Compositional differences among some wild grape germplasms native to East Asia

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Introduction

Sugars and organic acids are basic parameters to determine grape quality. Major organic constituents of grape such as sugars and organic acid composition determine the edibility of grape berry and final alcohol content of unfortified wine (Kliewer, 1967). Organic acids stabilize color and reduce microbial deterioration. Shiraishi (1995 and 1993) analyzed 259 grape accessions and proposed new descriptor for organic acids and sugars to evaluate grape germplasm. Compositional characterization of grape germplasm is necessary not only for chemotaxonomic classification but also for breeding purposes. Major grape genotypes such as *V. vinifera* (Kliewer, 1967), *V. labruscana* (Kluba *et al.*, 1978) and *V. rotundifolia* (Carroll and Marcy, 1982) have already been characterized for their berry composition but other minor grapes native to East Asia has been the object of fewer studies despite their potential characters. Hence, the aim of this study was to characterize the berry composition such as total soluble solids (TSS), titratable acidity (TA), organic acids (tartaric, malic and citric) and sugar composition (fructose, glucose and sucrose) of five wild grapes native to East Asia and two hybrids for possible industrial and breeding purposes. Comparisons were done with that of *V. vinifera* cv. Muscat of Alexandria, a white grape and Bailey Alicante A (*V. labruscana* cv Bailey x *V. vinifera* cv. Alicante Bouscat), a tenturier type grape.

Materials and methods

Plant materials and sample collection

Five wild grape genotypes, two hybrids derived from wild and cultivated grapes and two cultivated grapes, were used in this experiment (table 1). Except for *V. coignetiae* Pulliat, which was collected from vineyard of Hiruzen winery (Okayama, Japan), all other grapes were collected from experimental vineyards of Kagawa University (Sanuki City, Japan). The vines were pruned in February and trained in vertical trellis. Fifty to one hundred berries were harvested from three clusters of different vines on day 45 after veraison (DAV). Regular size berries were used as sample for TSS, TA, organic acids and sugar analyses. Samples were kept at -20 °C until further analysis.

Berry composition analysis

TSS (°Brix) was measured using a digital refractometer (Atago Co., Ltd., Japan) while TA was shown as tartaric acid content by titrating the juice with 0.1N NaOH to pH 8.1. For sugar and organic acid analyses, three to five gram of flesh was taken from 10 berries and homogenized (ultra sonic blender, Janke and Kunkel, Germany) with MilliQ water at 24,000 rpm for one minute. The mixture

was incubated at 60 °C for 30 min and centrifuged at 3,500 rpm for 10 min. The supernatant was collected and the residual tissue was re-extracted following the same procedure. Both extracts were mixed and filtered through a 0.47 μm filter (Waters Co, USA). The filtrate was further purified by passing through Sep-Pak C18 cartridge (Waters Co, USA). The Sep-Pak was preconditioned with 5 ml of 75 % acetonitrile and washed with 5 ml of distilled water before use. The elluent was diluted in appropriate concentrations using 75 % acetonitrile and was used for sugar and organic acids analyses by high performance liquid chromatography (HPLC; pump: PU 980; detector: RI-930, Jasco Inc. Tokyo, Japan). Sugar was eluted using a Shodex Asahipak NH2-504E column with 75 % acetonitrile-water (75:25) at a flow rate of 1 ml min^{-1} at 30 °C while organic acid was analyzed using a Develosil RPAQUEOUS-AR column with 0.1 % phosphoric acid (H_3PO_4) at a flow rate of 0.4 ml min^{-1} at 25 °C. Sugar and organic acids were identified based on their order of elution and retention time of the standard compounds and quantification was done by external standard method.

Data analysis

Differences between means were calculated by Duncan's Multiple Range Test (DMRT) at 5 % level of significance. Computations were done by SPSS for windows (Version 13.0).

Results and discussion

The wild grapes and their progenies showed wide variations in berry composition. Among the wild grape genotypes and their hybrids, *V. ficifolia* var. *ganebu* and Shiohitasibudou (tentative name) has the lowest (12.0) and highest (20.6) TSS value, respectively (figure 1). However, the TSS value of Shiohitasibudou was significantly higher ($p = 0.05$) compared with that of Muscat of Alexandria and Bailey Alicante A. On the other hand, the lowest (0.4 %) TA was obtained from *V. ficifolia* var. *ganebu* while the highest (1.9 %) TA was found in *V. coignetiae* Pulliat (figure 2). Muscat of Alexandria showed lower TA value compared to that of all wild grapes.

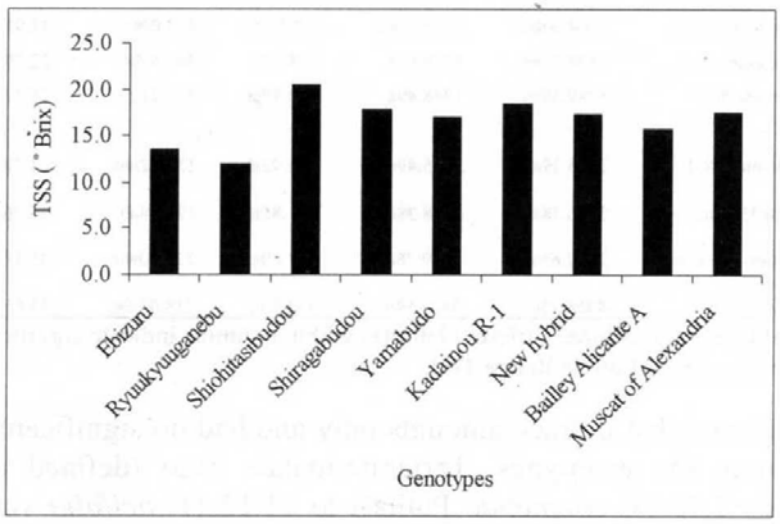

Figure 1 - TSS of wild grapes and their progenies.

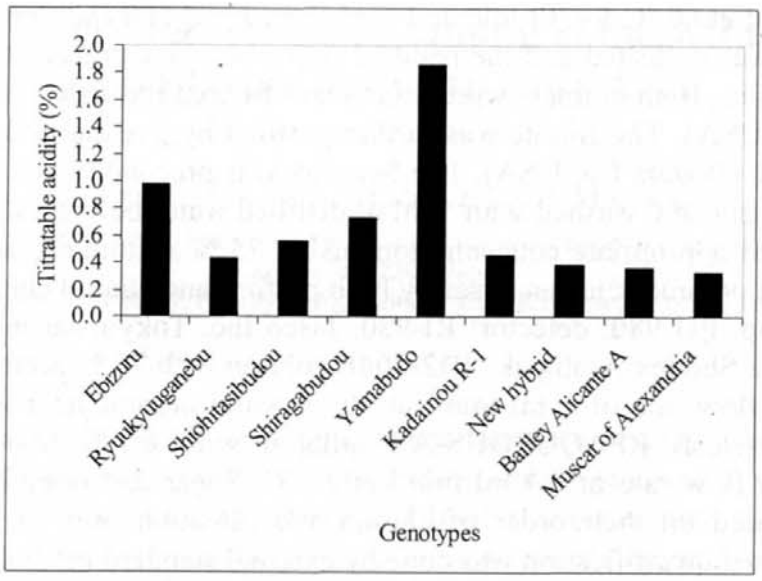

Figure 2 - TA of wild grapes and their progenies.

Fructose and glucose were found as major sugars and sucrose was only detected in trace amount. Among the wild grape genotypes and their hybrids, both the fructose and glucose sugars were recorded highest in Shiohitasibudou. The glucose-fructose ratio (defined as α ratio) was lower than that of Muscat of Alexandria and Bailey Alicante A in all wild grapes and their progenies. In addition to TSS, Shiohitasibudou grape contained highest amount of tartaric acid while *V. ficifolia* var. *lobata* contained highest amount of malic acid (table 1).

Table 1 - Sugar and organic acid composition of wild grapes and their progenies.

Scientific name or hybrid combinations	Common name	Sugar (mg/100 g fresh weight)		Organic acids (mg/100 g fresh weight)			α ratio	β ratio
		Glucose	Fructose	Tartarate	Malate	Citric		
V. ficifolia var. *lobata*	Ebizuru	1143.90[a]	1286.17a	1088.93bc	446.95c	44.21	0.89	2.44
V. ficifolia var. *ganebu*	Ryuukyuuganebu	1264.12ab	1560.69a	835.08ab	75.19a	19.32	0.81	11.11
V. sp.	Shiohitasibudou	3164.60bc	3434.95ab	1405.54c	373.00bc	42.91	0.92	3.77
V. shiragai	Shiragabudou	1404.71ab	1578.61a	548.12a	387.69bc	22.39	0.89	1.41
V. coignetiae Pulliat	Yamabudou	1789.39ab	1948.49a	759.73ab	439.21c	25.37	0.92	1.73
V. ficifolia var. *ganebu* x *V. vinifera* cv. Muscat of Alexandria	Kadainou R-1	2603.19ab	2825.49ab	673.92ab	155.02abc	14.79	0.92	4.35
Kadainou R-1 x Bailey Alicante A	New Hybrid	3046.18ab	3288.38ab	701.85ab	124.18ab	39.06	0.93	5.65
V. labruscana x *V. vinifera*	Bailey Alicante A	2859.65ab	3029.78ab	867.60ab	270.50abc	45.14	0.94	3.21
V. vinifera L.	Muscat of Alexandria	4468.25c	4409.59b	463.35a	288.03abc	31.61	1.01	1.61

Data are means of three replications. Different letter(s) within columns indicate significant difference at $p = 0.05$ by the Duncan's Multiple Range Test.

Citric acid was recorded in trace amounts only and had no significant difference ($p = 0.05$) among the genotypes. Tartarate-malate ratio (defined as β ratio) ranged between 1.73 (*V. coignetiae* Pulliat) to 11.12 (*V. ficifolia* var. *ganebu*). Several factors such as stage of maturity (Caroll and Mercy, 1982), variety and climate (López-Tamames *et al.*, 1996) are known to influence berry composition. Considering the berry composition of wild grapes native to East

Asia, these grapes can be utilized for wine or juice making purposes. Some grape genotypes showed specific characters such as extremely higher amount of tartaric acid and considerable amount of TSS in Shiohitasibudou, very low malic acid in *V. ficifolia* var. *ganebu* and very high amount of TA in *V. coignetiae* Pulliat. Hence, these traits can be used for breeding new grapes of desired characters.

Acknowledgement
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