Estimation of Caffeine in Different Brands of Soft Drinks by Ultraviolet Spectroscopy

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Abstract- This study was undertaken for the purpose to determine the concentration of caffeine in eight brands of soft drinks with the use of an Ultraviolet spectroscopy. This told us about the best brand among the different brands containing caffeine. The highest concentration of caffeine was found in Sting 500mL (560.29 µg/mL), so it is strongest CNS (central nervous system) stimulant among all samples and it is harmful for health. The lowest concentration of caffeine was found in 7up 500mL (29.71 µg/mL). So it is a weakest stimulant among all samples and can be sold in market.

Index Terms- Caffeine, Ultraviolet spectroscopy, soft drinks, central nervous system, drug.

I. INTRODUCTION

Caffeine is a naturally occurring chemical stimulant called trimethylxanthine. Its molecular formula is $C_8H_{10}N_4O_2$. It is a drug and shares a number of traits with more notorious drugs such as cocaine and heroin. Caffeine uses the same biochemical mechanisms as those other drugs to stimulate central nervous system (CNS) [1]. In its pure form, caffeine is a white crystalline powder that tastes very bitter. It is moderately soluble in water at room temperature (2 g/100 mL) but very soluble in boiling water (66 g/100mL) [2]. Caffeine does not contain any stereogenic centers and hence is classified as an achiral molecule [3, 4]. Common sources of caffeine are coffee, tea, soft drinks and energy drinks, caffeine supplements and (to a lesser extent) chocolate derived from cocoa beans [5]. It is medically useful to stimulate the heart and also serves as a mild diuretic. Today, caffeine is used as boost of energy or a feeling of heightened alertness [1]. Caffeine can have negative effects on anxiety disorders [6]. Caffeine is the world's most widely consumed psychoactive substance [7]. Caffeine has adverse effects on health [8-10]. Regular users, however, develop a strong tolerance to this effect and studies have generally failed to support the common notion that ordinary consumption of caffeinated beverages contributes significantly towards dehydration [11].

II. MATERIAL AND METHOD

The different brands of beverages were got from local market. The caffeine content of the different beverages was calculated by UV spectrophotometer 3000.

A. Preparation of standard and sample solution

a. Standard stock solution preparation

The standard stock solution of caffeine was prepared by weighing 0.02g of caffeine and was dissolved in 1000 mL of distilled water and got 10 mL of this solution and diluted up to 100 mL with distilled water.

After preparing the stock solution the dilutions were prepared as:

1 mL of stock solution dissolved in 40 mL of distilled water in first volumetric flask and 5 µg/mL dilution was prepared. 1 ml of stock solution was taken and dissolved in 20 mL of distilled water in second volumetric flask and 10 µg/mL dilution was prepared. 1 mL of stock solution was dissolved in 13.33 mL of distilled water in third volumetric flask and 15 µg/mL dilution was prepared. 1 mL of stock solution was dissolved in 10 mL of distilled water in fourth volumetric flask and 20 µg/mL dilution was prepared. 1 ml of stock solution was dissolved in 8 mL of distilled water in fifth volumetric flask and 25µg/mL dilution was prepared.

1 mL of stock solution was dissolved in 5.7 mL of distilled water in seventh volumetric flask and 35 µg/mL dilution was prepared. 1 ml of stock solution was dissolved in 5 mL of distilled water in eighth volumetric flask and 40 µg/mL dilution was prepared.

b. Sample solution preparation

1 mL of beverage sample was diluted up to 100 mL with distilled water and took the absorbance at 272 nm. The absorbencies of these different solutions were shown in Table 2.

B. Determination of Wavelength [λ_{max}]

The λ_{max} was determined by scanning the standard solution from 190-400 nm range. We got the maximum absorbance (λ_{max}) 272 nm. This value was used for calculating the absorbencies of different dilutions. The absorbencies of different dilutions are given in Table 1. Using the data obtained from UV spectrophotometer for the different dilutions of standard stock solution, a calibration curve got by plotting absorbance versus concentration of dilutions. The calibration curve is shown in Fig.1.

III. RESULT AND DISCUSSION

The absorbance of different brands of beverages both in 500 mL plastic bottles and 300 or 250 mL cans were measured at 272 nm and by applying the formula we determined the concentration of caffeine in them. The concentration of caffeine in 500 mL Pepsi bottle and 300 mL can was 255.27 and 227.07 µg/mL respectively. Similarly, the concentration of caffeine in Coke (500 mL bottle) and in its can (250 mL) was found to be 193.75

and 211.69 µg/mL respectively. The concentration of caffeine in 500 mL bottle Sprite and its 250 mL can was found to be 30.99 and 33.55 µg/mL respectively. The concentration of caffeine in 7up (500 mL bottle) and 250 mL can was 29.71 and 46.37 µg/mL respectively. The concentration of caffeine in Mountain dew (500 mL) bottle and in 250 mL its can was 119.42 and 118.14 µg/mL respectively. The concentration of caffeine in 500 mL Fanta bottle and its 250 mL can was 357.79 and 334.73 µg/mL respectively. Similarly the concentration of caffeine in 500 mL Marinda bottle and its 300 mL can was found to be 72.00 and 182.22 µg/mL respectively. The concentration of caffeine in Sting (500 mL plastic bottle) was found to be 560.29 µg/mL. It was concluded from the above data that the highest concentration of caffeine was found in Sting (500 mL bottle), so it is a strongest CNS stimulant among all samples and it is harmful for health. And the lowest concentration was found in 7up (500 mL), so it is a weakest CNS stimulant among all samples and can be sold in the market.

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FIGURE AND TABLES

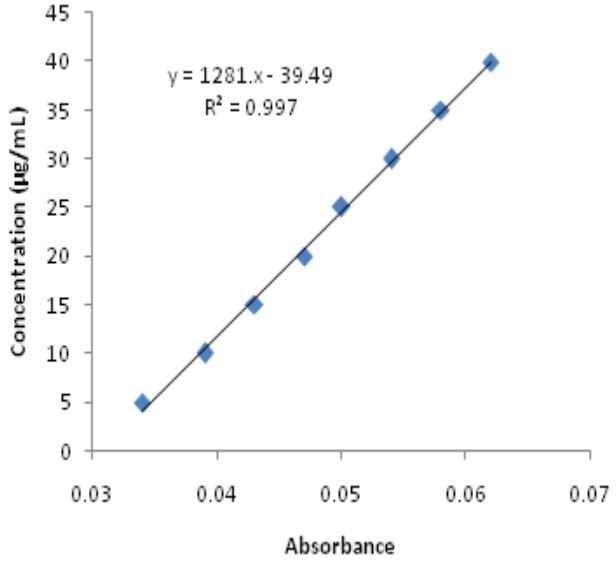

Fig. 1 Calibration curve between Absorbance and Concentrations.

Table 1. Absorbencies of dilutions

Sr.No	Dilutions(µg/mL)	Absorbencies
1	5	0.034
2	10	0.039

3	15	0.043
4	20	0.047
5	25	0.050
6	30	0.054
7	35	0.058
8	40	0.062

Table 2. Absorbencies of different brands of soft drinks

Sr.No.	Soft drink	Absorbance	Concentrations (µg/mL)
1	Pepsi(500mL)	0.230	255.27
2	Pepsi(300mL) can	0.208	227.08
3	Coke(500mL)	0.182	193.75
4	Coke(250mL) can	0.196	211.69
5	Sprite(500mL)	0.055	30.99
6	Sprite(250mL) can	0.057	33.55
7	7up(500mL)	0.054	29.71
8	7up(250mL) can	0.067	46.37
9	Mountain dew(500mL)	0.124	119.42
10	Mountain dew(250mL) can	0.123	118.14
11	Fanta(500mL)	0.310	357.79
12	Fanta(250mL) can	0.292	334.73
13	Marinda(500mL)	0.087	72.00
14	Marinda(300mL) can	0.173	182.22
15	Sting(500mL)	0.468	560.29