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Estimation of synthetic dyes in various food samples by spectrophotometric methods

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Abstract
In the present study an attempt has been made to perform extraction, identification and estimation of synthetic dyes in different food stuffs by Colorimeter and UV-Visible spectrophotometer. A reliable and fast method was developed and applied to the estimation of selected synthetic food dyes (Carmosine, Ponceau 4R, Sunset Yellow) in three different kinds of food stuffs: solid masala powders, mixed fruit jam and Tomato ketchup. Water was employed as a solvent system depending on the expected dyes in the studied samples. Synthetic food colors like Ponceau 4R, Carmosine,Sunset Yellow and three samples were detected at wavelengths 482nm,510nm,425nm. All the samples were studied as per USFDA. Carmosine and Poneau 4R in mixed fruit jam and tomto ketchup have exceed legislated values.

Keywords: Synthetic food colors, Food safety, Colorimetry, UV-Visiblse Spectrophotometer

1. Introduction

Synthetic food colours are substances of chemicals which do not occur in nature [12]. and have been made in factory [1]. These colours are usually water soluble [3]. and can be used in foods without any further processing [2]. This means that they have to be detected [8]. or enhanced to be further examined as a part of standard forensic procedure [6]. Knowledge of chemical composition and changes over time [11]. prove to be an important factor in the development of new detection techniques for synthetic food colours [5].
Examples of synthetic food colours. Ponceau4R, Carmosine, Erythrosine, Sunset yellow, Tartarazine.

Characteristics

An ideal food color should has the characteristics given below
Color should be uniform,
Highly stable to light, oxygen and PH
Inexpensive and easily available
Freely soluble in water
To give required colour in minimum concentration.

Classification

Classification of Synthetic food colors are mentioned in the following Table – 1. The principle sources of synthesized dyes are eighty synthetic dyes colored foods, and coal tar derivatives. According to the importance of Synthetic food colors a number of methods for their extraction and identification have been developed. Extraction from the food sample is carried out either by adsorption on wool.

Table 1: Classification of Food Colours

Sl. No	Color	Common Name	Color Shade	Color Index	Chemical Class	Empirical Formula
1	Red	Ponceau 4R	Strawberry Red	16255	Mono azo	C20H11N2O10S3Na3
		Carmoisine	Red	14720	Mono azo	C20H12N2O7S2Na2
		Erythrosine	Bright Pink / Red	45430	Xanthene	C20H8O5I4Na2
2	Yellow	Tartrazine	Lemon Yellow	19140	Mono azo	C16H9N4O9S2Na3
		Sunset Yellow	Orange	15985	Mono azo	C16H10N2O7S2Na2
3	Blue	Indigotine carmine	Royal blue	73015	Indigoid	C16H8N2O8S2Na2
		Brilliant Blue FCF	Turquoise Blue	42090	Triarylmethane	C37H34N2O9S3Na2
4	Green	Fast Green FCF	Sea Green	42053	Triarylmethane	C37H34N2O10S3Na2

Many methods have been used for the identification of the different colors used in food processing. In 1860, Hassall passed the first Food Adulteration Act; he analyzed the food samples firstly with a Microscope for identifying foreign organic matter, for which no chemical tests were available.
Arata (1889) developed the use of wool fibers for extraction and cleanup of food samples for colorant analysis. Ronald L. Stanley and Paul L. Kirk (1963) developed systematic identification of artificial food colors which are permitted in the United States. They are analyzed about artificial dyes in food and using Wool dyeing for screening, column adsorption on alumina for isolation and paper chromatography for isolation and identification [30]. David A. Katz (2009) developed the Extraction, separation and identification of synthetic food colors from various foods like candies and soft drinks.
Traditionally chromatographic methods are used. Paper chromatography plays the most important role. The applicability of the method was tested with a variety of synthetic food colorant sweets. It was found that the results are reliable, obtained by Paper chromatography. The most important method for the identification of synthetic food colors is UV Visible Spectroscopy, because all colorants have been characterized by this method

Adulteration of foods by synthetic colours

Synthetic food colors serves to mask defects in food making and inferior foods look superior. Synthetic food colors react with food and change into poisons in the body, causing mutations, cancer and other toxic effects. These colors produce allergic reactions in several individuals.

Causes for addition of Synthetic Food Colours

- Consumers demand color and variety in foods.
- The traders make their goods look superior, attractive and thereby increase of sales and profit.
- Consumer ignorance, carelessness, indifference and lack of organized action of check the menace.
- Inadequate enforcement of foods and absence of deterrent punishment for offenders.

Toxic Effects of Synthetic Food Color on Human Health

- They are carcinogenic and damage to kidneys and adrenals.
- Synthetic food colors, lowers the red cell count and hemoglobin concentration and allergic reactions. They inhibits dopamine uptake by nerve ending.
- These colors are associated with irritability, restlessness and sleep disturbance in atopic or hypertensive more effective to children than adults, effects on liver and Intestine.
- They cause exhibited symptoms glossitis (Inflamation of tongue).
- They inhibits dopamine uptake by nerve ending (reduced dopamine turnover
- Allergic responses vary from uticaria to dermatitis, angioedema, etc.
- They lead to Ear infections, Asthma, Dyslexia, Eczema, Autism, etc. when consumption of high level of synthetic food colours

2. Materials and methods

Different coloured food samples like tomato ketchup, fruit jam, food masala were taken from the market

Colorimeter, UV-VIS Spectrophotometer with 1.0 cm quartz cell (Lab India) was used for the measurement of absorbance of synthetic food colors.

Preparation of Standard Stock Solutions

Three standard dye solutions of concentration 100mg/ml were prepared by taking 0.1gm in 100ml of distilled water. From the above solution different concentrations 2,4,6,8,10 mg/ml of standard solutions were prepared freshly during analysis.

General Procedure for Preparation of Sample solutions / Extraction Method

Small quantity (2 g) of sample was measured and dissolved in 10ml of distilled water in a beaker. Then place it in centrifuge at 50,000 rpm. After 10 to 15 minutes, the sample solution was filtered and stored the solution in a stopperred glass 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 are given in table-1

Table 2: wavelengths of standard colours

Standard food colour	Color	Wavelength
Ponceau 4R	Light orange	482nm
Carmosine	Pink	510nm
Sunset yellow	Yellow	425nm

Ultraviolet-visible (UV- VIS) spectrophotometric analysis

Lab India 1800 UV/ VIS Spectrophotometer was used in this study, the UV/ visible spectrum of a substance over a certain wavelength range consists of absorption values measured at a number of wavelength points.

3. Results and discussion

The results obtained for the food samples after colorimetric Analysis were expressed in the terms absorbance at a specific wavelength were given in the table no.2

Table 3: Colorimetric estimation of food samples and standards

Sample	Wavelength	Sample Absorbance	Standard	Standard absorbance
Tomato ketchup	510nm	0.77	Carmosine	0.70
	482nm	0.40	Ponceau 4R	0.53
Fruit jam	510nm	0.72	Carmosine	0.70
	482nm	1.25	Ponceau 4R	0.53
Food masala	425nm	1.70	Sunset yellow	1.90

There is a great need to create awareness at different levels about the toxic effects of synthetic food colors. The present study reported that these synthetic food colors are extracted and identified by colorimeter and spectrophotometry. Mainly to detect the presence of synthetic food colors in foods are separated and identified based on the wavelength of standards and samples.

The absorbance of standard and samples absorbance of synthetic food colors, were given in the table no.3 and are graphically represented below.

Table 4: U.V spectrophotometry estimation of food samples and standards

Concentration (mg/ml)	Carmosine	Sunset Yellow	Ponceau 4R
	Absorbance	Absorbance	Absorbance
2	1.634	2.113	1.327
4	2.299	2.785	1.987
6	2.980	3.046	2.516
8	3.184	3.123	2.710
10	3.285	3.267	2.939
Sample (2mg/ml)	JAM-2.136	KETCHUP-1.708	MASALA-2.403

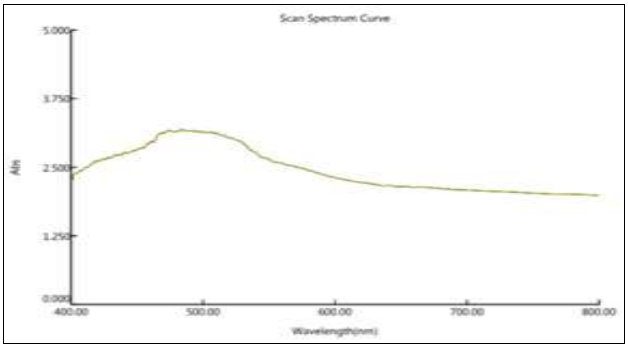

Fig 1: Tomato ketchup

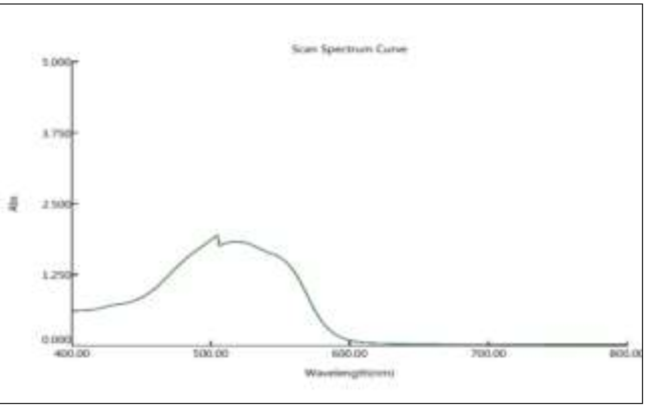

Fig 2: Carmosine

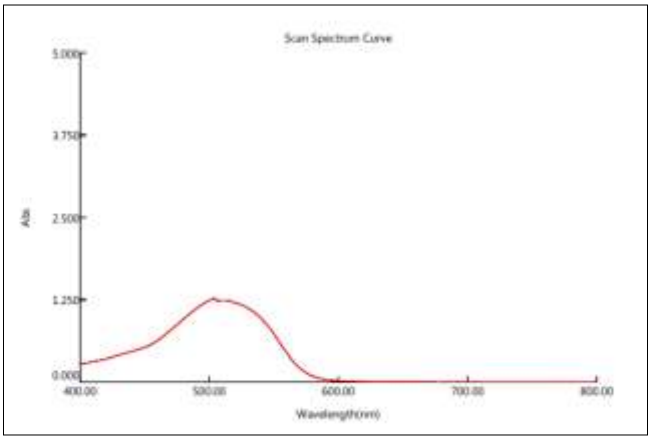

Fig 3: Ponceau 4R

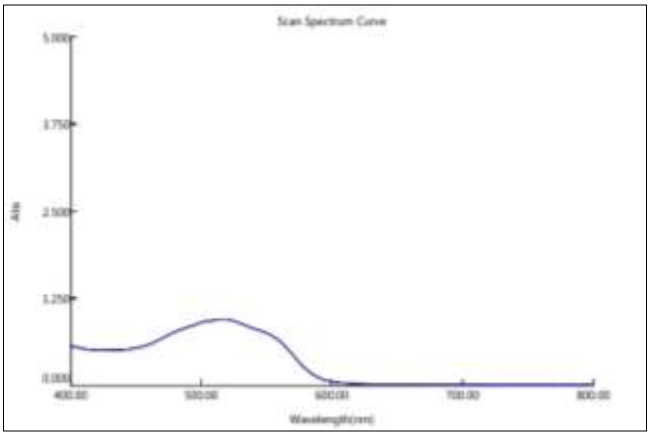

Fig 4: Mixed fruit jam

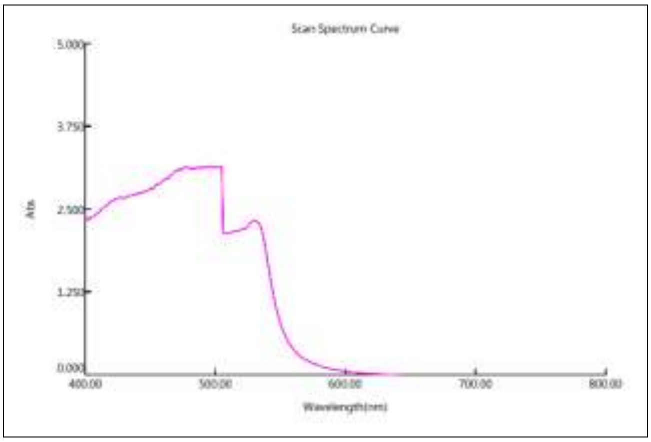

Fig 5: Sunset yellow

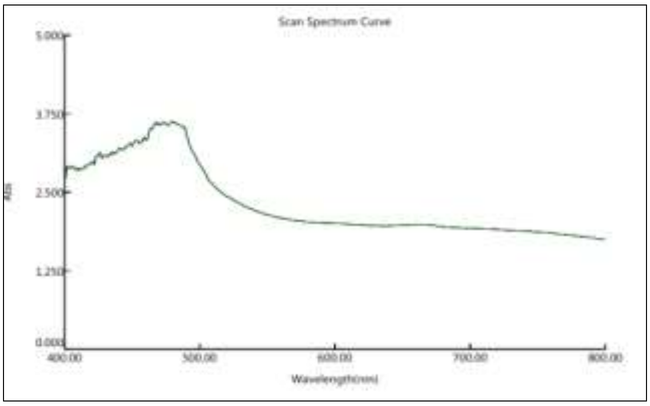

Fig 6: Food masala

Conclusion

It is concluded that preliminary examination like colorimetric analysis was done for synthetic food colors. UV-Vis spectrophotometer is widely used for qualitative analysis and the data presented in various tables and graphs show that the remarkable identification of adulteration of synthetic food colors. This study concluded that the techniques and data can be used for adulteration identification in different types of food stuffs. Nowadays, synthetic food colors are frequently used, therefore results of the study is found to be very useful to prevent the malpractice of synthetic food color adulteration. The present study showed that synthetic dyes in food masala are within the safety limit (0.01mg/kg) and in tomato ketchup and mixed fruit jam is above the safety limits.

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