Estimation of Synthetic Dyes in Various Food Samples by UV-Visible Spectrophotometric Method

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***Abstract*- The study aimed in focusing on the measurable amount of food colors or dyes used in food industry. A reliable and fast method was developed and applied in the estimation of selected food dyes i.e., Carmosine, Ponceau 4R, Sunset Yellow in various food materials such as Maggie Masala, mixed fruit jam, tomato ketchup and candies. Synthetic food colors like Ponceau 4R, Carmosine, Sunset Yellow and three sample were detected at different wavelengths 482nm, 510nm, and 425nm respectively. All the samples were studied and the amount of food dyes present were estimated as per USFDA limits.**

***Index terms*- Ponceau 4R, Carmosine, Sunset Yellow, Synthetic Dyes, Spectrophotometer**

I.INTRODUCTION

Synthetic food colours: Synthetic colors can be produced by chemical reactions and are extensively utilized in both the food and pharmaceutical industries. Commonly used food colors include Tartrazine, Amaranth, Quinoline Yellow, Sunset Yellow, Allura Red, Dazzling Blue, Indigo and Carmine. Natural colors are being promoted more due to consumer worries about synthetic dyes. Because they are less expensive and offer a more intense and consistent color, certified synthetic colors are widely used [1]. Artificial food coloring use is dropping significantly in India as more people become aware of its detrimental consequences. Because natural colors tend to be more expensive than synthetic colors, there appears to be an improvement to avoid them [2].

Regulation: The most significant aspect is that it demonstrates the product's required distinctive features as set out by regulation, whether natural or manufactured. The FSSAI, an Indian regulatory organization, has established guidelines for the use of food colors in various food consumption. If the stipulated requirements are not met, even if there is a preference for natural things, this is nonsensical [3].A good food color should have the following characteristics: color consistency and stability against oxygen, light, and pH, freely soluble in water [4].

Historical Perspectives: In ancient times, naturally occurring color additives derived from vegetable and mineral sources were utilized to color meals, medicinal products, and cosmetics. Some examples include Paprika, Turmeric, Saffron, Iron, Lead oxides, and Copper sulfate. The early Egyptians utilized artificial colors in cosmetics and hair dyes. Beginning around 300 BC, wine was artificially tinted. William Henry Perkin discovered the first synthetic natural color, Mauve, in 1856. Related dyes were discovered soon after, and they were immediately utilized to color foods, pharmaceuticals, and cosmetics. Many of these dyes were initially created as byproducts of coal production and were known as "coal-tar colors. “Color additive licensing has begun in the late 1880’s. The United States Department of Agriculture's (USDA) and Bureau of Chemistry began study on the use of colors in food since 1881, and it was one of the initial public efforts done by the country [5]. The federal government initially permitted the use of artificial colorings in butter and cheese. By 1900, many foods, pharmaceuticals, and cosmetics had been artificially colored. However, not all coloring compounds were hazardous, and some were used to conceal substandard or faulty meals, improve the overall appearance of the food, and make it more appealing and colorful [6].

A detailed examination of the chemicals used to pigment food at the time revealed the presence of several clearly toxic elements such as Lead and Arsenic. In many circumstances, the very initial components are fatal. In 1927, responsibility for enforcing the Food and Drugs Act of 1906 was given to the newly established FDA. The agency was first called the Food, Drug, and Insecticide Administration and was given its current name in 1930. By 1931, there were 15 straight colors approved for use in food, including six of the seven in use today: FD&C Blue No. 1 (Brilliant Blue FCF), FD&C Blue No. 2 (Indigotine), FD&C Green No. 3 (Fast Green FCF), FD&C Red No. 3 (Erythrosine), FD&C Yellow No. 5 (Tartrazine), and FD&C Yellow No. 6 (Sunset Yellow). (Sunset Yellow) [7,8].

Synthetic Food Color Adulteration-Artificial food colorings interact with food and turn into toxins in the body, where they cause cancer, mutations, and other negative consequences. Synthetic colors are added to meals to replace natural colors lost during processing and to eliminate batch-to-batch variance [9].

Causes for addition of Synthetic Food Colors:

1. Because off-color meals are often seen as of lower quality, colors are added.
2. Color and variety of meals are desired by consumers. The dealers improve the appearance of their items in order to enhance sales and profit.
3. Consumer ignorance, carelessness, indifference and lack of organized action of check the menace.

Toxic Effects of Synthetic Food Color on Human Health-Children who consume more artificially colored foods are more likely to experience insomnia, irritability, and restlessness. Consumption of artificial food colors is also linked to melancholy, memory loss, and hostility. Synthetic food colors, lowers the red cell count and hemoglobin concentration and causes allergic

reactions. Excess consumption of food colors also exert symptoms like glossitis (Inflammation of tongue).They inhibits dopamine uptake by nerve ending [10] (reduced dopamine turnover in the body).

II. Materials and methods:

Different colored food samples like tomato ketchup, fruit jam, and food masala were taken from the market. Calorimeter, UV-VIS Spectrophotometer with 1.0 cm quartz cell (Lab India) was used for the measurement of absorbance of synthetic food colors. The chemical classification and formula was tabulated under table-1.

Table-01 Chemical Name and Grouping of the synthetic dyes used in Food Industry

S. No	Color	Common Name	Color Shade	Color Index	Chemical Class	Empirical Formula
01.	Red	Ponceau 48	Strawberry Red	16255	Mono azo	$C_{20}H_{11}N_2O_{10}S_3Na_3$
		Carmoisine	Red	14720	Mono azo	$C_{20}H_{12}N_2O_7S_2N_2$
		Erythrosing	Bright Pink/Red	45430	Xanthene	$C_{20}H_8O_5I_4Na_2$
02.	Yellow	Tartrazine	Lemon Yellow	19140	Mono azo	$C_{16}H_9N_4O_9S_2Na_3$
		Sunset Yellow	Orange	15985	Mono azo	$C_{16}H_{10}N_2O_7S_2Na_2$
03.	Blue	Indigotine carmine	Royal blue	73015	Indigoid	$C_{I6}H_8N_2O_8S_2Na_2$
		Brilliant Blue FCF	Turquoise Blue	42090	Triarylmethane	$C_{37}H_{34}N_2O_9S_3Na_2$
04.	Green	Fast Green FCF	Sea Green	42053	Triarylmethane	$C_{37}H_{34}N_2O_{10}S_3Na_2$

Preparation of Standard Stock Solutions-The standard dye i.e, Ponceau 4R, Carmosine, and Sunset Yellow was accurately weighed by taking 0.1gm into a clean dried 100 mL volumetric flask and prepared a concentration 100mg/mL using distilled water. From the prepared stock solution, working standard solutions of concentrations 2, 4, 6, 8, 10 mg/mL were prepared respectively afresh to the analysis.

Sample Extraction Method-Accurately measured and transferred 2 g of sample into a beaker and dissolved in 10mL of distilled water. Stir occasionally for uniform mixing and transfer into a centrifuge tube and place it in centrifuge at 50,000 rpm for 10min. After 10 to 15 minutes, carefully filter the sample solution and store the filtrate in a stoppered glass tube for further analysis.

Colorimetric analysis- In colorimeter the absorbance of the synthetic food colors in both standard and the sample were compared, and all samples showed the presence of the synthetic food colors. The different wavelengths of the selected standards were tabulated under table-02.

Table-02 Wavelength Maxima of Standard Dye

Standard Food Dye	**Color**	**λmax**
Ponceau 4R	Light orange	482nm
Carmosine	Pink	510nm
Sunset yellow	Yellow	425nm

III. RESULTS AND DISCUSSION- the synthetic dyes as per the availability were procured and were analyzed in the samples like Masala, Candies, Jam and Tomato Ketchup. The analysis was performed using colorimetric methods of determination and the sample were analyzed at the particular λmax with respective of the standard at different conc. levels and determined the amount of colors added in the samples. The comparative estimations of the sample and the standard were depicted under table 3 and 4

Table-03 UV Spectrophotometric Estimation of Synthetic dyes in Food Samples and Standards

Standard	**λmax**	**Std Abs**	**Sample**	**Spl Abs**
Carmosine	510nm	2.451	Ketchup	0.157
Carmosine	510nm	2.451	Jam	0.236
Sunset Yellow	425nm	1.013	Maggie Masala	1.72
Fast Green FCF	420nm	1.987	Gems (Green)	0.356

Table-04 UV Absorbance for Standard dyes and Samples at different conc. levels

Concentration (mg/mL)	**Carmosine UV Abs**	**Sunset Yellow UV Abs**	**Fast Green FCF UV Abs**
2	1.372	0.858	1.327
4	2.451	1.116	1.987
6	3.984	1.473	1.992
8	4.022	2.236	2.710
10	4.119	2.501	2.822
Sample	Ketchup-0.157 Jam-0.236	Maggie Masala-0.14	Candies -0.356

The samples were analyzed and the respective standards were estimated. The amount of dyes used in the food samples were found to be more than the prescribed limit of the FSSAI. The total amount found and the specified limits were tabulated under table-5. The UV Visble spectra of both samples and Standards were shown under Fig 1.

Table-5 Food Colour Limits According to FSSAI:

Sample	**Limits as per FSSAI (%)**	**Amount found (%)**
Ketchup	0.5 -1.0	6.4
Jam	5.0-7.5	9.6
Maggie Masala	0.5-5.0	12.5
Candies	0.5-7.5	17.9

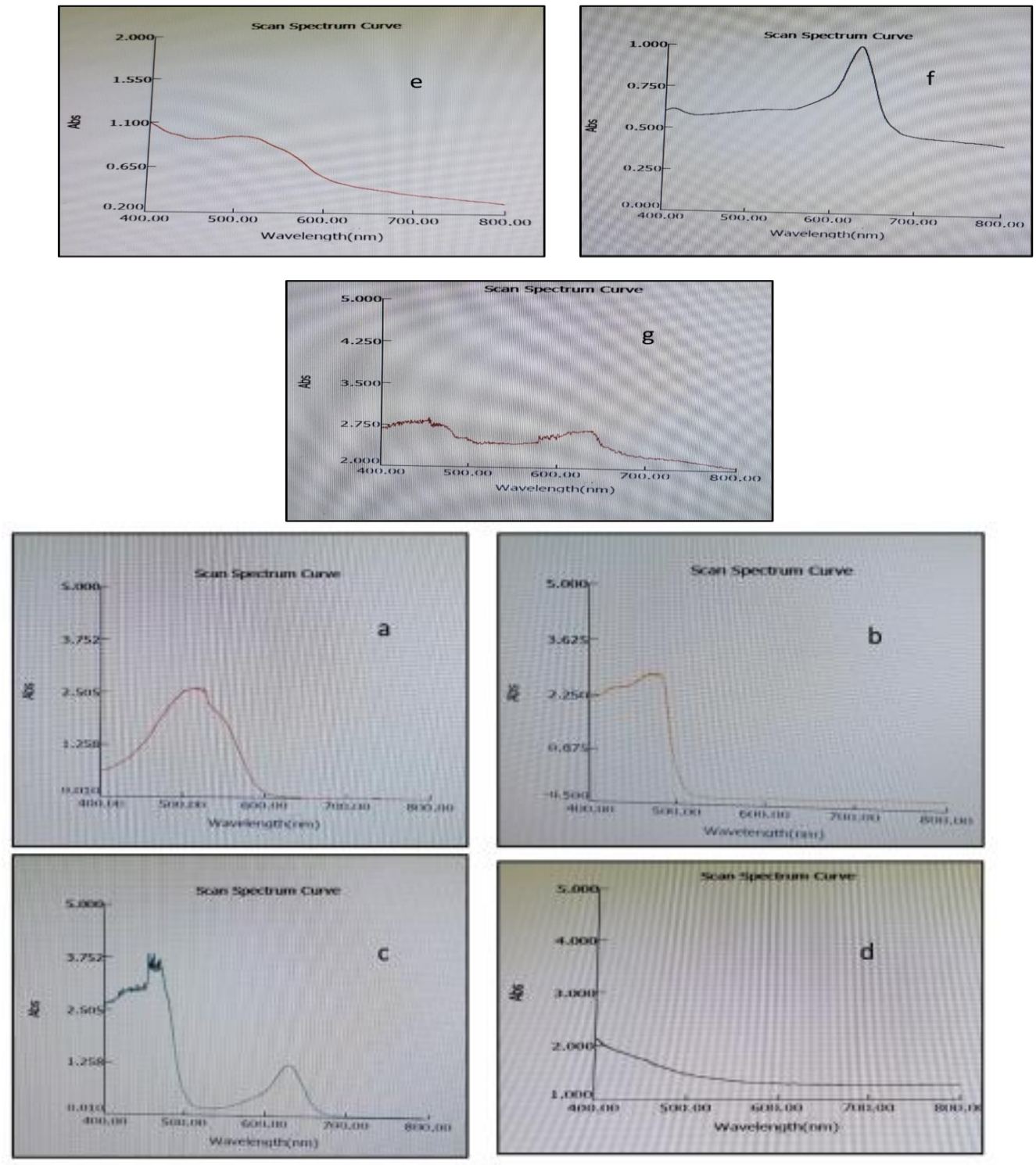

Fig 1- UV Septra of a. Carmosine standard b. Sunset Yellow sample c. Fast Green standard d. Green Candies e. Ketchup sample f. Blue Candies g. Maggie Masala Sample

IV. CONCLUSION-From the study it was concluded that the preliminary examination like colorimetric analysis was done for synthetic dyes used as food colors to make the food more appealing. UV-Vis spectrophotometer is widely used for qualitative analysis and the data presented in various tables and graphs show that the remarkable identification of synthetic food colors. This study concluded that the techniques and data can be used for identification in different types of food stuffs. Because synthetic food colors are often used nowadays, the study's findings are particularly valuable in preventing the misuse of synthetic colors added to meals. The current investigation found that synthetic colors in food masala are safe (0.01mg/kg) and within the limitations. The current study revealed that the levels of food dyes contained in various samples were found to be higher than the required limits, i.e., tomato ketchup, sweets, and mixed fruit jam are higher than the safety limits, which is harmful to one's health and makes it difficult to live a healthy lifestyle.

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