Identification of food azo dyes in mislabelled products

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One of the essential aspects of food production safety is the accuracy of information provided on product labels. In Ukraine, food adulteration remains a pressing issue, particularly the concealment or misrepresentation of synthetic food dyes used to enhance product appearance. Synthetic dyes pose potential health risks even at allowed levels, while exceeding these thresholds creates tangible hazards[1]. In this study, the voltammetric identification of synthetic food dyes in selected food products was conducted, the results were confirmed spectrophotometrically.

Selection of samples

Products with bright coloration were chosen for analysis, specifically those whose packaging either failed to declare synthetic dyes or listed them incorrectly. Samples were purchased from retail chains in Lviv.

Selected items included: dry mixtures for jelly preparation with kiwi and mojito flavors, labeled with the dye “Green apple”, which is not recognized in official food additive nomenclature[2]; Brightly colored carbonated beverages (red and green) with blackcurrant and feijoa flavors. Multicolored candied fruit cubes (pineapple core), with no declared dyes on the packaging.

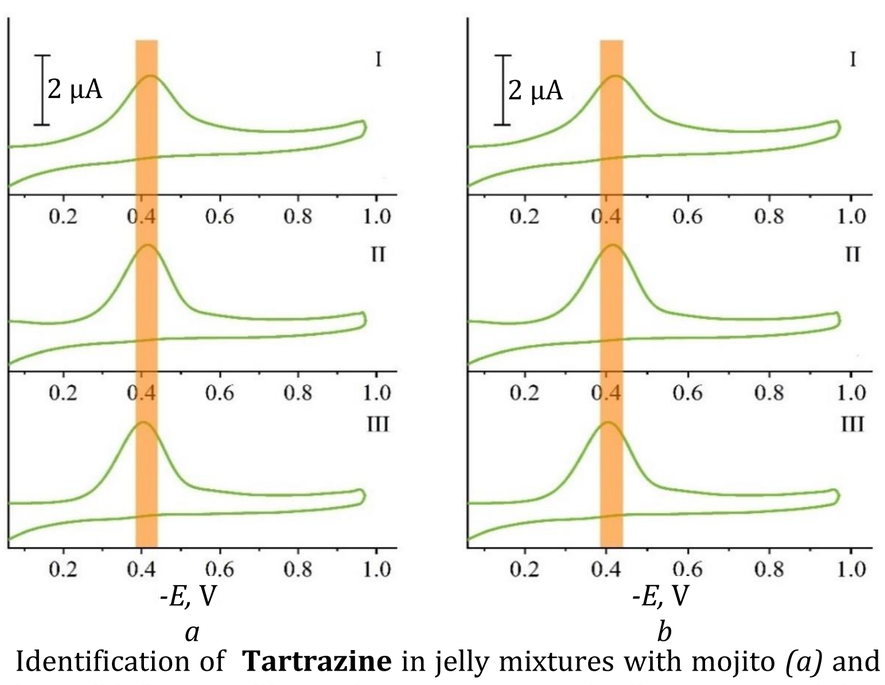
Sample Preparation

- Jelly mixes (~2 g) were extracted with 15 mL of bidistilled water, decanted, transferred to a 25.0 mL volumetric flask, mixed with 10 mL of background electrolyte (pH 3.4), and diluted to the mark.
- Degassed beverages (2.0 mL aliquots) were transferred to 25.0 mL volumetric flasks, mixed with background electrolyte (pH 5.0 for blackcurrant, pH 3.4 for feijoa), and diluted to the mark.
- Candied fruit samples (~1.5 g) were ground and subjected to fivefold re-extraction with heated bidistilled water (70 °C, 5–7 mL) until complete decolorization. Combined extracts were collected in a 50.0 mL volumetric flask, diluted to the mark, and aliquots (5.0–10.0 mL) were prepared with background electrolyte.

As the background electrolyte the Britton-Robinson buffer solution was used.

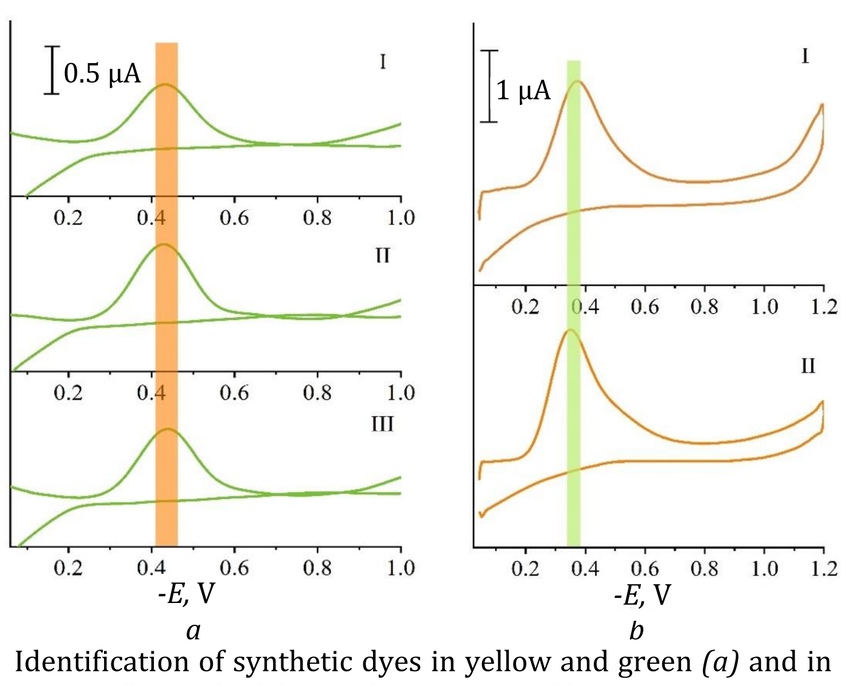
Voltammetric Identification

Measurements were carried out in a three-electrode electrochemical cell with a silver solid amalgam working electrode modified with a mercury meniscus (m-AgSAE), a saturated calomel reference electrode and a platinum counter electrode. Dissolved oxygen was removed from the measured solution by its bubbling with argon Identification was performed using voltammetric fingerprinting, comparing reduction peak potentials of samples with standard azo dye solutions under identical conditions. Spectrophotometric analysis confirmed the voltammetric data by matching absorption maxima of sample and standard solutions.



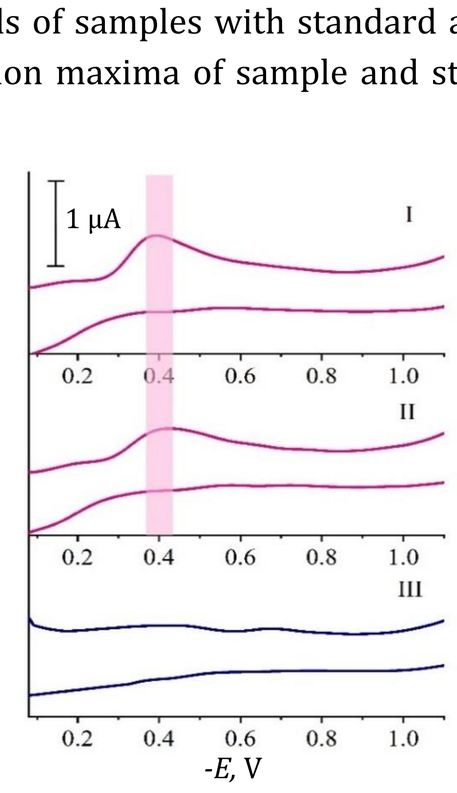
Identification of **Tartrazine** in jelly mixtures with mojito *(a)* and kiwi *(b)* flavors: (I) – voltamperograms of jelly mixtures, (II) – voltamperograms of **Tartrazine** standard solution, (III) – voltamperograms of modelled solution of **tartrazine** and Brilliant Blue FCF**.**

The conditions: *c* (**Tartrazine**) = $1.0 \cdot 10^{-5}$ mol/L, *c (*Brilliant Blue FCF*)* = $1.8 \cdot 10^{-6}$ mol/L, pH 3.4 , *v* = 1 V/s, E_{acc} = -0.05 V. t_{acc} = 30 s.



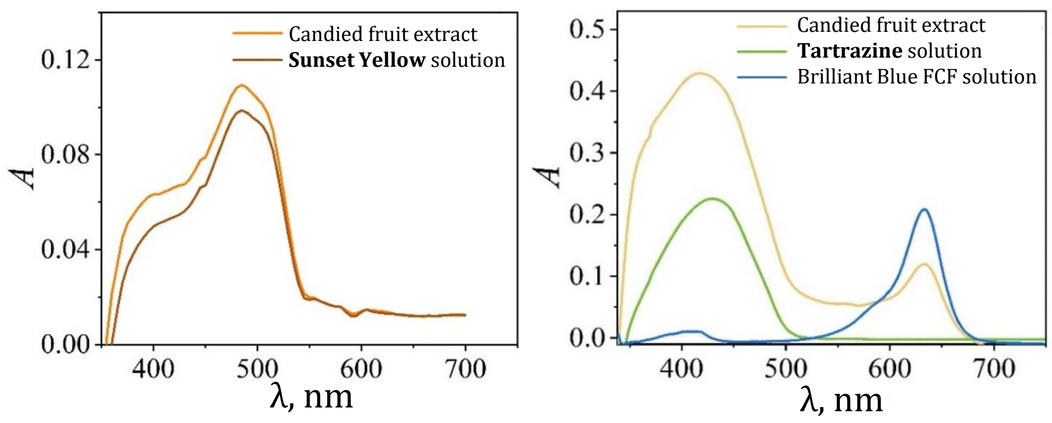
Identification of synthetic dyes in yellow and green *(a)* and in orange *(b)* candied fruit cubes extracts: (I) – voltamperogram of yellow *(a)* and orange candied fruit cubes extracts, (II) – voltamperograms of **Tartrazine** *(a) and* **Sunset Yellow FCF** *(b)* standard solutions, (III) – voltamperograms of green candied fruit cubes extract.

The conditions: *c* (**Tartrazine**, **Sunset Yellow FCF**) = $8.0 \cdot 10^{-6}$ mol/L, pH 3.4 *(a) and* pH 4.0 *(b)* , v = 1 V/s.



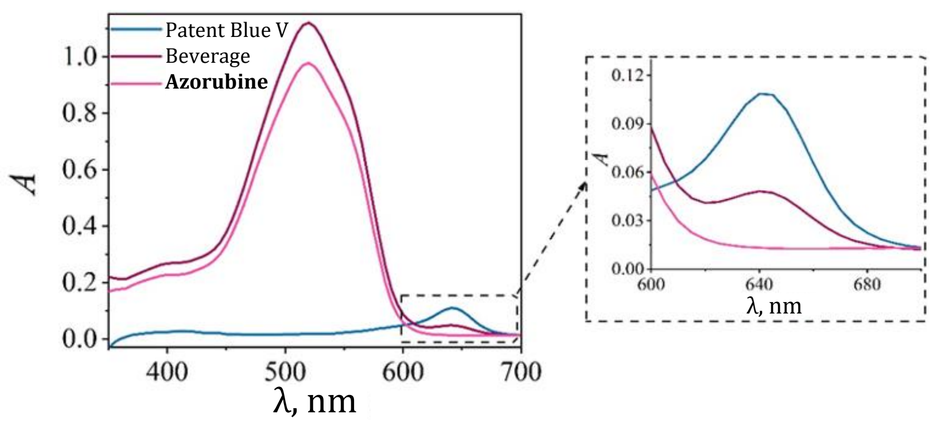
Identification of synthetic dyes in blackcurrant flavored beverage: (I) – voltamperogram beverage mixture, (II) – voltamperogram of **Azorubine** standard solution, (III) – voltamperogram of Patent Blue V standard solution.

The conditions: *c* (**Azorubine**) = $2.0 \cdot 10^{-6}$ mol/L, *c (*Patent Blue V*)* = $4.0 \cdot 10^{-6}$ mol/L, pH 5.0 , *v* = 1 V/s, E_{acc} = -0.05 V. t_{acc} = 30 s.



Absorption spectrum of the orange candied fruit cubes extract and **Sunset Yellow** solution *(a)*, and extracts from green candied fruit cubes with **Tartrazine** and Brilliant Blue FCF solutions.

The conditions: *c* (**Sunset Yellow**) = $4.0 \cdot 10^{-6}$ mol/L, *c* (**Tartrazine**) = $8.0 \cdot 10^{-6}$ mol/L, *c (*Brilliant Blue FCF*)* = $2.5 \cdot 10^{-6}$ mol/L, pH 3.5.



Absorption spectrum of the blackcurrant flavored beverage, **Azorubine** and Patent Blue V solutions.

The conditions: pH 2.7, *c (*Patent Blue V*)* = $1.0 \cdot 10^{-6}$ mol/L, *c* (**Azorubine**) = $4.0 \cdot 10^{-5}$ mol/L.

Conclusions

Tartrazine was identified in jelly mixes (kiwi and mojito), candied fruits, and the feijoa-flavored beverage. The declared dye “Green Apple” was found to be a mixture of **tartrazine** and Brilliant Blue FCF. **Sunset Yellow FCF** was also identified candied fruit cubes. **Azorubine** was identified in the blackcurrant-flavored beverage, alongside Patent Blue V. All voltammetric identifications were fully confirmed by spectrophotometrically analysis. The study revealed cases of food adulteration through concealment or mislabeling of synthetic dyes. An official complaint was submitted to the State Service of Ukraine on Food Safety and Consumer Protection “Держпродспоживслужба України”, whose subsequent inspections confirmed labeling violations. The developed analytical approach based on linear voltammetry proved effective for food quality control, offering low cost, rapid analysis, and simple sample preparation.

[1] Balachandran B.; Sabumon P. C., J. Hazard. Mater. Adv., 2025, 19, 100834 https://doi.org/10.1016/j.hazadv.2025.100834.
[2] DSTU-N CODEX STAN 192:2014. Food Additives: Nomenclature and General Requirements. Effective from 1 July 2015. Official edition. Kyiv: Ministry of Economic Development and Trade of Ukraine, 2016, 242 p.