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Pyrene Attributes and Seediness Evaluation of Blackberry Genotypes

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Abstract

Fresh market blackberries can feel "seedy" when consumed. This "seediness" is associated with the presence of pyrenes which are comprised of a single seed enclosed in an endocarp. Small pyrene size (< 3 mg) is preferred in both fresh-market and processed blackberry products. Yet, the proportion of pyrene weight to total berry weight can be more important than pyrene size. The objective of this study was to determine and compare descriptive sensory analysis and pyrene characteristics of blackberry genotypes from the University of Arkansas Division of Agriculture blackberry breeding program. Panelists were trained according to Spectrum® methods and evaluated 20 genotypes for overall seediness. Pyrene characteristics, including weight and dimension, were measured. Six of the 22 genotypes had an individual pyrene weight of 3 mg or less. 'Tupy' had low individual pyrene weights and a low pyrene weight/berry weight ratio, which are most likely factors that contribute to its widespread acceptance by consumers. Pyrene weight/berry weight ratio was positively correlated to descriptive overall seediness (r = 0.70) but not to number of pyrenes/berry. Therefore, finding a desirable pyrene weight to berry weight ratio is integral to decreasing perceived seediness in the development of new blackberry cultivars.

Blackberries are grown throughout the United States and in other countries and used for both fresh market and processing. Blackberries are classified as a member of the *Rosaceae* family and *Rubus* genus (Finn and Clark, 2012). A blackberry fruit is an aggregate fruit comprised of many drupelets surrounding the receptacle or torus. An individual drupelet includes a thin exocarp, a fleshy mesocarp and a hard, lignified endocarp, also known as a pyrene, which encloses a single seed (Tomlik-Wyremblewska et al., 2010).

The structure, size, and number of pyrenes may influence mouth feel of the blackberries when consumed (Clark et al., 2007). Small seed size (< 3 mg) is preferred in both fresh-market and processed blackberry products (Moore et al., 1975). Fruit qualities such as seediness are important to consumers whether the berries are processed or consumed fresh (Clark and Finn, 2008). Large pyrene size, based on weight or volume and seediness are also undesirable in processed blackberry products (Takeda, 1993). Yet, the proportion of pyrene weight to total berry weight can be considered as more important than pyrene size (Darrow and Sherwood, 1931).

Even though studies on blackberry pyrene characteristics and morphology on a limited number of cultivars have been published, there is little information on descriptive sensory analysis of fresh blackberries and the composition attributes that affect sensory scoring. The objective of this study was to investigate the descriptive sensory analysis and composition of blackberry genotypes from the University of Arkansas blackberry breeding program.

Materials and Methods

Blackberry fruits were hand-harvested from the Fruit Research Station, Clarksville, AR in 2012. Six cultivars and 15 breeding

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selections were harvested from late May until mid-June (Table 1). In addition, blackberries were purchased commercially including 'Tupy' (Naturipe, Salinas, CA; fresh-market blackberries imported from central Mexico) and commercial frozen blackberries (Great Value, Wal-Mart Stores, Inc. Bentonville, AR, cultivar unknown).

Descriptive sensory analysis of the fresh berries was performed the same day as harvested at the Sensory and Consumer Research Center, University of Arkansas, Fayetteville. Eight descriptive panelists participated in a 3 h orientation session where the descriptive ballot was developed through consensus. The commercial frozen blackberries were thawed and used as the reference sample at each session and were scored a 7 for overall seediness on a 10-point scale (0 = no seeds to 9 = extremely seedy).

Three samples of approximately 100 g of berries were collected for each genotype and stored in plastic bags at -20°C for composition analysis. From the frozen berries, three berries per genotype and replication were used to determine the following pyrene attributes: number/berry, dry weight/berry, and individual pyrene length, width, and height.

After extraction using pectinase enzyme, the pyrenes for each three-berry sample were counted and weighed. The pyrenes were further dried in a laboratory oven at 55°C for approximately 24 h. The pyrenes were weighed and the dimensions of six randomly selected pyrenes per genotype and replication were measured with a digital caliper.

The experiment utilized a randomized complete block design with the 20 blackberry genotypes. Analysis of data was done with JMP® (version 8.0; SAS Institute Inc, Cary, NC). Tukey's HSD (Honestly Significant Difference) was used for mean

Table 1. Berry and pyrene attributes of blackberry genotypes.

Genotype	Pyrenes/ berry	Pyrene weight (mg)/ berry	Pyrene weight/ berry weight (%)	Pyrene volume (mm^3)[y]
A-2108	74 defghi [z]	324 cdef	3.8 bcdef	8.7 abcde
A-2215	67 fghi	226 fgh	3.0 ef	8.1 bcdefg
A-2312	92 cdef	330 cde	4.2 abcdef	8.9 abcd
A-2316	88 cdef	257 defgh	4.1 abcdef	7.0 defg
A-2416	73 efghi	183 gh	2.8 f	6.2 g
A-2418	91 cdef	356 bcd	4.8 abc	9.4 abc
A-2419	99 bcd	271 defg	3.5 cdef	6.5 fg
A-2434	110 abc	452 ab	4.7 abcd	10.7 a
A-2473	94 cde	317 cdef	4.6 abcd	7.6 cdefg
APF-156	125 a	380 bc	4.3 abcde	7.7 bcdefg
APF-185	70 efghi	245 efgh	3.6 cdef	8.7 abcde
APF-190	84 defg	276 defg	3.3 def	8.4 bcdef
APF-205	122 ab	313 cdef	4.1 abcdef	6.7 efg
APF-227	91 cdef	301 cdef	4.3 abcde	8.5 bcdef
Natchez	131 a	491 a	5.2 ab	8.9 abcd
Navaho	53 i	179 gh	3.4 cdef	8.0 bcdefg
Osage	73 efghi	273 defg	4.1 abcdef	8.4 bcdef
Ouachita	78 defgh	259 defgh	4.1 abcdef	7.2 defg
Prime-Ark® 45	85 cdefg	318 cdef	5.4 a	8.1 bcdefg
Tupy	53 hi	160 h	2.7 f	8.1 bcdefg

[z] Means with different letter(s) for each attribute are significantly different ($p<0.05$) using Turkey's HSD.

[y] Volume calculated as length x width x height.

separation. Pearson's correlation was used to describe the relationship within and between descriptive intensity scores and composition.

Results and Discussion

Scores for overall seediness as rated by the panelists were not statistically different among the genotypes evaluated (data not shown). The average overall seediness ratings ranged from 4.4 for 'Tupy' to 7.3 for A-2416. The lack of differences reflects substantial variation in the seediness ratings recorded by panelists.

'Natchez' contained the greatest number of pyrenes having on average 131/berry and 'Navaho' and 'Tupy' the least averaging 53/berry (Table 1). Number of pyrenes/berry for 'Natchez', A-2434, APF-156, and APF-205 were significantly higher than the averages for A-2108, A-2215, A-2416, APF-185, APF-190, 'Navaho', 'Osage', 'Ouachita', and 'Tupy'. Genotypes having individual pyrene weight of 3.0 mg or less included: A-2416 (2.5 mg), APF-205 (2.6 mg), A-2419 (2.7 mg), A-2316 (2.9 mg), 'Tupy' (3.0 mg), and APF-156 (3.0 mg); overall mean standard error for individual pyrene weight was 0.05. Genotypes A-2434 and A-2108 had individual pyrene weights of 4.0 mg or higher (data not shown). Average dry weight of pyrenes/berry varied from 160 mg ('Tupy') to 491 mg ('Natchez') (Table 1).

The proportion of pyrene weight per berry to total weight of berry is more important than pyrene size (Darrow and Sherwood, 1931). The pyrene weight/berry weight ratios for 'Prime-Ark® 45' and 'Natchez' were significantly higher than those for A-2215, A-2416, A-2419, APF-185, APF-190, 'Navaho', and 'Tupy'. Even though some genotypes had a high proportion of pyrene weight to berry weight, these did not necessarily have the most pyrenes per berry. For example, the proportion of pyrene weight per berry to total berry weight for 'Osage' and APF-205 was 4.1%. However, the average number of pyrenes/berry for APF-205 was 122 pyrenes/berry and was significantly higher than that for 'Osage' which had 73 pyrenes/berry. This was especially notable for 'Prime-Ark® 45' which had 85 pyrenes per berry and a proportion of 5.4%. Conversely, 'Navaho, and 'Tupy' had very low values for berry weight and average weight of pyrenes/berry. Pyrene volume ranged from 6.2 mm^3 (A-2416) to 10.7 mm^3 (A-2434) (Table 1).

Pearson's correlation was used to understand the relationship within and between descriptive intensity scores and composition attributes. For all genotypes, positive and negative correlations with significance were r = 0.98 - 0.70 ($p < 0.001$), r = 0.69 - 0.56 ($p < 0.01$), and r = 0.55 - 45 ($p < 0.05$).

Pyrenes/berry was positively correlated to pyrene weight/berry (r = 0.84) and pyrene weight/berry weight ratio (r = 0.63) (Table 2). Pyrene weight/berry was positively correlated to pyrene weight/berry weight ratio (r = 0.80). Descriptively-evaluated overall seediness was positively correlated to pyrene weight/berry (r = 0.51) and pyrene weight/berry weight ratio (r = 0.70).

Table 2. Correlations between sensory descriptive analysis and composition attributes.[z]

	Pyrenes/berry	Pyrene wt (mg)/berry	Pyrene wt/berry wt (%)	Overall seediness
Pyrenes/berry	1.00			
Pyrene wt (mg)/berry	0.84***	1.00		
Pyrene wt/berry wt (%)	0.63**	0.80***	1.00	
Overall seediness	0.25	0.51*	0.70***	1.00

[z] Correlations with significance were r=0.98 - 0.70 (p<0.001), r=0.69 - 0.56 (p<0.01), and r=0.50 - 45 (p<0.05), respectively, ***, **, and *.

Conclusions

Texture attributes, including seediness, are important to consumers and processors. Seven of the 22 genotypes had an individual pyrene weight of 3 mg or less and may be more accepted by consumers than those with higher pyrene weights. This may be a contributing factor to the widespread popularity of 'Tupy', which is grown in central Mexico but marketed in the United States from October until June. 'Prime-Ark® 45' had a high proportion of pyrene weight to berry weight and was scored among the highest for overall seediness. Conversely, 'Tupy' was among the lowest for both attributes. The positive correlation between pyrene weight to berry weight ratio and descriptive overall seediness supports Darrow and Sherwood's (1931) findings that can be useful for evaluating new developments in the Arkansas blackberry breeding program.

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