Application Note AN-V-235

Cadmium in chocolate

Determination using anodic stripping voltammetry after dry ashing in a muffle furnace

The element cadmium (Cd) is toxic to humans and can be found in the environment as a natural contaminant. Some soils contain increased cadmium concentrations in combination with high bioavailability. Under such conditions, the cacao tree can accumulate cadmium, mainly in the beans, which are then processed into cocoa. Chocolate produced from the affected beans will contain elevated cadmium levels.

To reduce the risk for consumers the maximum concentration in chocolate and other foods is often limited by the government. Typical limit values in the European Union are between 100 µg/kg and 800 µg/kg (EU Commission Regulation 1881/2006) depending on the cocoa content of the chocolate. Chocolate produced from cocoa beans with increased cadmium concentrations may exceed the maximum concentration limit.

Anodic stripping voltammetry (ASV) can be used to accurately determine trace quantities of cadmium in chocolate down to approximately 10 µg/kg. The method is simple to perform, specific, and free of interferences. Prior to determination the samples are ashed in a furnace at 450 °C.

SAMPLES

Dark chocolate, milk chocolate, cocoa powder

EXPERIMENTAL

First, the samples are mineralized by dry ashing in a furnace at 450 °C for 16 hours. The remaining ash is then dissolved in a small amount of concentrated nitric acid and diluted with ultrapure water. The cadmium determination is carried out on the 884 Professional VA with the Multi-Mode Electrode pro as working electrode using the parameters listed in Table 1. The concentration of Cd is determined by two additions of Cd standard addition solution.

Figure 1. 884 Professional VA

Table 1. Parameters for ASV analysis of Cd in chocolate

Parameter	Setting
Working electrode	HMDE
Mode	DP – Differential Pulse
Deposition potential	-0.8 V
Deposition time	60 s
Start potential	-0.8 V
End potential	-0.2 V
Peak potential Cd	-0.55 V

ELECTRODES

- Working electrode: Multi-Mode Electrode pro with silanized glass capillaries
- Reference electrode: Ag/AgCl/KCl (3 mol/L) reference electrode with electrolyte vessel. Bridge electrolyte: KCl (3 mol/L)
- Auxiliary electrode: Platinum rod electrode

RESULTS

The determination of Cd in dissolved ash of chocolate samples can be carried out in a simple and straightforward manner with ASV. The method is selective and free of interferences. It is suitable for cadmium concentrations down to 10 µg/kg with respect to the solid chocolate sample.

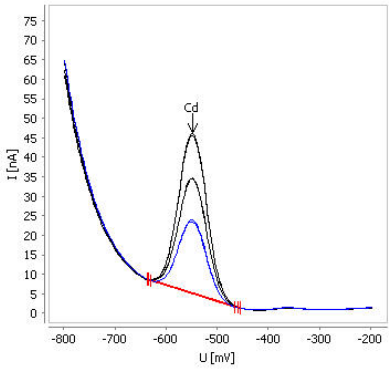

Figure 2. Determination of Cd in dark chocolate (72% cocoa).

Table 2. Results of Cd analysis with the 884 Professional VA

Sample	Cd [µg/kg]
Milk chocolate (29% cocoa)	10.4
Milk chocolate (34% cocoa)	37.0
Dark chocolate (72% cocoa)	164
Dark chocolate (87% cocoa)	346
Cocoa powder	98.2

Internal reference: AW VA CH4-0579-032019

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CONFIGURATION

884 Professional VA manual for Multi-Mode Electrode (MME)

884 Professional VA manual for Multi-Mode Electrode (MME) is the entry-level instrument for high-end trace analysis with voltammetry and polarography with the Multi-Mode Electrode pro or the scTRACE Gold or the Bismuth drop electrode. The proven Metrohm electrode methods in combination with a high-performance potentiostat/galvanostat and the extremely flexible viva software open up new perspectives for the determination of heavy metals. The potentiostat with a certified calibrator readjusts itself automatically before each measurement, thus guaranteeing maximum precision.

Determinations with rotating disc electrodes can also be performed with the instrument, e.g. determinations of organic additives in electroplating baths with "Cyclic Voltammetric Stripping" (CVS), "Cyclic Pulse Voltammetric Stripping" (CPVS), and chronopotentiometry (CP). The replaceable measuring head enables rapid changes between the various applications with different electrodes.

The viva software is required for control, data collection, and evaluation.

The 884 Professional VA manual for MME is supplied with extensive accessories and a measuring head for the Multi-Mode Electrode pro. Electrode set and viva license need to be ordered separately.

VA electrode equipment with Multi-Mode Electrode pro for Professional VA instruments

Complete electrode set for polarographic and voltammetric determinations. Includes Multi-Mode Electrode pro, reference electrode, platinum auxiliary electrode, measuring vessel, stirrer, electrolyte solution and additional accessories for setting up and operating the Multi-Mode Electrode.