Examining Various Phytochemical Attributes of Southern Highbush and Rabbiteye Blueberry Genotypes

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Summary

Georgia blueberry production includes both rabbiteye (*V. virgatum* Aiton), sold as fresh and frozen, and southern highbush (species complex between *Vaccinium corymbosum* L. and *V. darrowii* Camp) sold primarily as fresh earlier in the season. The main objective of this study was to examine various phytochemical attributes of varieties grown in Georgia. Fruit were harvested at ca. 50% ripe from nine southern highbush and seven rabbiteye blueberry genotypes grown at the University of Georgia Blueberry Research Farm near Alapaha, GA during 2014. Southern highbush genotypes included 'Camellia', 'Emerald', 'Farthing', 'Legacy', 'Meadowlark', 'Rebel', and 'Star', and two advanced breeding selections: TH-1111 and TH-1125. Rabbiteye genotypes included 'Alapaha', 'Brightwell', 'Ochlockonee', 'Powderblue', 'Premier', 'Tifblue', and 'Vernon'. Fruit were frozen for seven to eight months before chemical analyses. Measurements included total titratable acids (TTA), soluble solids content (°brix), total monomeric anthocyanin concentration (mg/L cyanidin-3-glucoside equivalents), sugars, organic acids, antioxidants, and sugar acid ratio (°brix /TTA and total sugars/total acids).

Overall, southern highbush genotypes were significantly higher (P<0.05) for total titratable acids (0.69% vs. 0.43%), and rabbiteye genotypes were significantly higher for soluble solids (13.4% vs. 11.6%) and sugar acid ratio (°brix /TTA) (34.5 vs. 23.3). Sucrose was significantly higher in rabbiteyes (2.54 mg/g vs. 0.10 mg/g), and rabbiteyes were significantly higher for three of the six organic acids (oxalic, succinic, and malic acid) and were over 60% higher for total acids (12.2 mg/g vs. 7.5 mg/g). For antioxidants, rabbiteyes were 23% higher for catechin (39.7µg/g vs. 32.3µg/g), two times higher for caffeic acid (108.6 µg/g vs. 52.7 µg/g), over four times higher for quercetin (7,831 µg/g vs. 1,743 µg/g), 50% higher for ferulic acid (33.0 µg/g vs. 22.0 µg/g) and 37% higher for total antioxidants (20,482 µg/g vs. 14,934 µg/g). Results from this study show variation within genotypes for fruit quality and suggest that rabbiteye varieties are quite high in many important compounds. Future studies will be conducted to determine the effect of fruit quality across years and in consumer perception.

Fruit Collection and Traits Measured

Fruit Collection: Fruit from early, mid and late season ripening genotypes of 9 southern highbush (SHB), including 2 breeding selections, and 9 rabbiteye (RE), were collected from the UGA Blueberry Research Farm. Fruit were harvested from 3 plants (reps) per genotype when approximately 50% ripe, from May – July 2014. Fruit were packed in coolers, and transported back to UGA Griffin campus, Griffin, GA. Fruit were stored in freezer bags at approximately -15°C until processing.

Juice Extraction and Traits Evaluated: Frozen berries were thawed, and juice was extracted from 50+/- 1.0g of fruit. Titratable acids (TTA) (citric acid equivalents) were measured using a 0.01M NaOH solution to an endpoint titration of pH=8.1. Soluble solids content (°brix) were measured using a Digital Hand-held Pocket Refractometer. Total monomeric anthocyanin concentration (mg/L cyanidin-3-glucoside equivalents), sugars, organic acids, antioxidants, and sugar acid ratio (°brix /TTA and total sugars/total acids), as well as total sugar, organic acid, and antioxidant content were determined.

Data Analyses: Data were analyzed using PROC GLM in SAS (v.9.4) to examine genotype and type differences. Genotype differences were examined using the Tukey HSD (P≤0.05).

Results: °Brix and TTA

Table 1. Percent juice[A], total titratable acids (TTA), and soluble solids (°brix) in nine southern highbush (SHB) and seven rabbiteye (RE) genotypes harvested from Alapaha, GA in 2014.

	Genotype	N	% Juice	TTA	pH	°Brix	°Brix/TTA
SHB	Camellia	3	27.2 BDC[B]	0.88 BA	3.8 CEBD	11.3 EGF	12.9 G
	Emerald	3	42.2 BAC	1.06 A	3.8 CEBD	11.9 EGDF	11.3 G
	Farthing	2	33.3 BDAC	0.57 FBEDC	3.8 CEBD	12.2 EDF	22.1 FGED
	Legacy	3	23.3 DC	0.87 BAC	3.9 CBD	10.6 G	13.5 G
	Meadowlark	3	35.3 BDAC	0.31 FE	4.5 A	12.2 EDF	40.3 BDC
	Rebel	3	19.3 DC	0.22 F	4.6 A	13.1 BDC	61.6 A
	Star	3	23.9 DC	0.58 BEDC	4.1 B	11.4 EGF	19.7 FGE
	TH-1111	3	53.9 A	0.65 BDC	4.0 CB	11.3 EGF	17.5 FG
	TH-1125	3	29.6 BDC	1.00 A	3.8 CEBD	10.8 GF	11.0 G
RE	Alapaha	3	20.2 DC	0.36 FED	3.9 CBD	13.9 BAC	38.4 BEDC
	Brightwell	3	49.3 BA	0.29 FE	4.0 CB	14.5 BA	51.3 BA
	Ochlockonee	3	29.1 BDC	0.33 FED	3.7 CED	14.9 A	45.4 BAC
	Powderblue	3	27.2 BDC	0.54 FEDC	3.5 E	14.9 A	27.9 FGEDC
	Premier	3	18.8 D	0.56 FBEDC	3.6 ED	11.2 GF	22.1 FGED
	Tifblue	3	56.9 A	0.62 BEDC	3.7 CED	12.6 EDC	20.5 FGE
	Vernon	3	36.9 BDAC	0.33 FED	3.7 CED	11.9 EGDF	36.2 FBEDC
SHB		26	32.0 A	0.69 A	4.0 A	11.6 B	23.3 B
RE		21	34.0 A	0.43 B	3.7 B	13.4 A	34.5 A

[A] % Juice of fruit (mL of juice / g fresh weight). [B] % Differences examined using the Tukey HSD (P≤0.05).

Results: Sugars, Acids, Anthocyanins and Antioxidants

Table 2. Sugars[A] and relative sweetness[B] in nine southern highbush (SHB) and seven rabbiteye (RE) genotypes harvested from Alapaha, GA in 2014.

	Genotype	N	Sucrose	Glucose	Fructose	Total Sugar	Total Sugar/ Total Acid[A]	Relative Sweetness
SHB	Camellia	3	0.03 D[C]	15.1 BC	15.8 DC	30.9 DC	4.9 A	39.0 BC
	Emerald	3	0.04 D	22.1 BAC	21.8 BDAC	44.0 BDAC	3.5 A	54.9 BAC
	Farthing	2	0.01 D	19.5 BAC	20.5 BDAC	40.0 BDAC	5.7 A	50.6 BAC
	Legacy	3	0.02 D	19.5 BAC	12.9 D	25.7 D	4.2 A	32.1 C
	Meadowlark	3	0.42 D	12.1 C	19.8 BDC	39.7 BDC	6.8 A	49.7 BC
	Rebel	3	0.02 D	12.3 C	13.2 D	25.3 D	5.0 A	41.4 BC
	Star	3	0.26 D	27.9 BA	13.0 D	25.6 D	5.8 A	32.2 C
	TH-1111	3	0.05 D	13.3 C	14.2 DC	56.2 BAC	4.0 A	32.3 C
	TH-1125	3	0.03 D	11.9 C	12.6 D	27.5 DC	4.3 A	70.5 BA
RE	Alapaha	3	1.69 CD	32.4 A	35.0 A	26.3 DC	13.3 A	34.8 BC
	Brightwell	3	2.78 CB	12.8 C	16.3 DC	70.1 BA	4.8 A	32.7 BC
	Ochlockonee	3	1.33 CD	15.5 BC	17.8 DC	33.1 DC	2.5 A	88.2 A
	Powderblue	3	3.31 B	17.0 BC	8.8 D	38.0 DC	2.5 A	47.1 BC
	Premier	3	0.02 D	8.1 C	28.3 BAC	16.9 D	2.4 A	21.5 C
	Tifblue	3	7.21 A	32.3 A	32.8 BA	72.3 A	3.4 A	88.8 A
	Vernon	3	1.42 CD	11.7 C	13.4 DC	26.5 DC	3.9 A	33.7 BC
SHB		26	0.10 B	17.1 A	17.6 A	34.8 A	4.9 A	43.8 A
RE		21	2.54 A	18.4 A	19.5 A	40.5 A	4.7 A	50.5 A

[A] Values expressed in mg/g fresh weight. [B] Relative sweetness=(sucrose*1)+(glucose*0.75)+(fructose*1.75). [C] Differences examined using the Tukey HSD (P≤0.05).

Table 3. Acids[A] in nine southern highbush (SHB) and seven rabbiteye (RE) genotypes harvested from Alapaha, GA in 2014.

	Genotype	N	Oxalic	Citric	Tartaric	Ascorbic	Succinic	Malic	Total Acids
SHB	Camellia	3	0.0020 EF[B]	2.36 CB	0.10 A	0.12 CD	0.32 C	0.20 BAC	6.3 DEC
	Emerald	3	0.0031 EF	4.25 A	0.15 A	0.18 BC	2.41 BC	0.16 BAC	12.5 BDEC
	Farthing	2	0.0025 EF	1.62 CBD	0.09 A	0.15 BCD	1.38 BC	0.07 BAC	6.9 BDEC
	Legacy	3	0.0017 EF	0.95 ED	0.21 A	0.09 CD	0.22 C	0.05 BC	5.8 DE
	Meadowlark	3	0.0026 EF	1.11 ED	0.02 A	0.16 BCD	1.16 BC	0.10 BAC	5.9 DEC
	Rebel	3	0.0014 F	0.25 E	0.07 A	0.09 CD	1.26 BC	0.07 BC	5.0 DE
	Star	3	0.0018 EF	1.22 CED	0.01 A	0.10 CD	0.74 BC	0.07 BC	4.4 E
	TH-1111	3	0.0040 EDF	2.81 B	0.13 A	0.24 BA	2.59 BC	0.11 BAC	14.3 BAC
	TH-1125	3	0.0022 EF	2.83 B	0.10 A	0.13 CD	0.82 BC	0.10 BAC	6.5 DEC
RE	Alapaha	3	0.0047 EDF	0.09 E	0.09 A	0.07 D	1.51 BC	0.03 C	5.3 DE
	Brightwell	3	0.0141 A	0.21 E	0.08 A	0.24 BA	2.31 BC	0.13 BAC	15.0 BA
	Ochlockonee	3	0.0083 BDC	0.14 E	0.02 A	0.15 BCD	3.94 BA	0.16 BAC	13.1 BDAC
	Powderblue	3	0.0098 BAC	0.19 E	0.05 A	0.13 CD	6.46 A	0.08 BAC	15.3 BA
	Premier	3	0.0065 EDC	0.10 E	0.03 A	0.09 D	1.41 BC	0.27 A	7.0 BDEC
	Tifblue	3	0.0115 BA	0.35 ED	0.10 A	0.30 A	6.48 A	0.24 BA	21.3 A
	Vernon	3	0.0044 EDF	0.23 E	0.07 A	0.12 CD	4.27 BA	0.08 BAC	8.5 BDEC
SHB		26	0.0024 B	1.95 A	0.10 A	0.14 A	1.21 B	0.10 B	7.5 B
RE		21	0.0085 A	0.19 B	0.06 A	0.16 A	3.77 A	0.14 A	12.2 A

[A] Values expressed in mg/g fresh weight. [B] Differences examined using the Tukey HSD (P≤0.05).

Table 4. Total anthocyanins[A] and antioxidants[B] in nine southern highbush (SHB) and seven rabbiteye (RE) genotypes harvested from Alapaha, GA in 2014.

	Genotype	N	Total Anthocyanins	Catechin	Caffeic Acid	Quercetin	Ferulic Acid	Total Antioxidants
SHB	Camellia	3	131.9 A[C]	32.7 BDC	14.6 C	796.8 E	13.3 CD	9,438 DC
	Emerald	3	161.2 A	34.8 BDC	98.7 BC	3,601.1 ED	24.8 CBD	24,443 BAC
	Farthing	2	156.8 A	40.3 BDAC	14.3 C	736.1 E	31.4 CBD	11,908 BDC
	Legacy	3	.	23.8 D	20.2 C	1,457.8 E	17.2 CD	9,037 DC
	Meadowlark	3	118.7 A	35.3 BDC	36.2 C	856.9 E	28.0 CBD	18,904 BDAC
	Rebel	3	118.6 A	23.1 D	13.0 C	516.2 E	5.6 D	6,296 D
	Star	3	109.9 A	20.6 D	60.8 BC	2,176.4 ED	15.0 CD	9,238 DC
	TH-1111	3	114.2 A	53.4 BAC	136.2 BAC	3,160.0 ED	44.5 B	31,429 A
	TH-1125	3	182.6 A	29.0 DC	64.0 BC	1,979.7 E	20.9 CBD	12,590 BDC
RE	Alapaha	3	147.6 A	19.5 D	31.3 C	2,653.0 ED	21.2 CBD	8,231 DC
	Brightwell	3	127.4 A	59.6 BA	125.9 BAC	9,914.1 BAC	32.0 CB	30,252 A
	Ochlockonee	3	197.2 A	30.3 DC	230.9 A	15,627.2 A	36.2 CB	30,012 BA
	Powderblue	3	174.9 A	39.9 BDC	181.4 BA	10,730.7 BA	77.4 A	23,931 BAC
	Premier	3	115.1 A	27.2 DC	42.0 C	3,992.5 EDC	13.7 CD	7,541 D
	Tifblue	3	192.9 A	67.5 A	99.0 BC	8,350.7 BDC	34.0 CB	27,971 BA
	Vernon	3	132.3 A	33.9 BDC	49.6 C	3,549.4 ED	16.4 CD	15,440 BDAC
SHB		26	135.4 A	32.3 B	52.7 B	1,743.5 B	22.0 B	14,934 B
RE		21	155.4 A	39.7 A	108.6 A	7,831.1 A	33.0 A	20,482 A

[A] Total monomeric anthocyanin concentration expressed in (mg/L cyanidin-3-glucoside equivalents). [B] Values expressed in µg/g fresh weight. [C] Differences examined using the Tukey HSD (P≤0.05).

Summary: Comparing SHBs to REs

- Overall there were significant differences for genotypes for nearly all traits examined (Tables 1-4).
- SHBs were higher than REs for TTA, and REs were higher than SHBs for °brix and °brix/TTA (Table 1).
- Sucrose was higher in REs, and SHBs and REs were not different for all other sugars, including relative sweetness (Table 2).
- REs were higher than SHBs for three of the six acids profiled and total acids. SHBs were higher than REs for citric acid. SHBs and REs were not different for taratric acid and ascorbic acid (Table 3).
- REs were higher than SHBs for all four antioxidants examined, including total antioxidants (Table 4).

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