

ABSTRACT

Investigations of Heavy Metals in Cocoa in Trinidad and Tobago

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Trinidad and Tobago produces fine or flavour quality cocoa, which is in high demand and fetches premium prices on the international market. However, continued export of our cocoa beans may be affected by increasingly stringent regulations by chocolate-manufacturing countries governing the safety of agricultural commodities, including cocoa beans. These include the European Union (EU), Canada and the USA. Recent trends in food safety issues have generated concerns over the levels of heavy metals in cocoa, especially lead, cadmium, copper and nickel. While copper, nickel and zinc are essential trace elements at low concentrations; excessive levels may have adverse health effects. However, lead and cadmium are not considered essential elements and consequently are more strictly controlled in foods.

It was therefore essential that steps be taken to protect the local cocoa industry, through monitoring and control of these heavy metals cadmium, copper, nickel, lead and zinc in local cocoa beans. For this purpose, a method of analysis of heavy metals in cocoa and cacao tissues was validated and quality-controlled, using Certified Reference Materials and internal quality control materials prepared from local cocoa beans. Additionally, local technical personnel were trained in the test method, to allow for independent monitoring of heavy metals by local laboratories.

A survey of cocoa beans, cacao tissues, soil and litter from Trinidad and Tobago was undertaken between 2006 and 2009. This study confirmed that levels of nickel, lead and zinc in cocoa nibs all met international food safety standards, whereas only a few samples exceeded the maximum permissible levels for

copper. However, cocoa nibs from some areas of Trinidad and Tobago are unlikely to meet food safety standards for cadmium in chocolates and other cocoa products, if >50% cocoa solids are used in such products.

The study also demonstrated that shells of cocoa beans have significantly higher cadmium levels than nibs. Thus if the entire cocoa beans, rather than the nibs only are used to determine the cadmium contents of beans, such a distribution can cause results of analyses of cadmium-contaminated beans to be higher than those for nibs alone. Since entire cocoa beans are still being analyzed by some cocoa-purchasing countries, this may lead to incorrect decisions on the acceptability of cadmium levels in cocoa beans, based on food safety standards and possibly adverse effects on the marketability of such beans.

Additionally, significant correlations were obtained in metal concentrations between cacao tissues, soil and litter samples, suggesting that soils are the main route of cadmium uptake by the cacao tree. Soils and cacao nibs of North-Eastern Trinidad have been found to contain higher levels of cadmium compared to those from other areas of Trinidad. However, flooding of cacao fields during the wet seasons, as well as some granular fertilizers, also contribute to cadmium in soils.

The evaluation of different single-extraction procedures demonstrated that the complexing extractant DTPA can be used to measure cadmium bioavailability in soils. A lime treatment of cadmium-contaminated soils at a cacao farm in North-Eastern Trinidad has resulted in expected increases in pH and decreases in leaf cadmium levels, but unexpected increases in bioavailable soil cadmium. While consistent trends have not yet been obtained in these variables, the results demonstrate that soil treatment may provide a means of reducing cadmium uptake by cacao plants. However, this will require monitoring over many years, to determine the true effects of liming on cadmium uptake by cacao trees

A preliminary greenhouse trial with a commercial soil mycorrhizal preparation in a cadmium-spiked soil and a single cacao variety did not yield the expected decrease cadmium uptake by cacao plants. However, further investigations are

suggested with other soil mycorrhiza and cacao varieties, to determine the potential of such soil treatments for reducing cadmium uptake by cacao plants.

Low-level cadmium contamination from storage bags, tools and fermentation boxes during cacao bean fermentation and drying has also been demonstrated. Consequently, recommendations to prevent cadmium contamination from such sources, as well as from fertilizers used on cacao fields, have been made.

Keywords: Cocoa; cacao; soils; heavy metals; cadmium; Trinidad; Tobago