Quantitative Estimation of Tartrazine In Yellow-Colored Drinks And Sweets Using UV-Visible Spectroscopy

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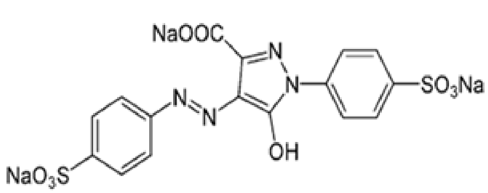
Abstract- *Tartrazine, a synthetic lemon-yellow azo dye, is widely used in food and beverages for its appealing color. This study investigates the presence and concentration of tartrazine in commonly available, yellow-colored drinks and sweets. UV-Visible spectrophotometry was employed to determine the absorbance values at the dye's maximum wavelength (427 nm). Using a calibration curve of known tartrazine concentrations, the absorbance of commercial food products was analyzed and compared to safety limits prescribed by regulatory standards. Results showed several products exceeded safe levels, indicating potential health risks from excessive consumption.*

Keywords- Tartrazine, Synthetic Food Dyes, UV-Visible Spectrophotometry, Yellow-Colored Sweets, Commercial Beverages, Food Safety, Azo Dyes, Calibration Curve, Food Colorants, Public Health, Regulatory Compliance

I. INTRODUCTION

Have you ever noticed the vibrant yellow hue in packaged snacks and beverages? This brightness is often the result of synthetic food colorants such as Tartrazine, a widely used azo dye. It is known chemically as FD&C Yellow No. 5 and is classified as a monoazo dye with a molecular structure that includes sulfonic acid groups and a nitrogen-nitrogen double bond linking aromatic rings (Coultate, 2009, Food: The Chemistry of Its Components, 5th ed., p. 227). While



Though regulatory agencies like the FDA maintain that tartrazine is safe within specified limits, growing concern has prompted renewed interest in natural alternatives (Branen et al., 2002, Food Additives, 2nd ed., p. 359). Tartrazine was discovered in 1884 by Swiss chemist Johann Heinrich Ziegler, who developed the yellow azo dye in the laboratories of the Bindschedler'sche Fabrik für chemische Industrie in Basel (CIBA). This was patented and produced in Germany by BASF in 1885 (DRP 34294). The process was first presented in 1887 in Chemische Berichte, the journal of the German Chemical Society.

Consuming it in a very little concentration and after a very long-time gap may not show any harmful effects in adults, but its frequent intake has surely proved it harmful. Generally, people with tartrazine allergy have suffered allergic reactions such as hives, itching, and difficulty in breathing. It has caused Asthma, skin problems such as Eczema or Dermatitis in some adults. Whereas in children it has been linked to increased hyperactivity like ADHD, irritability, restlessness, and sleep disturbances. The artificial dye TRZ showed toxic, cytotoxic, and mutagenic effects on plant, animal, and human cells. TRZ is clastogenic and causes mitotic spindle disorders. These data demonstrated that TRZ may be harmful to health and its prolonged use is thought to trigger carcinogenesis.

The present study for the detection of concentration of tartrazine was conducted on some sweets and a few beverages that are easily available in local sweet shops. With the help of UV-VIS Tartrazine is approved for use in many countries, it has been the subject of health-related debates due to its potential to trigger allergic reactions and behavioral effects. Studies have indicated that sensitive individuals may experience symptoms such as urticaria, asthma, or atopic dermatitis upon ingestion (Stevens et al., 2010, Food Additives and Human Health, p. 101). Furthermore, research has shown a possible link between synthetic food dyes and hyperactivity in children, especially those with ADHD (Feingold, 1975, Why Your Child is Hyperactive, p. 63).

A. SAMPLE COLLECTION.

Yellow-colored, various milk-based sweets were collected from local sweet shops for the purpose of analysis. The selection included commonly available traditional sweets that are known to have a yellow appearance, which may indicate the presence of added food coloring, particularly tartrazine.

For beverages, a variety of yellow-colored fruit juices and soft drinks were chosen from several popular commercial brands. These included products such as Minute Maid, Tang, Swing, Mountain Dew, Aloha, and others. The selection was made to represent a wide range of commonly consumed drinks that are likely to contain synthetic food dyes.

Beverages Chosen:

- Minute Made (Mixed Fruit)
- Mogu Mogu (Mango Flavor)
- Mountain Dew
- Tang
- Aloha (Peach drink)
- Paper boat swing (Mango Flavor)
- Amul Milk (Mango Flavoured)

Sweets Chosen:

- Boondi Laddoo
- Mysore Paak
- Mango Malai Barfi
- Pineapple Sponge Cake
- Kesar Pedha
- Mango Halwa
- Mango Pedha
- Mango Barfi,
- Kesar Halwa
- Kesar Barfi
- Jalebi

B. EXTRACTION PROCEDURE FOR TARTRAZINE.

The extraction of food colors was carried out using the method detailed by Bachalla et al.(2016)[4-5], Spectrophotometry on this supernatant, we obtained the data about presence of concentration of tartrazine in the respective sweets

II. MATERIALS & METHODS

solution was centrifuged at 2000 rpm for 1 hour at 35 °C.
Following centrifugation, the supernatant was carefully separated from the sediment. The supernatant was then filtered through Whatman filter paper. To aid in further dilution, 3 mL of distilled water was added to the filtrate. This extraction protocol was consistently applied to all sweet samples for uniformity in tartrazine analysis.
Beverage samples were analyzed directly without the need for any extraction procedures.

C. UV SPECTROPHOTOMETRIC ANALYSIS.

The spectrophotometric analysis of the extracted food colors was conducted following the methodology outlined by Bachalla et al. (2016) [4-5], with some modifications. A series of standard tartrazine solutions were prepared in the concentration range of 10 to 150 ppm. These standard solutions were analyzed using a UV-Visible spectrophotometer to determine their absorbance values at the maximum wavelength (λmax) specific to tartrazine. A calibration curve was constructed by plotting absorbance against concentration. Using this standard calibration curve, the concentrations of tartrazine in the extracted sweet samples and beverage samples were determined by comparing their absorbance values to the curve. This method enabled the quantitative estimation of tartrazine present in the tested food products.

III. RESULTS

A. CALIBRATION DATA.

The maximum absorbance wavelength for Tartrazine was observed at 427 nm, as determined using a UV-Visible spectrophotometer. A calibration curve was established using standard Tartrazine solutions in the concentration range of 10–150 ppm, displaying a strong linear relationship between absorbance and concentration within this range. The linear trend confirmed the reliability of Beer's Law under these conditions, and the calibration curve was used to estimate the dye concentrations in food and drink samples.

incorporating minor adjustments. To estimate the tartrazine content, 2 grams of each sweet sample were accurately weighed and transferred into a conical flask. The samples were then dissolved in 10 mL of distilled water. The mixture was subjected to continuous stirring using a rotary flask shaker at 35 °C for 30 minutes, maintaining a speed of 100–125 rpm to ensure thorough homogenization. After the mixing process, the resulting

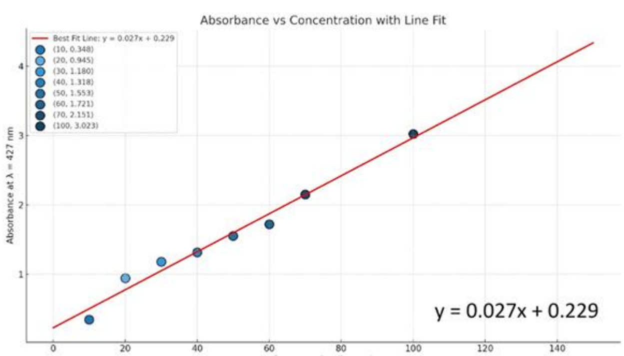
Table 1. Standardization data.

Sr. No.	Concentration of Tartrazine (in ppm)	Wavelength of Max.Absorbance (in nm)	Max Absorbance
1.	10	422.4	0.448
2.	20	418.2	1.009
3.	30	424.8	1.58
4.	40	430	1.52
5.	50	427.2	1.753
6.	60	427.2	1.921
7.	70	435.6	3.151
8.	100	472.8	4
9.	150	452.4	4

Following are the obtained points from UV-Visible Analysis of solutions of known concentrations of tartrazine:

Table 2. Calibration Data.

Sr.No.	Concentration of Tartrazine	Absorbance at (λ)max=427
1.	10	0.348
2.	20	0.945
3.	30	1.18
4.	40	1.318
5.	50	1.553
6.	60	1.721
7.	70	2.151
8.	100	3.023
9.	150	2.981



Graph 1. Absorbance vs Concentration.

- Maximum absorbance wavelength: 427 nm
- Calibration curve: Linear trend observed between 10–150 ppm
- Actual Wavelength for Maximum Absorbance of Tartrazine = 425-435nm

B. ANALYSIS OF BEVERAGES.

The absorbance values of various commercially available drink samples were recorded at 427 nm and mapped onto the calibration curve to determine the Tartrazine concentrations. The results are summarized below:

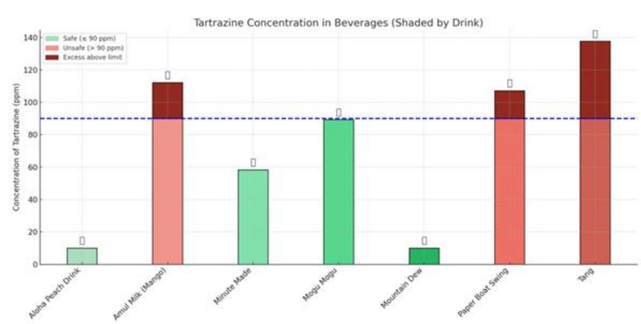
- Safe Drinks (Tartrazine ≤ 90 ppm): Aloha Peach Drink, Minute Maid, Mogu Mogu, Mountain Dew.
- Unsafe Drinks (Tartrazine > 90 ppm): Amul Milk (Mango), Paper Boat (Mango), Tang.

Among the drinks tested, Tang exhibited the highest Tartrazine concentration (137.71 ppm), significantly exceeding the permitted limit of 90 ppm. In contrast, Aloha Peach Drink and Mountain Dew contained only 10 ppm of Tartrazine, falling well within the safety threshold.

Table 3. Analysis of Beverages

Drink	Brand	Absorbance (λ = 427 nm)	Tartrazine Conc. (ppm)	Permitted Limit	Safe?
Aloha Peach Drink	Aloha!	0.198	10	90	☑
Amul Milk (Mango)	Amul	3.301	112.18	90	✕
Minute Maid	Coca-Cola	1.827	58.35	90	☑
MoguMogu	Sappe Public Company Limited	2.672	89.21	90	☑
Mountain Dew	PepsiCo	0.333	10	90	☑
Paper Boat (Mango)	Hector Beverages	3.164	107.18	90	✕
Tang	Mondelēz International	4.0	137.71	90	✕

Absorbance was measured at the maximum absorbance wavelength of Tartrazine (λ = 427 nm) using a UV-Visible spectrophotometer. The Tartrazine concentration (in ppm) was determined using the calibration curve. The permitted limit for Tartrazine in beverages is set at 90 ppm as per food safety regulations. A green check (✔) indicates compliance, while a red cross (❌) indicates exceedance of the safety limit.



Graph 2. Tartrazine Concentration obtained in beverages.

C. ANALYSIS OF SWEET SAMPLES.

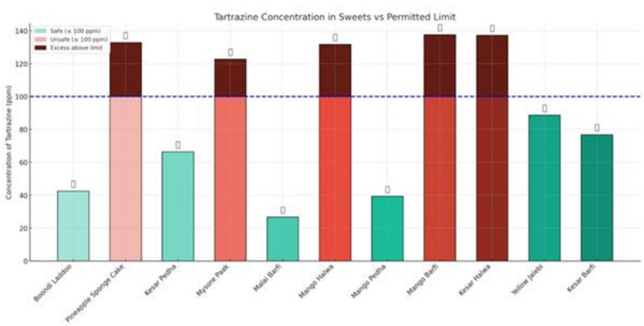
Similar analysis was carried out for traditional Indian sweets. The following trends were observed:

- Safe Sweets (Tartrazine ≤ 100 ppm): Boondi Laddoo, Kesar Pedha, Malai Barfi, Mango Pedha, Yellow Jalebi, Kesar Barfi.
- Unsafe Sweets (Tartrazine > 100 ppm): Pineapple Sponge Cake, Mysore Paak, Mango Halwa, Mango Barfi, Kesar Halwa.

The Mango Barfi and Kesar Halwa samples showed Tartrazine concentrations exceeding 137 ppm, breaching the 100-ppm permissible limit. The presence of such high dye levels raises health concerns, especially due to the cumulative effects of synthetic dyes.

Table 4. Analysis of Sweet.

Sr.No.	Sweets from aLocal Shop	Absorbance at λ = 427 nm	Actual Concentration of Tartrazine Present	Permitted Concentration	Is it safe to eat
1	Boondi Laddoo	1.394	42.54	100	☑
2	Pineapple SpongeCake	3.87	132.96	100	✕
3	Kesar Pedha	2.047	66.39	100	☑
4	Mysore Paak	3.593	122.84	100	✕
5	Malai Barfi	0.959	26.65	100	☑
6	Mango Halwa	3.84	131.86	100	✕
7	Mango Pedha	1.306	39.32	100	☑
8	Mango Barfi	4	137.71	100	✕
9	Kesar Halwa	3.99	137.34	100	✕
10	Yellow Jalebi	2.658	88.7	100	☑
11	Kesar Barfi	2.334	76.87	100	☑



Graph 3. Tartrazine Concentration obtained in sweets.

IV. DISCUSSION

The results from the UV-Visible spectrophotometric analysis indicate a wide variation in tartrazine concentration among different commercial sweets and beverages. The standard calibration curve confirmed a consistent and reliable relationship between absorbance at 427 nm and tartrazine concentration, reinforcing the validity of this method for food dye analysis (refer to Table 1., Table 2. and Graph 1).

Among beverage samples, products like Tang, Amul Mango Milk, and Paper Boat (Mango) were found to significantly exceed the permitted limit of 90 ppm. Tang had the highest concentration of tartrazine at 137.71 ppm, surpassing the safe threshold by over 50%. Similarly, Amul Mango Milk recorded a concentration of 112.18 ppm, raising concerns particularly because this product is often marketed to children and families. These results suggest that some commercial drink manufacturers might be using tartrazine in higher quantities than allowed, potentially to enhance the visual appeal and marketability of their products (refer to Graph 2.).

In sweet samples, six out of eleven exceeded the 100-ppm safety limit. Notably, Pineapple Sponge Cake, Mango Barfi, and Kesar Halwa each contained more than 130 ppm of tartrazine. The widespread use analytical tool for detecting and quantifying tartrazine in food and beverages. The linear correlation between absorbance at 427 nm and tartrazine concentration allows for accurate estimation using a standard calibration curve.

Our findings reveal a substantial overuse of tartrazine in several commercially available sweets and beverages. More than half of the sweet samples and nearly half of the beverage samples tested had tartrazine levels that exceeded the legally permitted concentration. Such excessive use may pose health risks, especially with frequent consumption, emphasizing the need for routine quality checks.

This research highlights an urgent call for improved regulatory oversight, especially in regions where traditional sweets are produced without standardized procedures. It also stresses the importance of consumer education. Shoppers must be made aware of the potential health implications of food dyes and the importance of reading product labels.

Future research should consider a broader sample size across different regions and seasons to monitor trends in food dye usage. There is also scope for investigating the health effects of chronic exposure to synthetic dyes in local populations, particularly children.

In conclusion, while tartrazine remains a legally approved food dye, its use must be balanced with safety. Food manufacturers, regulators, and consumers all share the responsibility of ensuring that what looks good on the plate is also safe to eat.

of tartrazine in traditional Indian sweets could be attributed to the strong consumer preference for vibrant colors, which are often associated with richness and flavor. However, repeated or high consumption of these sweets may expose individuals to levels of synthetic dyes that exceed acceptable daily intake values, especially for vulnerable populations such as children (refer to Graph 3.).

Another critical point is the general lack of labeling and awareness about the presence of food dyes in these products. Many locally made sweets are sold without nutritional or ingredient labels, making it difficult for consumers to make informed choices. While most commercial beverages provide labeling, it may not always reflect accurate dye concentration levels.

This study also sheds light on the need for stricter regulatory monitoring. Although guidelines exist for maximum allowable levels of food dyes, enforcement and quality control mechanisms are often lacking in both organized and unorganized sectors. Regular testing and public awareness campaigns could help bridge this gap.

V. CONCLUSION

The study underscores the effectiveness of UV-Visible spectrophotometry as a simple yet powerful

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