The Effect of Fluorescence in Energy Drinks

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I. Abstract- (75 words)

The experiment investigates what causes energy drinks to emit luminescence. This research helps provide better insights about vitamin B2 and could lead to the development of new energy drinks. Students place cuvettes containing different energy drink samples into a spectrophotometer to record the maximum absorbance and corresponding wavelength. Graphs are made to show the maximum fluorescence for samples from the data within the chart.The discussion provides an explanation about the relevance of the data.

II. Introduction

In today's scientific research, the use of fluorescence spectrophotometers is highly relevant. A spectrophotometer is an instrument that measures the intensity of light at different wavelengths in solutions by directing a source energy through an interferometer, through the sample (*Physical & Theoretical Chemistry*, 2015). It has become an invaluable tool in analysis of beverages. It aids in testing the fluorescent components to provide detailed information in both quantitative and qualitative data types. It also describes the fluorescent properties in various substances. Some beverages that can be tested include drinking water, fruit juice, milk, coffee, tea and alcoholic beverages (Sikorska, 2019). Understanding the amount of fluorescence in energy drinks can help researchers gain better insights into the interactions between the vitamin B2 and the reason why energy drinks exhibit fluorescence. It also lays out information for consumer safety and food industry standards.

When the sample is placed in the spectrophotometer, xenon light passes through the excitation monochromator, reflects colorful lights through the samples to the mirror on the back and to the emission monochromator in blue to the detector through the photomultiplier. Then the graphing of the wavelength gets displayed on the monitor.

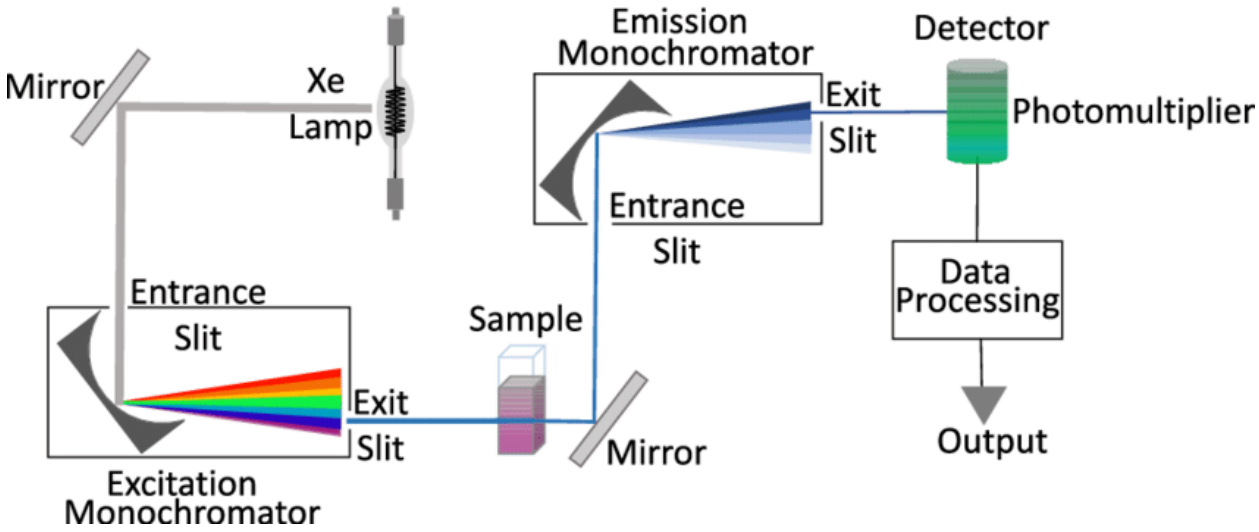

Figure 1. Major Components of Fluorescence Spectrophotometer (Gome, 2019)

Energy drinks, which contain large amounts of caffeine, sugars, other additives and legal stimulants, are used for people to increase alertness, be more energetic and bring up attention (Ishak, 2012). Vitamin B2 is present in many drinks, as is the ability of producing light energy when certain lights go through. One study reports the detection of the fluorescent nanoparticles, approximately 5 nm in size, in two of the most popular drinks: Coca-Cola and Pepsi-Cola (Li, 2018).

Fluorescence is the component resulting in a glowing effect due to their chemical and physical mechanism. Riboflavin, also known as Vitamin B2 is a type of fluorescent compound that emits light. This property is observed in many beverages, where compounds emit light when exposed to certain wavelengths. The electrons of riboflavin become excited by jumping to higher energy levels to remain in an unstable state of excitation when absorbing ultraviolet light. When luminescence occurs, the molecular structure and chemical environment determine the intensity of emission. Fluorescent molecules are conjugated systems; they occur when an atom or molecule, after being electronically excited, relaxes to its ground state through vibrational relaxation (Gome, 2019).

This research is using a spectrophotometer to determine the amount of fluorescence in energy drinks. The light in the spectrophotometer passes through the energy drink samples to the detector after being reflected through the excitation monochromator and the emission monochromator and then comes up with the maximum wavelength of the fluorescence.

III. Materials and Methods

Figure 2. Image of the spectrophotometer

The materials used to conduct the experiment included a spectrophotometer seen in Figure 2, the riboflavin sample otherwise known as Vitamin B2, five different energy drinks; C4, Reign. Redbull, Monster, and Dino Luzzi; a labquest, Spectral Analysis app, Goggles, Cuvette(s), Distilled water, and lastly a Wash bottle.

Students started first by creating a control cuvette filled ¾ by distilled water. Next students launched the lab quest app, connected it to the spectrophotometer and chose advanced full spectrum. The control cuvette was then placed into the probe and calibrated by selecting absorbance mode in the settings and pressing calibrate. The control was taken out after calibration was completed and swapped out with three mL of 20 mg/L riboflavin sample. Data was then collected for the B2 sample and recorded in student's logbooks. Maximum absorbance was collected.

Next students created another control cuvette filled ¾ with distilled water to calibrate the fluorescence mode. The settings were changed as follows: integration time to 100 ms, wavelength smoothing to 1 nm, temporal averaging to 4, and the excitation wavelength to 405 nm. Calibrate was clicked and when finished the cuvette was taken out and once again swapped with the riboflavin sample. Record the maximum fluorescence and the wavelength at which it occurred. Without recalibrating, pour each energy drink into 5 different cuvettes again filled ¾ of the way. Place each of them individually into the spectrophotometer and record the maximum fluorescence.

IV. Results

Our project is to measure the different fluorescence of Vitamin B2 in energy drinks compared to the fluorescence of Riboflavin (Vitamin B2).

	Riboflavin	Dino Luzzi	Monster	C4	Red Bull	Reign
Minimum	-2.729	-0.811	-0.792	-0.792	0.252	-0.792
Maximum	-0.032	-0.031	-0.13	-0.013	0.741	-0.013
Mean	-0.344	-0.37	-0.351	-0.351	0.566	-0.351
SD	0.24622	0.28035	0.28036	0.28036	0.17868	0.28036
Sample	34	34	34	34	34	34
Change in Y	0.698	0.78	0.78	0.78	0.489	0.78
Change in X	24.6	24.6	24.6	24.6	24.6	24.6
Wavelength(in	384	380.3	380.3	380.3	380.3	380.3

Figure 3. Research Conducted by Students in a Data Table (Yu, Sachdeva, 2024)

The Chart provides the data of the minimum and maximum fluorescence levels measured in relative fluorescence units. It also provides the wavelength measurements.

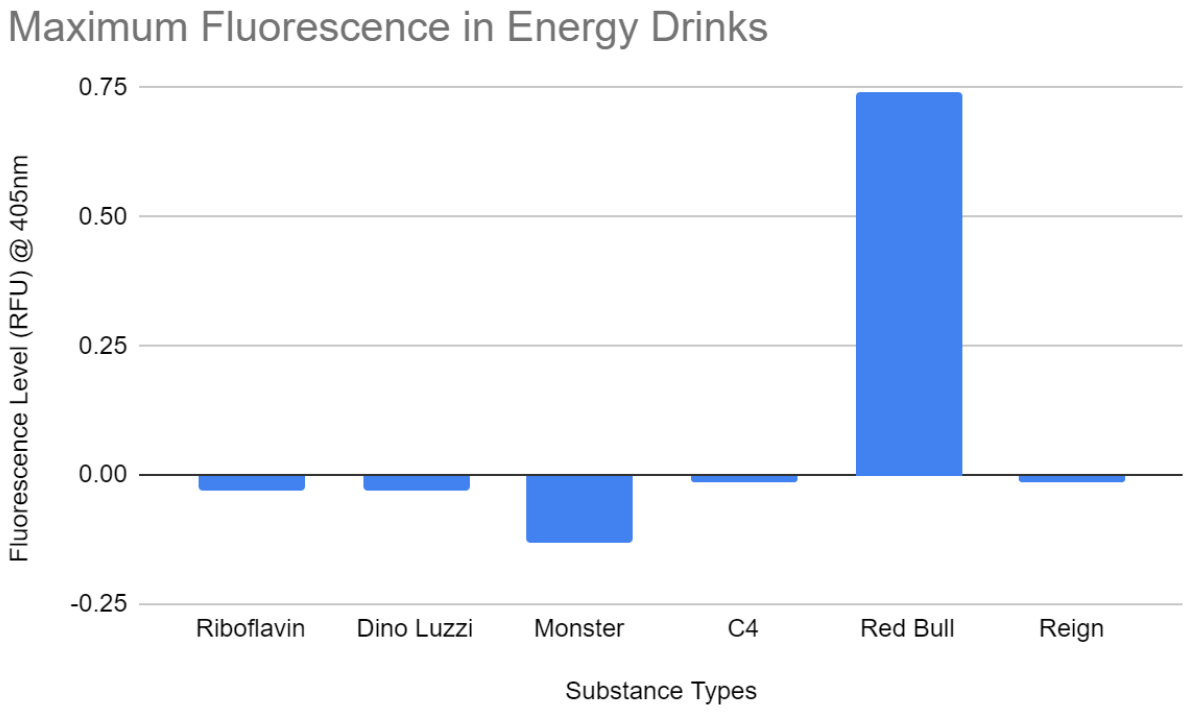

Figure 4. Maximum Fluorescence Seen in the Energy Drinks in a Bar Graph (Yu. Sachdeva, 2024)

The graph shows the Maximum fluorescence for each substance with the data from the chart. This graph was chosen as it helps clearly and accurately compare the different measurements.

V. Discussion

The table, Figure 3. (Yu, Sachdeva, 2024) shows many statistical measurements for the Vitamin B2 (Riboflavin) sample and five different energy drinks: Dino Luzzi, Monster, C4, Red Bull, and Reign. Each row includes different measurements such as the minimum, maximum, mean, standard deviation (SD), sample size, changes in Y and X, and wavelength.

Riboflavin has the largest range of any substance going from -2.729 to -0.032 between the min and max values. This shows that riboflavin has a larger range of data points than the other substances. On the other hand, all of Red Bull's data points are positive and centered within a range of 0.252 to 0.741.

In the bar graph Figure 4. (Yu, Sachdeva, 2024) there is evidence that Red Bull has a significantly higher fluorescence level compared to other substances. It is at approximately 0.75 RFU. Monster also has a positive fluorescence level at slightly above 0.00 RFU. Riboflavin, Dino Luzzi, C4, and Reign all show very low to nearly zero fluorescence levels.

The fluorescence is measured in Relative Fluorescence Units. This data proposes that Red Bull has a component that fluoresces at 405 nm. Something that is not significantly present in the other drinks tested.

In the energy drink Red Bull there is a high amount of fluorescence shown. Usually Riboflavin (Vitamin B2) is known to emit a fluorescence under UV light but in this research, it shows a small amount of fluorescence at 405 nm. This may be possible due to its concentration, the excitation wavelength used, or an error in conducting the experiment.

VI. References

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