

Linking Measure of the Tropical Stingless Bee (*Apidae*, *Meliponini*, and *Heterotrigona itama*) Honey Quality with Hives Distance to the Source of Heavy Metal Pollution in Urban and Industrial Areas in Sabah, Borneo

ABSTRACT

Honey is a natural product of bees, and its chemical composition depends on the nectar sources of the surrounding flora as well as environmental factors. However, keeping hives in areas polluted with heavy metals can affect the quality of bee products such as honey. To date, there have been very few studies on the health risks of consuming honey at various locations in the Malaysian state of Sabah, Borneo, in relation to food standards and heavy metal contamination of honey from the stingless bee, *Heterotrigona itama* in association with pollutant sources. A total of 63 samples of raw and unprocessed honey were collected directly from beekeepers producing honey at five sites in the industrial areas. All selected heavy metals were measured using an inductively coupled plasma optical emission spectrophotometer (ICP-OES). Overall, the most frequently detected element was Zn (0.090 mg/kg), followed by Pb (0.012 mg/kg), As (0.004 mg/kg), and Cr (0.003 mg/kg), while Cd (0.001 mg/kg) was the lowest element in honey from all areas. With the exception of Cr and Zn, a significant correlation was found between PCA factor score 1 and heavy metal concentration in honey for Pb, Cd, and As, suggesting that the source of pollution for these metal elements was from hives closer to major roads, cities/town, petrochemical hub, and power plants. Although the heavy metal concentrations in the honey samples did not exceed the food standard limits and therefore do not pose a health risk, the observed increase in heavy metal concentrations in honey in industrial areas could pose a potential risk in the future due to the growing interest in rearing of stingless bees for honey production in these areas of Sabah.