Characteristics of fine and coarse particles collected from open burning of jujube tree branches

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This study investigates the chemical characteristics of particles that were collected from the open burning of jujube tree branches (agricultural waste), and evaluates the impact of such burning on regional air quality. The atmospheric particulate samples were collected in a jujube farm at Pingtung City in southern Taiwan. The area of jujube farm was 800 m^2 and the weight of jujube tree branch waste was 4.5 T. The sampling time was divided into three periods: before (background), during, and after open burning. During the open burning period, the A, B, C, and D samples were taken from four locations with distances of 1, 7, 11, and 16 m, respectively, away from the open burning site. The particle size distribution was collected using a micro-orifice uniform deposition impactor (MOUDI) and the particulate water-soluble ions in fine (D_p < 2.5 μm) and coarse (2.5 < D_p < 10 μm) particles (or particulate matter (PM)) were collected using a Dichot sampler. The masses and water soluble ions of particles collected on filters were analyzed using a digital balance and an ion chromatographer (IC, DIONEX ICS-3000), respectively.

The results indicate that the $PM_{2.5}$ concentrations at sampling sites A, B, C, and D during open burning were 103, 17.2, 13.5, and 5.59 times the background value, respectively, or on average, 34.9 times the background value. The average $PM_{2.5}/PM_{10}$ ratio at sample sites A during open burning (0.91) was higher than those before (0.62) and after burning (0.52). Also, the concentrations of $PM_{2.5}$ and $PM_{2.5\text{-}10}$ sharply dropped as the distance between the sampling point and the burning source increased. Ryu *et al.* (2007) also found that the average concentrations of fine or coarse particles in the early summer in the rural areas of Korea were higher during biomass burning than during a haze or normal period. In this study, the average $PM_{2.5}/PM_{10}$ ratio during open burning was 0.90, which exceeded that (0.79) obtained in Korea during a season of extensive open burning (Ryu *et al.*, 2007). In this study, before open burning, the particles had a bi-modal size distribution with one main peak in the coarse size range (3.2–5.6 μm) and the other peak in the fine size range (1–1.8 μm); during open burning, the particle size distribution was uni-modal, with a peak in the fine size range (Figure 1).

As shown in Figure 2, before and after jujube fruit branches were burned in the open space, NO_3^- had the highest concentration of all of the water-soluble ions in the particles, followed by SO_4^{2-}, and then NH_4^+. This result is similar to that obtained for particulate matter in the atmosphere. However, the concentrations of particle-bound Cl^- and K^+ rose sharply during open burning. Before burning, the concentration of Cl^- in $PM_{2.5}$ was 1.69 μg m^{-3}. The Cl^- concentrations in $PM_{2.5}$ that was collected at samples sites A, B, C, and D during open burning were 136, 61.8, 57.3, and 18.0 μg m^{-3}, respectively. The highest of these values was 84.5 times the background value. The K^+ concentration of samples that were collected at sites A, B, C, and D were 5–197 times higher than the background value, 0.87 μg m^{-3}. Khalil and Rasmussen (2003) indicated that K and Cl can be used as a tracer of wood smoke.

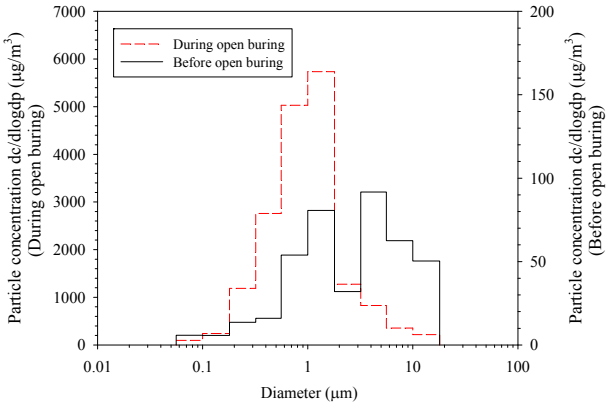

Figure 1. Size distributions of the particles collected before and during open burning.

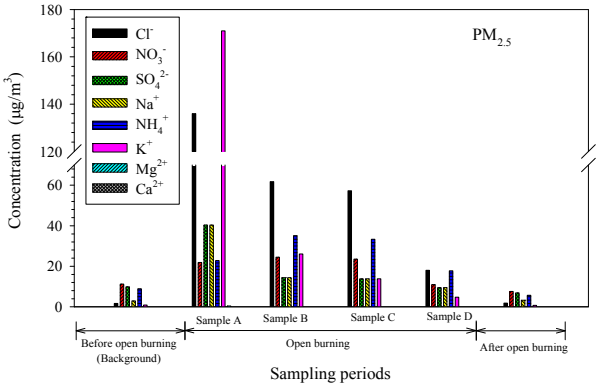

Figure 2. Concentrations of water-soluble ion in fine particles. (Sites A, B, C, and D were 1, 7, 11, and 16 m, respectively, from the open burning site.)

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