Determination of Some Heavy Metals by ICPoES in the Dark Chocolate

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Abstract - This study was performed for the determination of some heavy metals in dark chocolate obtained from a local market in Burdur city at Turkey. In general, the chocolate was prepared with sugar, cocoa mass, cocoa butter, and genus and/or cocoa powder, flavourings, milk and/or milk powder, and permissible additive agents. The cocoa solids contents in the commercial dark chocolate can be ranged from 47% to 75% and the heavy metals may be found in the cocoa solids at trace level. Owing to this, the concentration of heavy metals should be determined in the chocolate to decide whether it is healthy or not? In this proposed study, some heavy metals such as arsenic (As), bismuth (Bi), cadmium (Cd), cobalt (Co), copper (Cu), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb), antimony (Sb), vanadium (V) and zinc (Zn) were determined by Inductively Coupled Plasma Optical Emission Spectroscopy (ICPOES).

I. INTRODUCTION

Heavy metal is considered as the density of metal greater than 5 g/mL. There are more than 40 elements in this circumstance. Some of them are copper (Cu), lead (Pb), zinc (Zn), iron (Fe), cobalt (Co), nickel (Ni), manganese (Mn), cadmium (Cd), chromium (Cr), mercury (Hg), tungsten (W), molybdenum (Mo), gold (Au) and silver (Ag) [1].

The heavy metals can be classified as the three groups. The first group is categorized as toxic such as arsenic (As), cadmium (Cd), chromium (Cr), mercury (Hg) and lead (Pb). On the other hand, the second group is likely essential such as nickel (Ni) and third group is categorized as essential such as copper (Cu) and zinc (Zn). The toxic metals can be harmful even if it is found at trace levels in any samples. In addition, the excessive intake of essential heavy metals also caused to toxic effects. In general, the heavy metals are of particular concern in worldwide as they are environmentally persistent and pose ecological risks [2]. Additionally, the heavy metals can cause several adverse effects for humans, such as cancer, hypertension and renal dysfunction [3]. The lead (Pb) can cause very significant disorders, such as headaches, hearing problems, learning disabilities, behavioural problems, brain damages and also they may cause to death [4]. The cadmium (Cd) is categorized as toxic heavy metals causes to adverse effects on the liver, lungs and kidneys because of the fact that it is stored on them [5]. The potassium (K) is one of the essential elements and it helps to biological reactions, such as hormone secretion, enzyme activation, balancing of pH and blood pressure. On the contrary, the excessive intake of it can cause some problems, such as, diabetes, cardiovascular and kidney problems, Addison’s disease, high blood pressure and stroke [6]. This result reveals that even if the any elements are essential, the excessive intake of them may cause the toxic effect. In recent years, the concentration of heavy metal has been increased in the environment due to industrial activities [7]. Therefore, the determination of heavy metals in any samples should be very important.

In this proposed study, some heavy metals were determined in the dark chocolate obtained from a local market in Burdur city at Turkey. In general, the chocolate was prepared with sugar, cocoa mass, cocoa butter, and genus and/or cocoa powder, flavourings, milk and/or milk powder, and permissible additive agents [8]. Although the chocolate is solid at room temperature, it melts in the mouth. This specific feature depends on the its fat amount [9]. In principle, the chocolate is made up of the fruit of the cocoa tree (Theobroma cacao). The cocoa is mainly grown in the West Africa, Central and South America and Asia. The dark chocolate is considered to be healthy among the other chocolate species. The cocoa and chocolate have different beneficial effects due to high content of antioxidants. They help to prevent infectious and autoimmune diseases and reduce the risk of heart disease. The anti-cancer substances are also found in them. Furthermore, they may help to decrease cholesterol levels and regulate blood flow. The cocoa solids contents in the commercial dark chocolate can be ranged from 47% to 75%. On the other hand, the heavy metals may be found also in the cocoa solids at trace level. Because of this reason, the concentration of heavy metals should be determined in the chocolate [10].

Inductively coupled plasma optical emission spectroscopy (ICPOES) can be used for the determination of approximately more than 70 elements at low concentrations. As the plasma temperature is high enough ranged from 6000 to 10000 K, all samples are destroyed at that temperature. This technique has many advantages which are simultaneous multi-element detection, high-speed, relatively high sensitivity and large linear dynamic range.
II. EXPERIMENTAL

This method was applied to determine the amount of As, Bi, Cd, Co, Cu, Mn, Mo, Ni, Pb, Sb, V and Zn in the dark chocolate obtained from the local market in Burdur city. Firstly, 2.5 g of chocolate samples was put into an Erlenmeyer. After that, the mixture of 6 mL concentrated hydrochloric acid (HCl) and 2 mL concentrated nitric acid (HNO₃) were prepared into a small beaker. The mixture was dribbled into the erlenmeyer and the erlenmeyer was shaken continuously. In addition to this, the sample in the erlenmeyer was introduced on the hot plate and the cautery process was performed as 5 hours at about 60–70°C. Then, the residue was washed using 5 mL of 1 M HNO₃ by two times and the erlenmeyer was shaken for a time. After ten minutes, the obtained homogenous solution was reached with filter paper (Munktell model; dia.: 125 mm). In addition to this, the solution was transferred to 25 mL volumetric flasks and diluted to 25 mL with 1 M HNO₃. The sample solution was placed in plastic containers and stored in the refrigerator until the analysis. In order to draw calibration plot, the working aqueous solutions of elements were prepared using the stock solution of elements (1000 mg/L) by necessary dilution. The elements (As, Bi, Cd, Co, Cu, Mn, Mo, Ni, Pb, Sb, V and Zn) were determined by Inductively Coupled Plasma Optical Emission Spectrometry (Thermo Icap 6500 model).

III. RESULTS

The concentrations of As, Bi, Cd, Co, Cu, Mn, Mo, Ni, Pb, Sb, V and Zn were determined in the dark chocolate using the calibration plot method. This values were shown in Table 1.

<table>
<thead>
<tr>
<th>Sample (mg/kg)</th>
<th>As</th>
<th>Bi</th>
<th>Cd</th>
<th>Co</th>
<th>Cu</th>
<th>Mn</th>
<th>Mo</th>
<th>Ni</th>
<th>Pb</th>
<th>Sb</th>
<th>V</th>
<th>Zn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark chocolate</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>&lt;0.2</td>
<td>&lt;0.4</td>
<td>5.0±0.1</td>
<td>14.0±0.4</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>&lt;0.4</td>
<td>24.0±0.2</td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES