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Seasonal Variations in Yields of Hwangchil Lacquer and Major Sesquiterpene Compounds from Selected Superior Individuals of *Dendropanax morbifera* Lév.

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We studied fluctuations in the production of Hwangchil lacquer and major essential oils by *Dendropanax morbifera* Lév. Considerable seasonal as well as intraspecific (individual-tree) variations were observed. Yields of Hwangchil lacquer as well as β-elemene, α-selinene, β-selinene, germacrene D, and δ-cadinene also depended on harvesting time, with levels being generally higher in July and August.

Keywords: *Dendropanax morbifera* Lév., essential oil, GC-Mass analysis, Hwangchil

Dendropanax morbifera Lév. (Araliaceae) is a subtropical broad-leaved tree, endemic to Cheju and Chonnam provinces in Korea (Lim, 1992; Jeong et al., 1995; Lim, 1997; Min and Kim, 1999). When injured, the plants secrete phytoalexins to promote protection and recovery (Deverall, 1982; Mansfield and Bailey, 1982). One example of this response is Korean Golden Varnish, or Hwangchil lacquer. The exudate that results from wounding of the inner bark has a golden color and is used as a traditional paint (Chung, 1993). In fact, to enhance its commercial production, lacquer yields can be increased by inoculating the damaged site with various microorganisms or other chemical treatments (Kim, 1998).

The monetary value of this species has risen because Hwangchil lacquer also has been shown to contain benzoic acid, an effective sedative (Kim and Chung, 2000; Ahn, 2001). However, its geographical distribution is restricted to a few islands, and populations have decreased. In addition, only extremely small amounts of lacquer and sesquiterpene compounds normally are secreted, varying greatly both seasonally and among individual plants (Jeong et al., 1995; Kim, 1998; Ahn et al., 2002). In this study, we measured seasonal fluctuations in the yields of lacquer and major aromatic essential oils from four individual trees. Ahn et al. (2002) had previously reported that those particular plants showed high production capacities.

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MATERIALS AND METHODS

Plant Material and Hwangchil Lacquer Harvest

From among 500 trees of *D. morbifera* Lév. that inhabit Jeju-do, Wan-do, Bogil-do, and Haenam in Korea, we had selected four individuals having high yield capacity of Hwangchil lacquer (Bogil-do No. 262, 273, 281; Haenam No. 492, Ahn et al., 2002). On each tree, we removed the bark at breast height and made four 1-cm-diameter holes in all directions. Harvesting

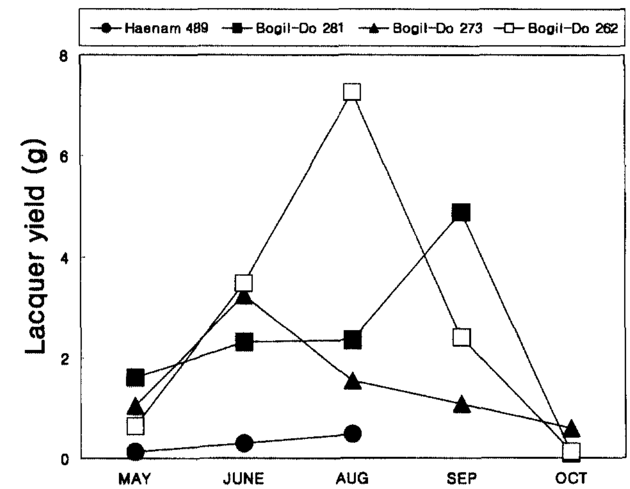

Figure 1. Time-course changes in Hwangchil lacquer yields from 4 trees of *D. morbifera* Lév (Haenam 492, Bogil-Do 262, Bogil-Do273, Bogil-Do 281). Rain made collection of Haenam-492 samples impossible in September.

Table 1. Operating conditions for GC-mass.

Column	HP-5MS (crosslinked 5% HP ME Siloxane)
Oven temperature	50°C (2-min retention) 10°C /min 200°C 5°C /min 250°C (5-min retention)
Inlet temperature	250
Detector temperature	270
Split ratio	20:1
Carrier gas	He gas
Injection volume	1 μL

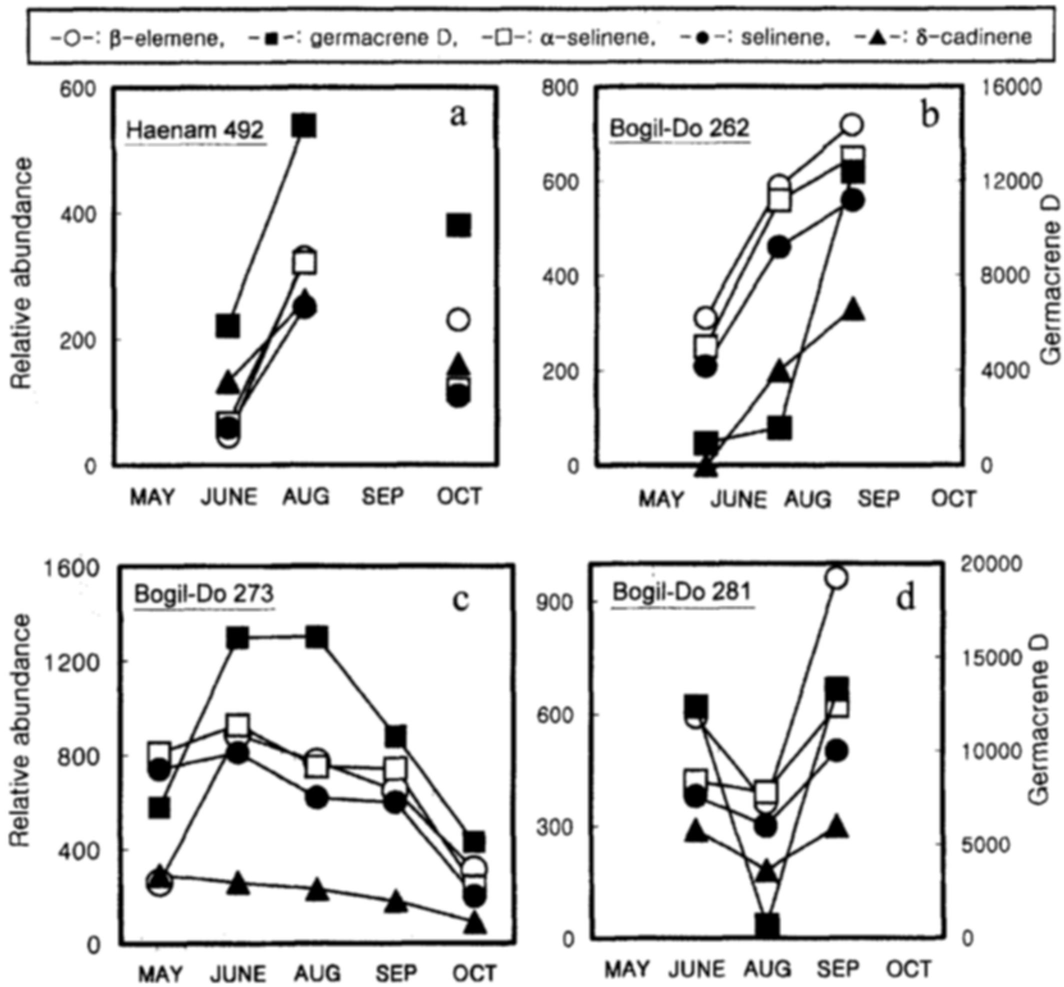

Figure 2. Time-course changes in relative contents of principal aromatic essential oils in Hwangchil lacquer from 4 trees of *D. morbifera* Lév (a, Haenam 492; b, Bogil-Do 262; c, Bogil-Do273; d, Bogil-Do 281). Component analysis of Haenam 492 in May and September was impossible because of extremely low lacquer yields and heavy rainfalls, respectively. Analysis of Bogil-Do 262 and 281 in May and October also could not be conducted because of extremely low yields of lacquer.

of the Hwangchil lacquer was done at six-week intervals (from May to October, 2001), beginning one week after the initial wounding treatment. The lacquer was lyophilized before the samples were weighed for component analysis.

Analysis of Essential Oils

Essential oil components were extracted three times with 5 mL pentane from the lyophilized samples (dry wt: 0.5 g). Extracts were then filtered and concentrated in a rotary evaporator without reducing the pressure. The concentrated solutions were resolved with 2 mL methanol for our GC-Mass analysis (Table 1).

RESULTS AND DISCUSSION

The four trees selected for the current study exhibited considerable seasonal as well as individual fluctuations in their yields of Hwangchil lacquer. Excretions began in May, increasing to a level that was maintained from July to September before decreasing sharply in October. Overall, production from the Bogil-Do individuals (262, 273, 281) was superior to that from Haenam 492. Among the Bogil-Do trees, 262 and 281 had higher levels of excretion in August and September; Bogil-Do 273, in June. Based on these results, we suggest that the best harvest season is summer (July to September). However, one must also consider variations among individuals, climates, and habitats when making this decision.

The major aromatic essential oils found in Hwangchil lacquer include 1,6-atadiene-3-ol, α-terpinene, α-cubebene, α-ylangene, α-copane, β-elemene, germacrene D, α-selinene, β-selinene, δ-cadinene, γ-cadinene, germacrene B, and germacrene D-4-ol (Jeong et al., 1995; Lim and Chung, 1998; Ahn et al., 2002). In this study, we examined the seasonal changes in the levels of five: β-elemene, α-selinene, β-selinene, germacrene D, and δ-cadinene. In the case of Haenam 492, analysis was impossible in May and September because of extremely low lacquer harvests and heavy rainfalls, respectively. For this individual tree, component levels were highest in August (Fig. 2a).

Although the yield from Bogil-Do 262 was highest in August, followed by a decline in September, the level of all components containing germacrene D increased gradually from June to September (Fig. 2b). Moreover, the relative content of that oil was five times greater than for any other, reaching a maximum in September. Bogil-Do 273 maintained a constant level of all components until contents began to decrease in August (Fig. 2c). In contrast, both the lacquer yield and the relative content of germacrene D were highest in September for Bogil-Do 281. In fact, the level of germacrene D was about 20 times higher than for the other components (Fig. 2d).

Many people in the south islands of Korea have begun to plant *D. morbifera* trees in competitions to achieve the greatest production of Hwangchil lacquer. Nevertheless, results from the study presented here demonstrate that yields of lacquer as well as the contents of essential oil components can greatly fluctuate according to harvesting season and individual trees. Therefore, we suggest that one must select superior planting stock. In addition, care should be taken to determine the optimal times for harvesting time and to standardize the desired components of Hwangchil lacquer.

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