 4-6).

Table 1: Severity of Red Drupelet Reversion in the cultivars 'Caddo,' 'Osage,' 'Ponca,' and 'Ouachita' at harvest and after 21 days of storage. Average number of berries exhibiting Red Drupelet Reversion (RDR) on the severity scale of No RDR, Low RDR, and High RDR (based on the number of reverted drupelets). Means with different letters for each harvest are significantly different ($P \leq 0.05$) using Tukey's significant difference test.

| | RDR Presence First Harvest 2023 | | | | | |
| Cultivar | Day 0 | | | Day 21 | | |
	No RDR	Low	High	No RDR	Low	High
Caddo	39 a	15 a	6 bc	27 a	28 a	5 b
Osage	41 a	16a	3 c	24 ab	26 a	10 b
Ponca	26a	12b	22 b	34 ab	10 b	16 a
Ouachita	8b	18 a	34 a	13 b	27a	20 a
P-value	<.0001	0.0070	<.0001	0.0290	0.0003	<.0001

Table 2. Severity of Red Drupelet Reversion in the cultivars 'Caddo,' 'Osage,' 'Ponca,' and 'Ouachita' at harvest and after 21 days of storage. Average number of berries exhibiting Red Drupelet Reversion (RDR) on the severity scale of No RDR, Low RDR, and High RDR (based on the number of reverted drupelets). Means with different letters for each harvest are significantly different (P ≤ 0.05) using Tukey's significant difference test

| | RDR Presence Second Harvest 2023 | | | | | |
| Cultivar | Day 0 | | | Day 21 | | |
	No RDR	Low	High	No RDR	Low	High
Caddo	37 a	16 ab	7 c	15 b	29	16 a
Osage	29 a	19 a	12 bc	19 b	30	11 ab
Ponca	26 a	10 b	24 b	17 b	25	18 a
Ouachita	5 b	13 ab	42 a	36 a	23	1 b
P-value	<.0001	0.0289	<.0001	0.0013	0.2019	0.0002

Table 3. Severity of Red Drupelet Reversion in the cultivars 'Caddo,' 'Osage,' 'Ponca,' and 'Ouachita' at harvest and after 21 days of storage. Average number of berries exhibiting Red Drupelet Reversion (RDR) on the severity scale of No RDR, Low RDR, and High RDR (based on the number of reverted drupelets). Means with different letters for each harvest are significantly different (P ≤ 0.05) using Tukey's significant difference test

| | RDR Presence Third Harvest 2023 | | | | | |
| Cultivar | Day 0 | | | Day 21 | | |
	No RDR	Low	High	No RDR	Low	High
Caddo	39 a	15 ab	6 b	26	31	3
Osage	41 a	16 a	3 b	35	21	4
Ponca	26 a	12 b	22 a	29	22	9
Ouachita	11 b	15 ab	34 a	31	24	5
P-value	<.0001	0.0275	<.0001	0.2430	0.2454	0.1145

Table 4: Severity of Red Drupelet Reversion in the cultivars 'Caddo,' 'Osage,' 'Ponca,' and 'Ouachita' at harvest and after 21 days of storage. Average number of berries exhibiting Red Drupelet Reversion (RDR) on the severity scale of No RDR, Low RDR, and High RDR (based on the number of reverted drupelets). Means with different letters for each harvest are significantly different (P ≤ 0.05) using Tukey's significant difference test

| | RDR Presence First Harvest 2024 | | | | | |
| Cultivar | Day 0 | | | Day 21 | | |
	No RDR	Low	High	No RDR	Low	High
Caddo	54	6	0	57 a	3 b	0 b
Osage	51	9	0	51 ab	8 ab	1 b
Ponca	51	9	0	45 b	13 a	2 ab

Ouachita	42	18	0	45 b	10 ab	5 a
P-value	NS	NS	NS	0.0033	<.0001	0.0174

Table 5: Severity of Red Drupelet Reversion in the cultivars 'Caddo,' Osage,' 'Ponca,' and 'Ouachita' at harvest and after 21 days of storage. Average number of berries exhibiting Red Drupelet Reversion (RDR) on the severity scale of No RDR, Low RDR, and High RDR (based on the number of reverted drupelets). Means with different letters for each harvest are significantly different (P ≤ 0.05) using Tukey's significant difference test

	RDR Presence Second Harvest 2024					
Cultivar	Day 0			Day 21		
	No RDR	Low	High	No RDR	Low	High
Caddo	59 a	1 b	0	45 a	8 b	7 a
Osage	55 ab	5 ab	0	43 a	11 ab	6 a
Ponca	57 ab	3 ab	0	38 ab	14 ab	8 a
Ouachita	53 b	7 a	0	34 b	15 an	11 a
P-value	0.0407	0.0407	NS	0.0079	0.0407	0.1821

Table 6: Severity of Red Drupelet Reversion in the cultivars 'Caddo,' 'Osage,' 'Ponca,' and 'Ouachita' at harvest and after 21 days of storage. Average number of berries exhibiting Red Drupelet Reversion (RDR) on the severity scale of No RDR, Low RDR, and High RDR (based on the number of reverted drupelets). Means with different letters for each harvest are significantly different (P ≤ 0.05) using Tukey's significant difference test

	RDR Presence Third Harvest 2024					
Cultivar	Day 0			Day 21		
	No RDR	Low	High	No RDR	Low	High
Caddo	57 A	3 A	0	59 a	1 c	0 c
Osage	58 A	2 A	0	47 b	11 ab	2 bc
Ponca	57 A	3 A	0	48 bB	8 b	4 ab
Ouachita	59 A	1 A	0	39 cC	15 a	6 a
P-value	0.5607	0.5607	NS	<.0001	0.0003	0.0018

Sensory Analysis

In 2023, significant differences in three to four attributes were found following two of three harvests (Tables 7 – 9).

At the first harvest, 'Caddo' was rated significantly higher than 'Ouachita' for overall flavor, overall appearance, size, and sweetness. 'Osage' was not significantly different from 'Caddo' in these attributes, and its flavor, size, and sweetness were also rated significantly higher than those of 'Ouachita.' 'Ponca' was rated in the middle and, while rated significantly higher than 'Ouachita' for overall flavor and significantly lower than 'Caddo' for size, its ratings were

usually not significantly different from those of other cultivars. At the third harvest, 'Osage' was rated significantly higher than 'Ouachita' in overall flavor, size, and sweetness. 'Caddo' and 'Ponca' ranked significantly lower than 'Osage' for size, while their ratings for flavor and sweetness were not significantly different from those of either 'Osage' or 'Ouachita'.

In 2024, 'Caddo' was the most favored cultivar in overall flavor across all three harvests (Tables 10-12). 'Ouachita' has the second highest rating in overall flavor, whereas 'Osage and 'Ponca' had variable results. All cultivars performed similarly in color perception, but 'Caddo' had the highest ratings in appearance in the three sensory evaluations. There were no significant differences in sourness across all cultivars, however, significant differences were found for sweetness. The panelist rated 'Osage,' as the least sweet cultivar in in the second and third sensory evaluation. On the contrary, 'Ouachita' has the highest rate of sweetness.

Table 7. Sensory attributes of the four blackberry varieties rated by non-trained panelists. Blackberries were harvested on June 8th and evaluated on June 9th, 2023. Panelists evaluated each attribute 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 difference test.

	Taste Panel – First Harvest						
Cultivar	Overall Flavor	Overall Appearance	Color	Size	Firmness	Sweetness	Sourness
Caddo	7.00 a	8.40 a	8.36	8.56 a	8.04	6.84 a	5.64
Osage	6.72 a	7.60 ab	7.96	7.68 ab	7.24	6.28 a	5.20
Ponca	6.68 a	6.92 b	7.92	6.72 bc	7.2	6.12 ab	4.68
Ouachita	5.08 b	7.20 b	7.48	6.64 c	7.08	4.84 b	5.64
P-value	0.0006	0.0004	0.0959	<0.0001	0.1223	0.002	0.2947

Table 8. Sensory attributes of the four blackberry varieties rated by non-trained panelists. Blackberries were harvested on June 14th and evaluated on June 15th, 2023. Panelists evaluated each attribute 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 difference test.

	Taste Panel – Second Harvest						
Cultivar	Overall Flavor	Overall Appearance	Color	Size	Firmness	Sweetness	Sourness
Caddo	6.91	8.18	8.32	7.95	7.59	6.82	5.36
Osage	6.23	7.05	7.59	6.64	7.05	6.45	5.5
Ponca	6.91	7.64	7.95	7.45	7.41	6.73	5.23

| Ouachita | 6.45 | 7.82 | 8.41 | 7.55 | 7.45 | 5.77 | 5.05 |
| P-value | 0.6157 | 0.1268 | 0.2254 | 0.0793 | 0.6471 | 0.3283 | 0.9385 |

Table 9. Sensory attributes of the four blackberry varieties rated by non-trained panelists. Blackberries were harvested on June 22nd and evaluated on June 23rd, 2023. Panelists evaluated each attribute 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 ≤ 0.05) using Tukey's significant difference test.

	Taste Panel – Third Harvest						
Cultivar	Overall Flavor	Overall Appearance	Color	Size	Firmness	Sweetness	Sourness
Caddo	6.72 ab	7.28	7.66	7.00 b	6.93	6.28 ab	5.62
Osage	7.24 a	7.97	8.14	8.24 a	7.66	6.79 a	6.17
Ponca	6.17 ab	7.57	7.86	7.00 b	6.86	5.86 ab	5.70
Ouachita	5.66 b	6.93	7.76	6.93 b	6.97	5.17 b	5.31
P-value	0.0072	0.0639	0.6154	0.0104	0.2370	0.0358	0.5141

Table 10. Sensory attributes of the four blackberry varieties rated by non-trained panelists. Blackberries were harvested on May 29th and evaluated on May 30th, 2024. Panelists evaluated each attribute 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 ≤ 0.05) using Tukey's significant difference test.

	Taste Panel – First Harvest						
Cultivar	Overall Flavor	Overall Appearance	Color	Size	Firmness	Sweetness	Sourness
Caddo	7.76a	8.04 a	7.96	7.84 a	8.08	5.08	5.48 ab
Osage	6.04 b	6.92 b	7.48	6.64 c	7.08	4.68	4.84 b
Ponca	6.84 b	7.2 ab	7.92	6.72 bc	7.20	5.64	6.12 ab
Ouachita	6.92 ab	7.6 ab	7.96	7.68 ab	7.24	5.2	6.28a
P Value	<.0001	0.0114	0.398	7.84 a	0.0011	0.4111	0.0196

Table 11. Sensory attributes of the four blackberry varieties rated by non-trained panelists. Blackberries were harvested on June 5th and evaluated on June 6th, 2024. Panelists evaluated each attribute 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 ≤ 0.05) using Tukey's significant difference test.

	Taste Panel – Second Harvest						

Cultivar	Overall Flavor	Overall Appearance	Color	Size	Firmness	Sweetness	Sourness
Caddo	8.23 a	7.86	7.68	7.18	7.09	6.23	5.27
Osage	6.72 b	7.32	8.41	7.54	7.32	6.41	4.501
Ponca	6.31 b	7.82	8.04	7.73	7.59	6.27	5.14
Ouachita	6.86 b	7.59	8.27	7.18	7.54	6.50	6.27
P Value	<.0001	0.6757	0.3737	0.667	0.656	0.9741	0.1119

Table 12. Sensory attributes of the four blackberry varieties rated by non-trained panelists. Blackberries were harvested on June 10th and evaluated on June 11th, 2024. Panelists evaluated each attribute 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 ≤ 0.05) using Tukey's significant difference test.

Taste Panel – Third Harvest							
Cultivar	Overall Flavor	Overall Appearance	Color	Size	Firmness	Sweetness	Sourness
Caddo	8.14 a	7.21	7.45	6.55 b	7.03	6.48 ab	6.21
Osage	7.00 b	7.34	7.93	7.1 ab	6.48	5.10 b	5.00
Ponca	6.0 c	7.21	7.55	7.24 ab	7.55	6.00 ab	5.48
Ouachita	7.03 b	7.07	8.38	8.24 a	7.31	6.79 a	6.07
P Value	<.0001	0.0939	0.0526	0.0024	0.0854	0.0156	0.1278

Physicochemical attributes

In 2023, significant differences in firmness were observed among cultivars across storage treatments. In harvest one, the 'Ponca' cultivar exhibited the lowest firmness at harvest, and 'Ouachita' had the lowest firmness after 21 days of storage (Table 13). In the second harvest, 'Caddo' exhibited the lowest firmness value at harvest, and after 21 days of storage (Table 14). In the third harvest, 'Osage' had the highest firmness across all storage treatments, and 'Caddo' had the lowest firmness (Table 15). 'Caddo' had the largest berry size across the three harvests, 'Ponca' and 'Ouachita' were most often the smallest (data not shown). There were no significant differences in TSS among cultivars or storage intervals (Table 16-18). In 2024, 'Ouachita' had higher firmness values at harvest compared to other cultivars. However, after 21 days of storage, 'Ouachita' had the lowest firmness. 'Osage' was consistently a firmer variety across harvest (Tables 19-21). In 2024, berry size significantly differed between cultivars, with 'Caddo' being the largest and 'Ouachita' being the smallest in each harvest (data not shown). No significant differences were found for TSS in the second year of the study (2024) (Tables 21-23).

Table 13: Firmness values of four blackberry cultivars at harvest and at different storage intervals. Different letters represent significant differences under Tukey's HSD at the 0.05

confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

			Firmness (N) First Harvest 2023		
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	1.236 Bc	1.303 Abc	1.462 Abb	1.907 Aa	<.0001
Osage	1.257 Bb	1.082 Bc	1.360 Bb	2.027 Aa	<.0001
Ponca	1.416 Ab	1.405 Ab	1.587 Ab	2.021 Aa	<.0001
Ouachita	1.235 Ba	1.340 Aa	1.348 Ba	1.366 Ba	0.0929
P-value	0.005	<.0001	0.0011	<.0001	

Table 14: Firmness values of four blackberry cultivars at harvest and at different storage intervals. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars, and lowercase letters (a) represent differences between days of storage.

			Firmness (N) Second Harvest 2023		
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	1.186 Ab	1.056 Bb	1.808 Aa	1.075 Bb	<.0001
Osage	1.257 Ab	1.392 Ab	1.947 Aa	1.385 Ab	<.0001
Ponca	1.277 Ab	1.151 Bb	1.464 Ba	1.240 ABb	<.0001
Ouachita	1.270 Ab	1.401 Ab	1.980 Aa	1.240 ABb	<.0001
P-value	0.1031	<.0001	<.0001	0.004	

Table 15: Firmness values of four blackberry cultivars at harvest and different storage intervals. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

			Firmness (N) Third Harvest 2023		
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	1.606 Ba	1.704 Ca	1.263 Bb	1.622 Bca	<.0001
Osage	1.780 Ab	1.912 Bab	1.562 Ac	2.072 Aa	<.0001
Ponca	1.810 Aa	1.810 BCa	1.209 Bb	1.744 Ba	<.0001
Ouachita	1.722 ABb	2.295 Aa	1.155 Bc	1.527 Cb	<.0001
P-value	0.012	<.0001	<.0001	<.0001	

Table 16: Total Soluble Content expressed as degree Brix $^\circ$ of four different blackberry cultivars. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence

level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

	Total Soluble Solids (%) First Harvest 2023				
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	9.56 Aa	7.33 Aa	7.83 Aa	8.77 Aa	0.6242
Osage	8.30 Aa	7.03 Aa	6.77 Aa	7.43 Aa	0.4907
Ponca	8.76 Aa	9.00 Aa	7.57 Aa	8.67 Aa	0.6862
Ouachita	8.63 Aa	8.30 Aa	6.03 Aa	7.1 Aa	0.1294
P-value	0.8595	0.4974	0.4738	0.3955	

Table 17: Total Soluble Content expressed as degree Brix ° of four different blackberry cultivars. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

	Total Soluble Solids (%) Second Harvest 2023				
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	9.93 Aa	7.26 Aa	7.97 Aa	9.0 Aa	0.379
Osage	6.03 Aa	7.86 Aa	7.8 Aa	7.13 Aa	0.4558
Ponca	7.26 Aa	7.13 Aa	9.03 Aa	9.47 Aa	0.5477
Ouachita	7.56 Aa	7.03 Aa	6.77 Aa	7.43 Aa	0.7568
P-value	0.1429	0.9724	0.378	0.0845	

Table 18: Total Soluble Content expressed as degree Brix ° of four different blackberry cultivars. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

	Total Soluble Solids (%) Third Harvest 2023				
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	8.83 Aa	7.57 Aa	8.67 Aa	7.13 Aa	0.6515
Osage	7.10 Aa	7.63 Aa	8.0 Aa	5.63 Aa	0.5034
Ponca	7.96 Aa	5.90 Aa	9.0 Aa	8.27 Aa	0.5032
Ouachita	9.30 Aa	7.87 Aa	7.8 Aa	7.13 Aa	0.3661
P-value	0.1929	0.72	0.8528	0.5976	

Firmness (N) First Harvest 2024					
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	1.42 Bb	2.09 Ab	1.46 Aba	1.91 Aa	<.0001
Osage	1.38 Bb	2.01 Abb	1.364 Ba	2.031 Aa	<.0001
Ponca	1.43 Bc	1.81 Bab	1.59 Abc	2.019 Aa	<.0001
Ouachita	1.65 Ab	2.18 Aa	1.351 Bc	1.37 Bc	<.0001
P-value	<.0001	0.0002	0.0012	<.0001	

Table 19. Firmness values of four blackberry cultivars at harvest and at different storage intervals. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between Cultivars and lowercase letters (a) represent differences between days of storage.

Table 20: Firmness values of four blackberry cultivars at harvest and at different storage intervals Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between Cultivars and lowercase letters (a) represent differences between days of storage.

Firmness (N) Second Harvest 2024					
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	2.1 Aba	2.09 Aa	1.51 Ab	1.28 Abc	<.0001
Osage	2.12 Aa	2.01 ABa	1.56 Ab	1.38 Ab	<.0001
Ponca	1.9 Ba	1.81 Ba	1.31 Cb	1.23 Bb	<.0001
Ouachita	2.03 Aba	2.18 Aa	1.35 BCb	1.06 Cc	<.0001
P-value	0.0266	0.0002	<.0001	<.0001	

Table 21: Firmness values of four blackberry cultivars at harvest and at different storage intervals. Difference letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between Cultivars and lowercase letters (a) represent differences between days of storage.

Firmness (N) Third Harvest 2024					
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	1.61 Ba	1.41 Bb	1.26 Bb	1.61 Ba	<.0001
Osage	1.78 Ab	1.46 Abc	1.57 Ac	2.08 Aa	<.0001
Ponca	1.81 Aa	1.59 Ab	1.21 Bc	1.74 Bab	<.0001
Ouachita	1.73 Aba	1.44 ABb	1.13 Bc	1.53 Bab	<.0001
P-value	0.0096	0.026	<.0001	<.0001	

Table 22: Total Soluble Content expressed as degree Brix ° of four different blackberry cultivars. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

	Soluble Solids (%) First Harvest 2024				
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	9.57 Aa	7.33 Aa	7.83 Aa	8.77 Aa	0.6242
Osage	8.3 Aa	7.03 Aa	6.77 Aa	7.43 Aa	0.4907
Ponca	8.77 Aa	9 Aa	7.57 Aa	8.67 Aa	0.6862
Ouachita	8.63 Aa	8.3 Aa	6.03 Aa	7.1 Aa	0.1294
P-value	0.8595	0.4974	0.4738	0.3955	

Table 23: Total Soluble Content expressed as degree Brix ° of four different blackberry cultivars. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

	Soluble Solids (%) Second Harvest 2024				
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	9.93 Aa	7.27 Aa	7.97 Aa	9 Aa	0.379
Osage	6.03 Aa	7.87 Aa	7.8 Aa	7.13 Aa	0.4558
Ponca	7.27 Aa	7.13 Aa	9.03 Aa	9.47 Aa	0.5477
Ouachita	7.57 Aa	7.03 Aa	6.77 Aa	7.43 Aa	0.7568
P-value	0.1429	0.9724	0.378	0.0845	

Table 24: Total Soluble Content expressed as degree Brix ° of four different blackberry cultivars. Different letters represent significant differences under Tukey's HSD at the 0.05 confidence level. Uppercase letters (A) represent differences between cultivars and lowercase letters (a) represent differences between days of storage.

	Soluble Solids (%) Third Harvest 2024				
Cultivar					
Days of Storage	0	7	14	21	P-Value
Caddo	8.83 Aa	7.57 Aa	8.67 Aa	7.13 Aa	0.6515
Osage	7.1 Aa	7.63 Aa	8 Aa	5.63 Aa	0.5034
Ponca	7.97 Aa	5.9 Aa	9 Aa	8.3 Aa	0.5032
Ouachita	9.3 Aa	7.87 Aa	7.8 Aa	7.13 Aa	0.3661
P-value	0.1929	0.72	0.8528	0.5976	

Conclusion

'Ouachita' was the least favored cultivar. 'Osage,' 'Caddo,' and 'Ponca' had numerically higher ratings for sweetness, size, and overall flavor following the first and third harvests, though differences were not consistently significant for all cultivars. 'Ouachita' had higher RDR at harvest, but RDR decreased after storage, maybe due to anthocyanin degradation.

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Fig. 2. The four blackberry cultivars released by the University of Arkansas commonly grown in South Georgia.

Figure 3. Hand harvesting blackberries in a commercial field located in Irwin County, Georgia

Figure 4. Firmness assessment using the FruitFirm®1000