

Research Note

A new grape cultivar 'Cheongsan' developed by a cross between genetic resources of Korean native *Vitis amurensis* Rupr.

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Key words: disease resistance; health-promoting substances; *Vitis amurensis* Rupr.

Introduction: Grape (*Vitis* sp.) belongs to the Family Vitaceae and is a commercially important fruit crop of Korea. In Korea grape cultivation began in the 14th century, and still ranks fifth in fruit production following apple, pear, citrus and persimmon. Korean grape cultivation area and production have declined substantially since 2000 because significant quantities of grapes have been imported from Chile and the United States. The primary grape cultivars produced in Korea are 'Campbell Early', 'Kyoho' and 'Muscat Bailey A', which account for over 90 % of total grape production in Korea (PARK *et al.* 2015a). There is a shortage of domestic grapes in Korea, and it is assumed that it would be difficult to compete with imported grapes. Recently, the amount of health-promoting substances has been considered as one of the most important factors for consumers to choose fruits and vegetables in the Korean market (LEE *et al.* 2012, JUN *et al.* 2013); thus, developments of new grape cultivars high in health-promoting substances may enhance the competitiveness of the Korean grape industry.

Vitis amurensis Rupr. is a member of the family Vitaceae and is found in several regions of Korea (PARK *et al.* 2005). It has been regarded as a healthy fruit with phytochemicals including flavonoids and phenolic compounds (JANG *et al.* 2015). Consumption of American and European grape cultivars in Korea has decreased, but consumption of *V. amurensis* has increased. In addition, *V. amurensis* is highly resistant to cold and disease (LIU and LI 2013), and can be easily cultivated in Korea which has humid summers and relatively cold winters. Fruits of *V. amurensis* generally have exceptionally high acidity and unstable productivity, and the introduction or breeding of *V. amurensis* with stable productivity is becoming more important to table grape growers in Korea. 'Gaeryangmeoru' was developed specifically for Korean vineyards by crossing wild grape species with 'Concord' but it failed to satisfy table grape growers in Korea since it had no attractive characteristics compared to other wild type *V. amurensis*. For this reason, the Gangwondo Agricultural Research and Extension Ser-

vices (GARES) has operated a breeding program to develop grapes with high fruit functionality and better productivity using *V. amurensis* Rupr. collected in Korea since 1990. As a result, we developed 'Cheongsan', and report its main characteristics in this paper.

Material and Methods: A total of 155 Korean native clones of *V. amurensis* Rupr. were collected from several regions of Korea, and their agricultural traits were evaluated from 1995 to 1998. From pilot experiments, we found wide genetic variations existed among accessions, and some had attractive agricultural characteristics, such as a unique aroma and high disease resistance. In 1999, 'Cheongsan' was obtained from a cross between KW-03 and KW-10 which had the most attractive fruit and vine characteristics among our genetic resources (Fig. 1). In 2000, 'Cheongsan' was initially named 'Gangwon-202' and grown in nursery box soil at the GARES orchard in Chuncheon, Korea. In 2001, it was transplanted and propagated at GARES farm, and three vines were spaced 3 m (between rows) x 2 m (between plants) and trained to an overhead arbor. No special irrigation was applied, and the soil surface was managed by sod

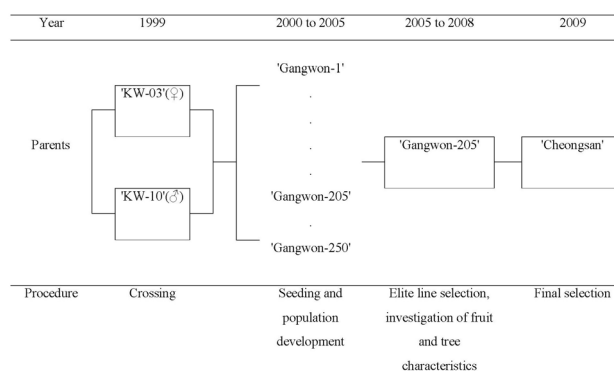


Fig. 1: Pedigree of 'Cheongsan' (*V. amurensis*) grape.

culture during the growing season. Bearing branches were spur pruned to two-buds every Feb., and the flowers were thinned 10 d before bloom. From 2002 to 2005, characteristics of these three vines were investigated following UPOV standards (UPOV 1994). Fruit and vine characteristics were also evaluated from 2005 to 2008. New grape cultivars must be resistant to downy mildew and gray mold to be widely cultivated in Korea, and these diseases were also evaluated in the field and *in vitro*, respectively. Resistance to downy mildew was determined by a severity evaluation using a graded scale ranging from 1 to 9 as follows: 1: highly resistant; 3: resistant; 5: moderately resistant; 7: susceptible; 9: highly susceptible (IPGRI 1997). Gray mold resistance was investigated by inspecting aqueous suspensions of *Botrytis* on fruit. The severity of the gray mold was rated using a 1 to 5 scale for lesion appearance and size. No visual evidence of gray mold was 1, less than 10 % of the surface infected was 2, 10-30 % infected was 3, 30-70 % was 4, and greater than 70 % was 5 (ARCHBOLD *et al.* 1997). Harvest time was established based on fruit maturity. Five berries were taken

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from each of three vines at the time of optimum maturity to investigate fruit characteristics. Fruit cluster weight was measured from the total average weight of 15 clusters, and berry weight was determined. Total soluble solids concentration was measured on each berry by expressing juice from each side of the fruit onto a digital refractometer (Atago PR-101, Japan). Titratable acidity of each berry was measured with an automatic titrator (Schott Titro-line alpha, Mainz, Germany), where the juice was titrated to an end-point of pH 8.2 using 0.1 N sodium hydrogen phthalate. Anthocyanin and resveratrol concentrations were measured using an extract obtained from 100 mg of berry skin using high-performance liquid chromatography (1100, Agilent, USA). The reference cultivar, 'Gaeryangmeoru', was also included for comparison, and it was cultivated in the same vineyard with typical management practices.

Results and Discussion: Shoot growth of 'Cheongsan' starts immediately after bud break and progresses quickly, but decreases steadily after full bloom. The shoots grow rapidly as berries mature, indicating that the shoot growth pattern of 'Cheongsan' is similar to that of commercial grapes. 'Cheongsan' is adapted to cold climates with no frost bud damage occurring at -30 °C in Chuncheon. It also has resistance to downy mildew and gray mold. Field evaluations under high temperatures and humidity favorable to the development of disease show that 'Cheongsan' is highly resistant (grade 1) to downy mildew. *In vitro* tests also indicate 'Cheongsan' is resistant (grade 1) to gray mold. Hence, it is expected that 'Cheongsan' is well adapted to and easily cultivated in local growing conditions. 'Cheongsan' reaches full flowering on May 15, and the average harvest date is Sept. 18. The number of days from full bloom to harvest is 123 d, which is 6 d longer than 'Gaeryangmeoru' (Table). The cluster appearance is excellent with uniform shape (Fig. 2), and the mean cluster weight is 83.4 g, 30.4 g heavier than 'Gaeryangmeoru'. Because the cluster weight is comparatively low, retaining two bearing canes does not delay fruit development or maturity. Fruit skin color at optimum maturity is black, and average berry weight is 1.3 g, with abundant juice

and a soft texture. In addition, 'Cheongsan' fruit has a rich ginseng aroma, similar to 'Cheongpung' (PARK *et al.* 2015b). Average total soluble solids concentration of 'Cheongsan' was 16.3 °Brix, 2.2 °Brix higher than 'Gaeryangmeoru'. Titratable acidity of 'Cheongsan' is slightly higher than for 'Gaeryangmeoru'. Skin cracking is not commonly observed in 'Cheongsan' or 'Gaeryangmeoru'. The anthocyanin and resveratrol concentrations of 'Cheongsan' were 60.4 mg·g⁻¹ and 0.25 µg·g⁻¹, respectively, which are much higher than those of 'Gaeryangmeoru'. These values are also three or four times higher than some American and European grape cultivars (data unpublished). In conclusion, it has been investigated that 'Cheongsan' has abundant health promoting substances, stable growth characteristics and high resistances to disease and freezing temperature. Hence, introduction of 'Cheongsan' will contribute to the diversification of Korean grape cultivars and to the maintenance of competitiveness of the Korean grape industry.



Fig. 2: Fruit appearance of newly bred 'Cheongsan' grape at harvesting season.

Passport data on this cultivar can be found under 'variety number vivc23609' in the *Vitis* International Variety Catalogue (<http://www.vivc.de>).

Table

Vine and fruit characteristics of 'Cheongsan' and 'Gaeryangmeru' grapes. Values are means recorded from 2005-2008 in Chuncheon, Republic of Korea

Characteristics	Cultivar	
	Cheongsan	Gaeryangmeoru
Tree		
Vigor	moderately vigorous	vigorous
Resistance to downy mildew	1	1
Resistance to gray mold	1	2
Flowering date	15 May	18 May
Yield (kg·10 acre ⁻¹)	12,000	10,000
Fruit		
Harvest date	18 Sept.	15 Sept.
Days from full bloom to maturity	123	117
Cluster weight (g)	83.4	53.0
Cluster shape	Conical	Conical
Berry weight (g)	1.3	1.0
Berry shape	Circular	Circular
Berry skin color	Black	Black
Total soluble solids (°BX)	16.3	14.1
Titratable acidity (%)	1.02	0.95
Anthocyanin content (mg·g ⁻¹)	60.4	16.6
Resveratrol content(µg·g ⁻¹)	0.25	0.12
Aroma	Yes	No

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