Heavy Metal in Chocolate

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Consumers in the United States reportedly purchased $23.9 billion worth of chocolate in 2022. Recent studies have shown that much of chocolate confectionary contains lead and cadmium, some at an unhealthy level. This Executive Briefing on Trade explains how lead and cadmium contamination can occur in the chocolate production process. The heavy metals enter chocolate through the cocoa beans, cadmium via the soil and lead via water or dust. As cocoa can only be grown in specific climates near the equator, U.S. chocolate producers must import the vast majority of their cocoa inputs. Many global sources of cocoa beans have environmental conditions high in heavy metals.

Owing to their presence in soil, water, and dust, heavy metals such as arsenic, mercury, cadmium, and lead are known to be present in many agricultural and food products, including chocolates. Consumers in the United States eat a lot of chocolate, second only to the EU in global per capita consumption. The National Confectioners Association (NCA) reported $23.9 billion of chocolate sales in 2022. According to the NCA, 64 percent of chocolate and candy sales in the United States occur between October and April, spiking during holidays. Of these sales, the majority are chocolate confectionary. Since 2014, various studies by Consumer Reports and the California-based group As You Sow have detected at least some level of cadmium and lead in virtually all foods containing cocoa. A 2023 study by Consumer Reports found roughly one-third of a representative sample of chocolate products sold in the United States contained levels of cadmium and lead above the maximum allowable dose levels (MADL) prescribed by California's Proposition 65 (Prop. 65) (table 1).[1] The heavy metals in the chocolate products were found in the cocoa solids, the primary ingredient in chocolates.[2] Likely due to the larger concentration of cocoa solids, dark chocolate in particular was found in some cases to contain dangerous levels of cadmium and lead.

How heavy metals get into chocolate: While both cadmium and lead have been detected in chocolates, the two heavy metals appear to get into cocoa via different avenues and at different times in the production process. Cadmium, found in the soil, is absorbed by the cocoa trees and accumulates in the beans as the cocoa trees grow. Lead appears to contaminate cocoa beans after harvest, during the drying process as dust and dirt containing lead stick to the outside of beans. Contact with roads and dirty equipment could also cause lead contamination. Proximity to industrial sites and locations using leaded gasoline in farming equipment increase the likelihood of lead contamination. Higher levels of cadmium tend to occur in countries with more volcanic soil while higher levels of lead contamination tend to occur in least developed countries.

Table 1: Share of Prop. 65 MADL of Lead and Cadmium, by product

Product	Metal	Average	High	Low
Dark Chocolate	Lead	195.4	539	36
	Cadmium	87.6	149	41
Milk Chocolate	Lead	41.2	67	11
	Cadmium	34.4	80	8
Chocolate Chips	Lead	62.9	121	29
	Cadmium	28.6	57	9
Cocoa Powder	Lead	132.5	324	77
	Cadmium	55.0	95	17
Hot Chocolate Mix	Lead	146.7	345	76
	Cadmium	30.7	88	12
Brownie Mix	Lead	71.5	108	34
	Cadmium	35.7	61	13
Cake Mix	Lead	103.7	218	52
	Cadmium	37.0	77	23

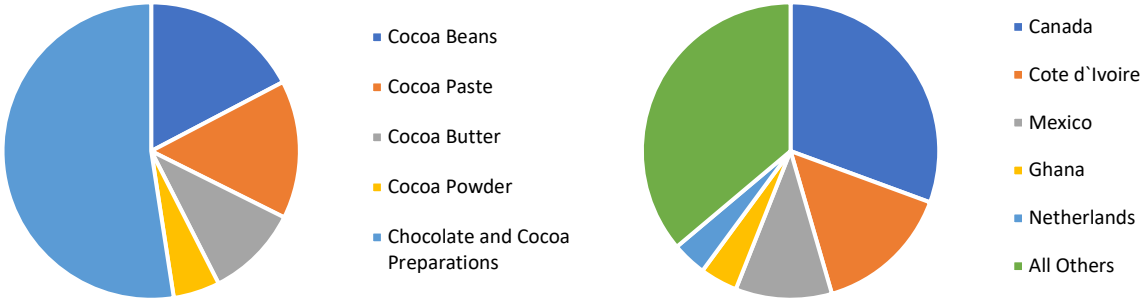
Note: Results based on a sample of products in the U.S. market.
Source: Consumer Reports, Dec. 15, 2022 and Oct. 25, 2023.

Where is the chocolate coming from: Chocolate confectionary products consumed in the United States are both imported and produced domestically. Because cocoa beans are commercially not grown in the United States, the U.S. chocolate industry is dependent upon imports of cocoa and chocolate products. Roughly half of the U.S. imports of cocoa and chocolate are chocolate confectionary, with the remainder consisting of cocoa beans and primary processed cocoa (figure 1).[3] Most of the cocoa beans and primary processed cocoa comes from Western Africa and

[1] The Consumer Reports and As You Sow studies only tested U.S. products but heavy metals are found in chocolate and cocoa products across global markets.
[2] Cocoa solids are what is left behind when cocoa butter is extracted from ground cocoa nibs.
[3] Primary processed products include cocoa paste (also known as cocoa liquor), cocoa powder, and cocoa butter.

Latin America while most of the chocolate confectionary comes from Canada and Mexico. Netherlands is the largest U.S. import source of cocoa powder.

Figure 1: U.S. imports of cocoa and chocolate products, by product and source, millions of dollars, 2018–22 average



Source: USITC DataWeb/Census, accessed November 7, 2023

What can be done about it: In the United States, the Food and Drug Administration (FDA) does not have a specific regulatory limit on lead and cadmium content for chocolate at this time. However, the FDA recommends no more than 2.2 parts per million (ppm) total daily lead intake for children and 8.8 ppm daily for women of childbearing age. The FDA also has a requirement to report cadmium content per ounce of 0.1 ppm for milk chocolate and 0.3 ppm for cocoa powder but not a content limit. Through its Closer to Zero initiative, the FDA is in the process of developing maximum heavy metal content limits for foods commonly eaten by children, including chocolate. Under Prop. 65, California maintains MADLs of lead and cadmium levels in all food, including chocolate, at 0.5 µg/day (microgram/day) for lead and 4.1 µg/day for cadmium.

Addressing lead and cadmium contamination in cocoa requires cocoa bean growers and processors to undertake different strategies with different timelines. Lead mitigation is likely the quicker fix, requiring changing harvesting and manufacturing processes to minimize contaminant contact with drying beans and more thoroughly cleaning beans before grinding. Reportedly results can be seen within a year of implementation of these practices. Cadmium mitigation strategies reportedly take more time and steps, but are also possible. In the short term, chocolate producers can survey soil and avoid regions with higher levels of cadmium. Chocolate producers can also blend beans from higher cadmium regions with beans from other regions. In the medium term, contaminated soil can be treated or replaced. Furthermore, since cadmium levels rise as trees age, older trees can be replaced. This has the added benefit of increasing yields since productivity declines as trees age. In the long run, it may be possible to genetically engineer cocoa trees less susceptible to cadmium contamination.

Sources: Ahn, "Dark Chocolate Might Have Health Perks," 12/17/22; Ahn et al., *Expert Investigation Related to Cocoa*, 3/28/22; Ahn, "Hershey's Faces a Lawsuit over Heavy Metals," 12/30/22; As You Sow, "Why Should We Worry," accessed 11/21/23; As You Sow, "Toxins in Chocolate," accessed 11/7/23; As You Sow, "Court Establishes Guidelines," 2/15/18; CBI, "What Requirements Must Cocoa Beans Comply," 12/14/22; Chalstrom, "Consumer Reports Just Found Lead and Cadmium," 12/19/22; DeAngelis, "One-Third of Chocolate Products," 11/1/23; Durkee, "Report On 'Unsafe' Lead In Dark Chocolate," 1/5/23; EC, "Cadmium in Chocolate," accessed 1/3/24; EIA, "Gasoline Explained," 12/29/22; FDA, "Cadmium in Food," 3/4/24; FDA, "Closer to Zero," 4/12/24; FDA, "Lead in Food," 3/6/24; ICCO, "Processing Cocoa," accessed 11/17/23; Johnson, "Is Eating Chocolate Safe?," 2/15/23; Lindell, "State of the Candy Industry 2021," 7/21/21; Loria, "How Lead and Cadmium Get Into Dark Chocolate," 10/30/23; Loria, "A Third of Chocolate Products ," 10/25/23; Loria, "Lead and Cadmium Could Be in Your Dark Chocolate," 10/25/23; Myers, "National Candy Month Data," 7/1/22; Myers, "Consumer Confidence for Seasonal Chocolate," 11/14/23; NCA, *Getting to Know Seasonal Chocolate & Candy Consumers 2023*, 11/9/23; NCA, "Sweet Insights," 2/26/23; Nguyen, "Some Popular Chocolate Products," 10/25/23; FDA, "Closer to Zero," 8/10/23; OEHHA, "Proposition 65 No Significant Risk Levels," 10/27/23; Statista, "Chocolate Industry in the United States," accessed 11/20/23; Wilson, "Lead and Cadmium in Chocolate," 3/3/23.