Comparison of ICP-OES, XRF and LIBS Techniques for Determination of Tin in Metal Containers

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Tin is used largely in soldering, tin plating, biocides and PVC stabilizers. Among them, tin plating is the second largest area that uses tin. Tinplate is a steel sheet which is coated with a thin layer of tin. It is the primary material used for food cans and food storage container. Tin prevents corrosion by covering the surface of iron. Chemical composition has an important role in corrosion resistance of tinplate [1]. According to Turkish Food Codex, the tin content in tinplate must be at least 4.9 g/m² [2]. As a result of the use of tinplate for food and beverage packaging, it is obvious that some tin will dissolve into the food content, particularly when plain uncoated internal surfaces are used. The Provisional tolerable weekly intake for tin is 14 mg/kg body weight and recommended maximum permissible levels of tin in food are typically 250 mg/kg for solid foods and 150 mg/kg for beverages [3].

In this study, the concentration of tin (Sn) in tinplate was determined by using different techniques such as ICP-OES (inductively coupled plasma optical emission spectroscopy), XRF (X-Ray fluorescence spectrometry) and LIBS (laser induced breakdown spectroscopy); the results were compared. For sample preparation, first the lacquer layer was removed from tin plate by heating in ammonia-aniline mixture. For ICP-OES analysis, can samples were dissolved with concentrated HCl by heating on hot plate and then the resulting solution was analyzed at 189.926 nm. Since other techniques, XRF and LIBS, are applicable directly to solids, samples were analyzed directly after the removal of lacquer layer. For portable XRF and portable LIBS analyses, standard reference materials C1103, C1105, C1107 and C1108 from NIST were used as standards. For portable LIBS, 242.92 nm and 270.68 nm Sn lines were used. Results of portable LIBS were higher than both ICP-OES and portable XRF because its penetration depth is smaller than the penetration depth of XRF. Since Sn is not distributed homogeneously in the sample, the results obtained by XRF and LIBS are related to the penetration depths of the respective techniques. To conclude, most accurate results could be found by ICP-OES since sample was dissolved completely for sample preparation. Although ICP-OES is a destructive technique, it has the advantage of determination of analyte irrespective of distance from the surface, satisfying the requirements of the Turkish Food Codex.

KEYWORDS: tin, ICP-OES, XRF, LIBS, food cans

REFERENCES: