

Study to Determine Level of Cadmium in Soil and Cacao in Kulon Progo, Indonesia

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Abstract

Indonesia is the third largest cacao producer and exporter in the world after Ghana and Ivory Coast. Cadmium (Cd) is one of the metal elements that is often found contained in cacao plants which usually accumulates in cacao bean. Excessive accumulation of Cadmium (Cd) can cause harmful effects on soil, plants, microorganisms, and humans. Soil properties such as texture and pH closely related to Cd elements transportation from soil to cacao bean through plant uptake. The purpose of this study was to determine the value of metal cadmium (Cd) in soil and cacao bean in Kulon Progo, Yogyakarta and it's correlation with soil properties. Soil samples in Banjarharjo village were taken from 10 location of different cacao farm and then divided into two types: disturbed with 2 different lengths (0 – 10 cm and 10 - 20 cm) and undisturbed. Plant samples were taken in each field at least one cacao pod. Land conditions and farm management (tree age, treatment, other type of trees, and environment) was recorded from interview to the farmers. The soil texture (silt, clay, sand), particle density, bulk density, organic content, and soil pH ranging between silt (26,82 %), clay (22,26 %) and sand (11.96 %) until silt (39.24 %), clay (52.09 %) and sand (49.04 %); 1.85 g/cm³ until 2.52 g/cm³; 0.66 g/cm³ until 1.08 g/cm³; 0.48 % until 5.76 %; and 5.85 until 7.68, respectively. The AOAC method was used to measure the Cd content with instrument using ICP-MS. Cd content in soil ranging between 0.105 mg/kg until 0.27 mg/kg with The highest concentration of Cd in cacao soil 0 – 10 cm were found in location 6 and cacao soil in 10 – 20 cm were found in locations 6 and 9. This result showed that 10 sites of cacao farms in Banjarharjo were below the critical limit of Cd in agricultural soil based on EU (3 mg kg⁻¹) and US EPA (0.43 mg kg⁻¹). Concentrations of Cd in cacao bean differed for each location, ranging between 0.08 mg/kg until 0.29 mg/kg. The highest concentrations of Cd in cacao bean were found in location 1. No location was higher than the maximum limits of Cd in dried cacao bean established by WHO (0.30 mg kg⁻¹). Concentration Cd in soil at depth 0 – 10 cm positively strong correlated with organic matter ($r = 0.83$, $P < 0.01$) and negatively correlated with cacao bean ($r = -0.74$, $P < 0.05$). Concentration Cd in soil at depth 10 – 20 cm negatively correlated with clay percentage in soil ($r = -0.68$, $P < 0.05$). Concentration Cd in cacao bean also negatively correlated with organic matter in 0 – 10 cm depth ($r = -0.65$, $P < 0.05$).

Keywords: cacao, heavy metals, cadmium, soil.