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DETERMINATION OF SUNSET YELLOW AS A SYNTHETIC FOOD COLORANT IN CONFECTIONERY PRODUCTS CONSUMED IN KATSINA METROPOLIS (NIGERIA) USING UV-VIS SPECTROPHOTOMETER

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ABSTRACT
The use of Sunset yellow as food colorants in non-alcoholic drinks, beverages and confectionery is rising despite their problems upon consumption by humans. It is therefore, necessary to constantly monitor the concentrations of these dyes in our foods, beverages and confectionery because of their health-related issues that include hyperactivity in children and immune system compromise. For these reasons, the concentration of sunset yellow used as colorants was determined in ten different brands of confectionaries using the spectrophotometric method of analysis. A cross-sectional primary data was obtained through experimental procedures in ten different samples of confectionary products procured (Central Market Katsina, Nigeria). The results shown that the concentration for the two samples; E and I are 52.311±0.178 mg/L and 87.887±0.018 mg/L respectively were found to be above the acceptable permissible limit of 50mg/L, while for the remaining eight samples; A, B, C, D, F, G, H, and J are, 46.523±0.116 mg/L, 49.364±0.418 mg/L, 41.924±0.029 mg/L, 27.853±0.029 mg/L, 33.045±0.018 mg/L, 29.515±0.028 mg/L, 34.250±0.019 mg/L and 33.295±0.018 mg/L respectively are within the acceptable permissible limit of 50 mg/L in accordance to Regulation (EC) No. 1333/2008 of the European Parliament and council establishing a Union list of food additives. Therefore, the results justify the safe consumption of samples A, B, C, D, F, G, H and J but samples E and I are not safe for consumption due to their concentration levels found above 50 mg/L.

Keywords: Sunset yellow, Food safety, Confectionaries, UV-Visible Spectrophotometer

INTRODUCTION

Food dye can be any chemical substance or pigment that will impart color to our food. The main purpose to add a food dye is to give a good appearance to foodstuffs, (Downham and Collins. 2000). It can be classified into two major groups, i.e. natural dyes and synthetic dyes. In the early times, colors were used to dye fabrics that were extracted from minerals, plants and animals, these dyes are categorized as natural dyes. After the production of these dyes a new class of dyes was produced which were cheaper, easy to apply and gives the colour more quickly than the natural dyes these are named synthetic dyes.

All food dyes can be divided into two basic, general categories: natural dyes and artificial dyes. The natural food dyes are derived from grapes, saffron, paprika, carrots, beets, and algae, and are used to color a variety of foods. The artificial food dyes (AFCs), which are mostly derived from petroleum, contain a single, or more, azo functional group (–N=N–), which most frequently connects the two aromatic parts. People associate specific colors with specific flavors, therefore colours of food can affect their perception of taste, especially their perception of sweets and beverages, (Nives *et al.*, 2018). Artificial dyes may improve on natural variations in color, may enhance colors that occur naturally, or may provide color to colorless and "fun" food, thereby making it appear more attractive and appetizing – e.g. adding a red, yellow or green color to gummy sweets, which would naturally be colorless, (figure 1) below showing the samples of confectionery.

Figure 1: Samples of confectionery

The Sunset Yellow FCF is disodium 2–hydroxy–1–(4–sulfonatophenylazo) naphthalene–6–sulfonate, also known as Orange Yellow S, Yellow 6, denoted in Europe by E Number E110 or C.I. 15985 is petroleum–derived orange food azo–dye, with the structure shown below (Figure 2). Beside sodium salts, calcium and potassium, salts are also approved as food dyes in Europe.

The Sunset Yellow FCF is present in many common food products, such as bakery products, sugar candies, sugar–coated pills, jelly beans, powdered drinks, sweets, nutrient–enhanced sports beverages, ice creams, and gelatins (Nevado *et al.,* 1997). The food categories most contributing to exposure are non–alcoholic beverages at maximum levels of 50 mg/L, as well as confectionery and fine bakery articles with a maximum level of 50 mg/kg. (Solymosi *et al.,* 2015). The Joint FAO/WHO Expert Committee on Food Additives (JECFA) and the European Commission's Scientific Committee on Food (SCF) established an acceptable daily intake (ADI) of 2.5 mg/kg for Sunset Yellow–yet lately, based on results from (Mathur *et al.,* 2005), the amount was reduced to 1 mg/kg.

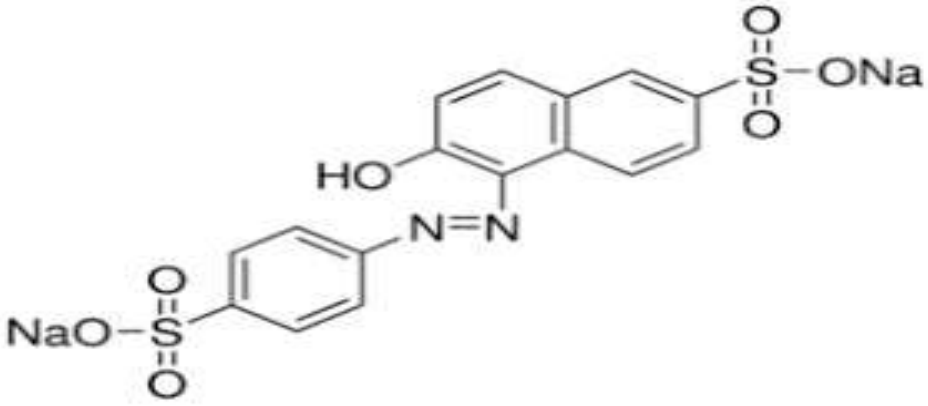

Figure 2: Structure of a water–soluble azo–dye, Sunset Yellow FCF (E 110).

Synthetic dyes are a non-nutritional, chemically active component that gives color or pigmentation to either processed or cooked food products, this practice is termed a food coloring. Synthetic dyes impart a secondary color to the food items (Naseem *et al.,* 2017). Unfortunately, the dye was reported to cause health issues that include hyperactivity in children when combined with some preservatives (such as sodium benzoate), allergic reactions in those with asthma or aspirin intolerance (Lockey *et al.,* 1977). Despite the above-mentioned side effects, the amount of AFCs used in foods has increased by 500 % in the last 50 years, with significant growth occurring during the last two decades.

Many analytical methods have been developed for the qualitative and quantitative analysis of food colours. These methods include thin-layer chromatography (TLC) with UV/VIS spectrophotometry (Gilhooley *et al.,* 1972; Love, 1984), column chromatography (Bell, 1990), mass spectrophotometry (Harada et al., 1991), DC-SPE (Dynamic Column-Solid Phase Extraction) system (Ashkenazi *et al.,* 1991), capillary electrophoresis (Suzuki *et al.,* 1994), C18 cartridge (Bell, 1990) or various combinations of these techniques. Chromatographic techniques have the disadvantages of requiring expensive equipment and demanding expert operators. The use of spectrophotometric method for the determination of tartrazine in beverages or soft drinks was successful. Fortunately, the method consumes only distilled water, hence it is classified as the most simple, accurate, easy and directly applicable in quantitative analysis. (Abubakar *et al.,* 2020). Therefore UV-Visible spectrophotometer (T60) at an absorption wavelength of 482nm was used to determine the concentration of Sunset yellow (E-110) in some selected different brands of confectionary.

MATERIAL AND METHOD

Instruments and Apparatus

The instruments used to carry out the research work include; Electrical P^H meter, Weighing balance, Hot flats, UV-Visible

spectrophotometer (T60), Mortar with pestle. While the laboratory apparatus used in the research work include; Beakers, Filter paper, Spatula, Measuring cylinder, Volumetric flasks, Stirrer, Foil paper, Wash bottle and plastic containers. Distilled water and detergent were used to wash all the glassware and then allowed to dry.

Chemicals and Reagents

The chemicals used in the research work include; Pattasiumphosphate (KH_2PO_4), Sodium hydroxide (NaOH). While the reagents used in the conduct of the research work include; Standard synthetic color additive Sunset Yellow (E-110) of analytical grade made by Tianjin Kemiou Chemical Reagent Co. Ltd. China and Distilled water.

Sample Collection

The sample collection was begin from 13^{th} - 17^{th} August 2020. Where ten Samples of confectionaries containing synthetic color additive Sunset Yellow (E-110) were collected as experimental materials from Central Market Katsina, Katsina state.

Preparation of Reagent

Adopted by (Guler Z, 2005). Phosphate buffer solution (P^H 7.0) was prepared by dissolving 6.8g of KH_2PO_4 into a 500 ml volumetric flask and mark onto volume with distilled water, and 2g of NaOH into 500 ml volumetric flask and mark onto volume with distilled. Then the 500ml solution of dilute KH_2PO_4 was transferred into 1000 ml volumetric flask and 291 ml solution of dilute NaOH was mixed and brought into volume with distilled water. P^H was controlled by an electrical P^H meter.

Preparation of Stock Solution

Therefore the stock solution of pure standard food colorants Sunset Yellow (E-110) was prepared by dissolving 0.1 g into 100 ml volumetric flask and brought into volume with phosphate buffer solution and by shaking for complete dissolution. A series of working solution of 0 ml, 5 ml, 10 ml, 15ml, 20 ml and 25 ml from the stock solution was carefully taken into 50 ml volumetric flask and brought into volume with phosphate buffer solution to give concentrations between 10 mg/L, 20 mg/L, 30 mg/L, 40 mg/L and 50 mg/L respectively.

Preparation of Sample Solution

The samples of confectionaries were grounded into powdered with a mortar with pestle. 1 g was measured using electrical weighing balance and dissolved into 50ml volumetric flask with phosphate buffer solution, and gently warmed using electrical hot flats for a complete dissolution of the sample; the sample solution was filtered and stored the solution in a stop in a 50ml bottle container for further analysis. 10 samples of confectionary containing Sunset Yellow (E-110) were used as experimental material for the analysis. The samples were arranged alphabetically for easy identification.

Instrumental Procedure

The absorption spectrum of each food colorant was obtained using (T60) UV-Visible spectrophotometer and recorded between 300 and 750 nm, For the standard working solutions, a small portion of the solutions was measured and transferred into 1.0cm path cell of (T60) UV-Visible spectrophotometer to obtained their absorbance values. The measurements or absorbance of the colorant standards were at 482 nm for Sunset yellow. This was repeated three times for all the working solutions and average absorbance values were calculated and used to plot the calibration curve, that which would be used to determine the concentration of the analyte in the samples. Therefore the absorbance of the sample solution was also obtained using (T60) UV-Visible spectrophotometer. This was also repeated three times for each sample's solution and average absorbance values were calculated and used on the linear equation of the calibration curve for each standard food colorant to evaluate the concentration of the analyte in the sample's solutions.

RESULTS

However based on the analysis conducted using UV – Visible Spectrophotometer, the concentration of sunset yellow (E-110) obtained from each sample of confectionary are shown below in Figure 3 and Table 1. The concentration values were obtained from the linear equation of the Standard Sunset yellow (E-110) calibration curve (figure 3).

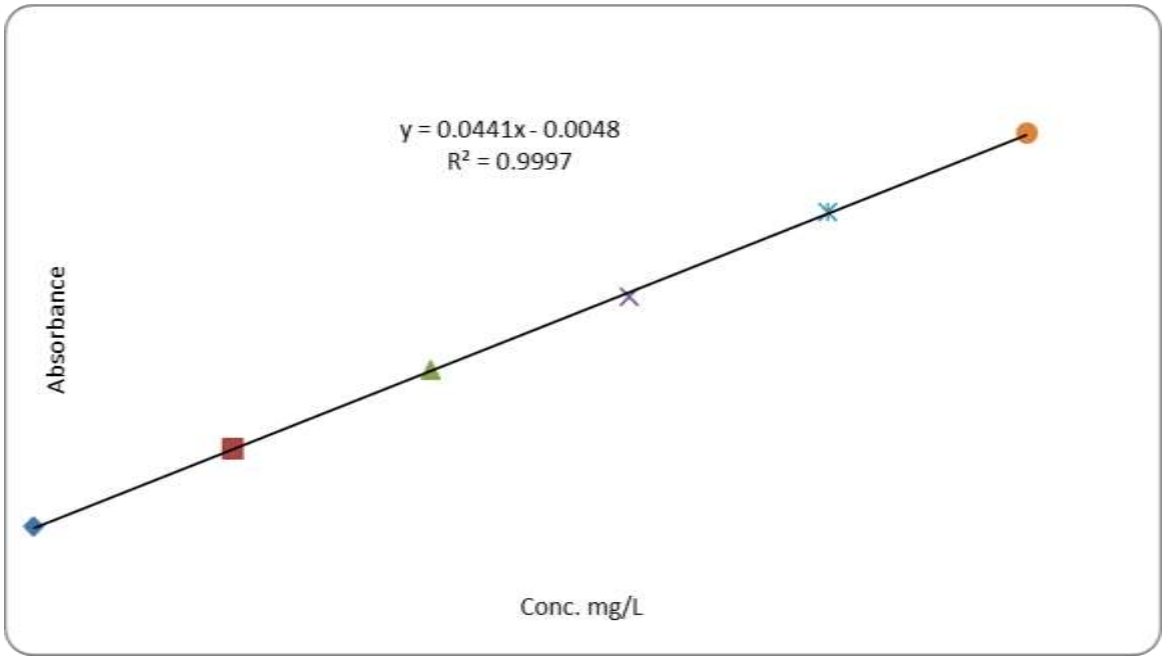

Figure 3: Calibration Curve of Sunset yellow (E-110)

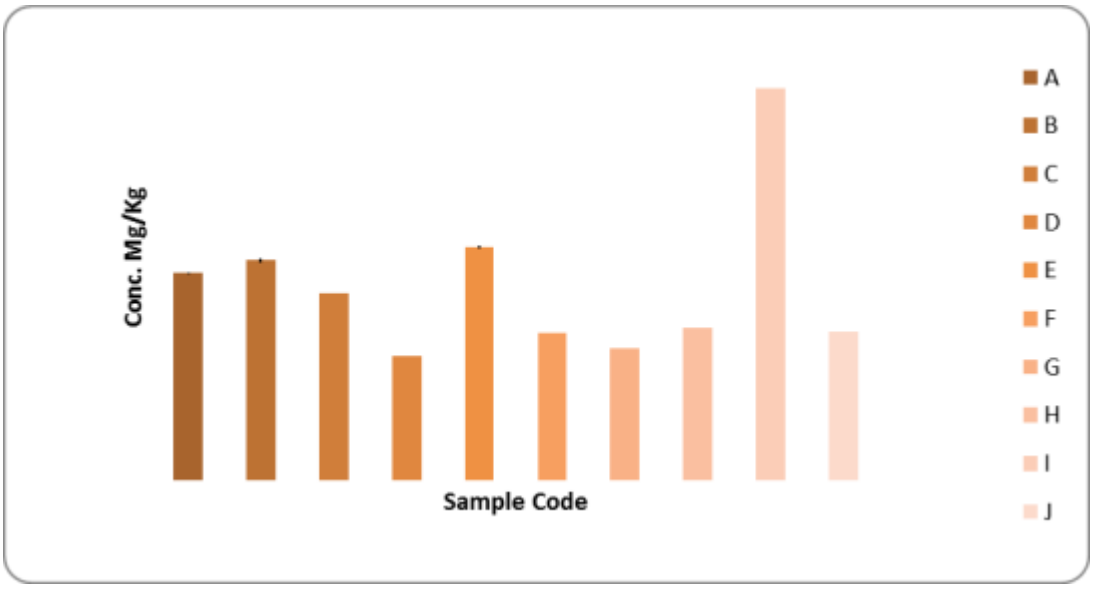

Figure 4: Showing the estimated concentration values of Sunset yellow (E-110) present in the samples of confectionary Used.

Table 1: The estimated concentration values of Sunset yellow (E-110) in the analyzed samples in comparison with 50 mg/L **permissible limit**

SAMPLE CODE	ABSORBANCE	CONC. OBTAINED (mg/L)
Sample A	2.043	46.523±0.116
Sample B	2.153	49.364±0.418
Sample C	1.841	41.924±0.029
Sample D	1.221	27.853±0.029
Sample E	2.298	52.311±0.178
Sample F	1.450	33.045±0.018
Sample G	1.295	29.515±0.028
Sample H	1.503	34.250±0.019
Sample I	3.863	87.887±0.049
Sample J	1.461	33.295±0.018

Key: Sample A – I Love fruits candy, Sample B – Crash tropical flavours, Sample C – Ci-mon fruity peach, Sample D – Crush tancy orange, Sample E – Toffix multi-vitamin, Sample F – Love pop lollipop, Sample G – Love pito lollipop, Sample H – Orange lollipop, Sample I – Ibon fruity candy, Sample J – Mentos orange.

DISCUSSION

In Nigeria food additive regulations are enforced by the National Agency for Food and Drug Administration and Control (NAFDAC). NAFDAC has not developed a positive additive list and maximum permissible limit for synthetic food dyes. The food additive and contaminant regulations of Codex Alimentarius Commission, EU, FDA and FSA are applied by NAFDAC in its assessment of food safety. (Elochukwu. 2015). However, due to the lack of maximum permitted level in Nigeria for synthetic food dyes, the results obtained are compared to the standard set by the UK Food Standards Agency (FSA) which is 50 mg/L maximum permitted limit of Sunset yellow in non - alcoholic flavoured drinks and confectionery (FSA, 2002). Based on the results obtained from the analysis conducted, the concentration of the analyte was found and contained in a Figure 3 and table 1 which indicate that the concentration values for Sample A, B, C, D, F, G, H, and J are, 46.523±0.116 mg/L, 49.364±0.418 mg/L, 41.924±0.029 mg/L, 27.853±0.029 mg/L, 33.045±0.018 mg/L, 29.515±0.028 mg/L, 34.250±0.019 mg/L and 33.295±0.018 mg/L respectively and are within the acceptable permissible limit of 50 mg/L. However, the food categories most contributing to exposure are non-alcoholic beverages at maximum levels of 50 mg/l and confectionary and fine bakery wares with a maximum level of 50 mg/kg, similar to other food colors, (European Commission, 2011). But the values for Sample E and I are 52.311±0.178 mg/L and 87.887±0.018 mg/L respectively found to be above the acceptable permissible limit of 50 mg/L. This could be due to the efforts of the confectionery industry to have the significant Market values and to attract more customers through the coloring of their finished product. This is in accordance with the literature previously reported (Nives *et al.,* 2018). The food categories most contributing to exposure are non–alcoholic beverages at maximum levels of 50 mg/L, as well as confectionery and fine bakery articles with a maximum level of 50 mg/kg. (Solymosi *et al.,* 2015). This is also in consistent with a survey of colours in sweets was conducted in the U.K. by the Food Standards Agency (FSA), where five out of 196 retail samples of packaged sweets were found to contain levels of either Sunset Yellow FCF or Carmoisine in excess of the maximum permissible limit of 50 mg/kg in confectionary (FSA, 2002).

CONCLUSION

Increased awareness of food safety is driving the improvement in quality control methodologies. In a world where global sourcing of food products is becoming the norm, concern about the type and quantity of color additives in food products is prompting regulators to harmonize regulations worldwide and is forcing the food industry to adopt stringent requirements. The use of UV- Visible spectrophotometric method of analysis for the determination of sunset yellow (E-110) in confectionaries was effective. Hence, the method was classified as simple, accurate, easy and directly applicable in quantitative analysis of synthetic color additives. The method in this study, with outstanding performance and a calibration curve encompassing the concentrations at which dyes are typically used. The results justify the proper consumption of sample A, B, C, D, F, G, H and J due to the level of analyte concentration found below the acceptable permissible limit, while sample E and I are not proper for consumption due the level of analyte concentration found above the acceptable permissible limit of 50mg/L in confectionaries as published by (European Commission, 2011).

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