Determination of Azo Food Colorants using Bismuth Film Electrodes and Voltammetric Techniques

A. Królacka, A. Bobrowski, J. Zarębski

Department of Building Materials Technology, Faculty of Materials Science and Ceramics, AGH - University of Science and Technology, Al. Mickiewicza 30, 30-059 Kraków, Poland

abobrow@agh.edu.pl

Water-soluble synthetic colourings are added to food, mainly to drinks, to replace colour lost during production, or to make food look more attractive. They are less expensive, more stable, controllable, and intense in hue than natural color sources. Azo colours contain the azo linkage -N=N- that undergoes enzymatic breakdown in mammals and decompose to aromatic amines, which are the cause of frequent headaches in adults and could induce hyperactivity and ADHD in children [1].

The synthetic colourings (brilliant black, sunset yellow, azorubine, new coccine, tartrazine) considered fit for human consumption were examined using bismuth film electrodes. Glassy carbon electrodes modified with bismuth film may be used to record developed voltammograms of reduction of azo food colourings with good sensitivity. Using cyclic voltammetry or square wave voltammetry (SWV), a large current is observed upon the reduction of adsorbed dyes in 0.5 M ammonia buffer (pH 9.3) compared to the current obtained at the bare electrode. The best shaped SW voltammetric signals are obtained for sunset yellow (Fig. 1). The sensitivity of SWV is sufficient to obtain a linear calibration curve for low concentration levels of SY (below 0.1 mg/L); however, for higher concentrations the surface saturation effect occurred and the calibration curve leveled off. In general, the concentrations of SY in the soft drink samples are relatively high and may vary from 1 to 50 mg/L, giving the solutions colours ranging from pale pastel to garishly orange. Chronoamperometry (flow injection with amperometric detection) was considered as a tool for the determination of relatively high concentrations (> 1 mg/L) of sunset yellow. The bismuth films used for this study were plated from HClO₄. Such bismuth films are compact, adhesive, resistant to mechanical damage, and do not exhibit the tendency to peel off, which makes them suitable for application in flow systems. A flow rate of 4.3 mL/min was used because of the most favorable signal-to-noise ratio. Flow injection calibration plots were constructed using the optimized parameters: electrode potential of -0.55 V, flow rate of 4.3 mL/min, and 0.2 mL injection. The relationship between the peak area and the concentration of SY produced a linear calibration plot (r² = 0.9954) between 0.6 and 8.8 mg/L. The limit of detection for SY was determined to be 0.3 mg/L using FIA.

Fig.1. SW voltammograms of solutions containing a) Brilliant Black, b) Sunset Yellow, c) Azorubine , d) New Coccine, e) Tartrazine

Supporting electrolyte: 0.5 M ammonia buffer. Instrumental parameters: E = -0.45 V, t = 60 s (a-c) and 120 s (d,e), t = 10 s, SWV: f = 250 Hz, A = 50 mV.

BiFE plating: 0.05 M Bi(III) in 1 M HClO₄ without stirring. E = -1.1 V.

KEYWORDS: adsorptive stripping voltammetry, azo food colorants, sunset yellow, bismuth film electrode

REFERENCES:


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