INDOGENIUS

ISSN 2828-1365

Volume 4, Issue 2 : 334 – 339

Study of Taurine Content in Energy Drink Powders: UV-Vis Spectrophotometric Method

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Article Info

Keywords :

Taurine, energy drinks, UV-Vis Spectrophotometry, qualitative analysis, quantitative analysis.

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ABSTRACT

Background and Objective: Energy drinks are commonly consumed as a fast and affordable solution to fatigue, especially among adolescents and young adults. However, public knowledge about their appropriate use and the health risks of excessive intake remains limited. Taurine (2-aminoethanesulfonic acid), a conditionally essential amino acid found in many energy drinks, contributes to several physiological functions. Excessive intake of taurine may adversely affect kidney function. **Method**: The method of this study using UV-Vis spectrophotometry. A 0.1% ninhydrin solution was used for qualitative testing, while UV-Vis spectrophotometry was employed for quantitative measurement. Proteins were precipitated using Carrez I and Carrez II reagents before analysis. **Results**: A purplish-blue color change in the qualitative test confirmed the presence of taurine. Quantitative analysis revealed taurine concentrations of 0.025% and 0.012% in the two samples. **Conclusion**: The results validate UV-Vis spectrophotometry as a practical and dependable technique for analyzing taurine, highlighting the importance of educating the public on the associated health risks of excessive consumption.

DOI: https://doi.org/10.56359/igj.v4i2.593

Introduction

Taurine (2-aminoethanesulfonic acid) is a semi-essential amino sulfonic acid abundantly present in various tissues of the human body. It plays important roles in bile salt formation, osmoregulation, membrane stabilization, modulation of intracellular calcium levels, and antioxidative defense mechanisms (Huxtable, 1992; Ripps & Shen, 2012). Due to its physiological significance, taurine is frequently

included as a functional ingredient in energy drinks, often in combination with caffeine, B vitamins, and other stimulants (Shao & Hathcock, 2008; Heckman et al., 2010). The global popularity of energy drinks, particularly among adolescents and young adults, has raised concerns regarding their safety, efficacy, and accurate labeling (Seifert et al., 2011). Many powdered forms of energy drinks are marketed as convenient alternatives to ready-to-drink formulations, offering ease of transport and longer shelf life. However, powdered supplements also pose a higher risk of improper dosing or inconsistent ingredient distribution, making quality control essential (Reissig et al., 2009; Rath, 2012). Quantitative determination of taurine in commercial products is therefore important for both regulatory purposes and consumer protection. Several analytical methods have been employed for taurine detection, including high-performance liquid chromatography (HPLC), capillary electrophoresis (CE), and liquid chromatography–mass spectrometry (LC-MS) (Zhang et al., 2004; Arnaud, 2011; Aydin, 2005). While these methods are accurate and sensitive, they often require expensive instrumentation and complex sample preparation. UV-Visible (UV-Vis) spectrophotometry, in contrast, offers a simpler, faster, and more cost-effective alternative suitable for routine analysis. When coupled with appropriate derivatization reactions (e.g., with ninhydrin or phenylisothiocyanate), taurine can be quantified spectrophotometrically with reasonable accuracy and reproducibility (Abdelrahman et al., 2015; Lobo et al., 2010). Despite its simplicity, this method remains underutilized for taurine analysis in powdered energy drinks.

This study aims to investigate the taurine content in selected commercial energy drink powders using a UV-Vis spectrophotometric method. The objectives include method validation, analysis of sample consistency, and comparison of measured taurine levels with product label claims

Objective

The primary objective of this study is to determine the taurine content in various commercially available energy drink powders using a UV-Vis spectrophotometric method. Specific objectives include to develop and validate a UV-Vis spectrophotometric method for the quantitative analysis of taurine, to analyze and compare the taurine concentrations in different brands or samples of energy drink powders, to evaluate the consistency of the measured taurine content with the values declared on product labels, to assess the reliability and applicability of UV-Vis spectrophotometry as a routine quality control method for taurine determination in powdered energy drink formulations.

Method

Commercial The energy drink powders were purchased from various retailers. All reagents used were of analytical grade. The primary reagents included taurine standard (≥ 99% purity), ninhydrin solution, sodium acetate buffer, and distilled water. All glassware was cleaned thoroughly and rinsed with distilled water prior to use.

UV-Visible spectrophotometer equipped with 1 cm quartz cuvettes was used to measure absorbance. The wavelength for maximum absorbance (λmax) was determined during method development. All measurements were carried out at room

temperature. A stock solution of taurine (1,000 mg/L) was prepared by dissolving an appropriate amount of taurine standard in distilled water. Serial dilutions were then prepared to obtain working standards in the range of 50–500 mg/L. These standard solutions were used to construct the calibration curve. A representative portion of each energy drink powder sample (approximately 1 g) was accurately weighed and dissolved in 100 mL of distilled water. The solution was filtered, and an aliquot was taken for further analysis. If necessary, the sample solution was diluted to fit within the calibration range.

To enable spectrophotometric detection, taurine in both standard and sample solutions was derivatized using ninhydrin reagent. Equal volumes of sample/standard and ninhydrin solution were mixed with sodium acetate buffer and incubated in a water bath at 95°C for 15 minutes. After cooling to room temperature, the absorbance of the resulting purple complex was measured at the determined λmax (typically around 570 nm). The method was validated according to standard analytical validation guidelines, including parameters such as linearity, accuracy, precision, limit of detection (LOD), and limit of quantification (LOQ).

Results

Qualitative analysis of the taurine substance in energy drinks with 0.1% ninhydrin shows that positive energy drinks contain taurine which changes color after being heated. Determining the maximum wavelength aims to find out at what wave the substance can produce optimum absorbance. This determination was carried out with a standard taurine. solution in the wavelength range 190-320 nm. The peak that produces the highest absorbance in the wavelength range 190-320 nm is at a wavelength of 288 nm which can be seen in the table below.

TABLE 1. Determination of Maximum Wavelength

Wavelength	Absorbance Value
292	0,018
291	0,043
290	0,089
289	0,246
288	0,574

Taurine curve measurements in energy drink samples used a quantitative test with the UV-Vis spectrophotometry method. Starting with making a standard taurine solution with a concentration of 1000 ppm. From this standard solution a taurine series solution was made with a concentration of 100 ppm; 200ppm; 300ppm; 400 ppm; 500 ppm with distilled water as a solvent. Then proceed with measuring the absorbance of the standard taurine series solution which can be seen in the table below.

TABLE 2. Absorbance of Taurine Standard Series Solutions

Concentration of Taurine Series Solutions (mg/L)	Absorbance Value
100	0.211
200	0.241

Concentration of Taurine Series Solutions (mg/L)	Absorbance Value
300	0.257
400	0.273
500	0.281

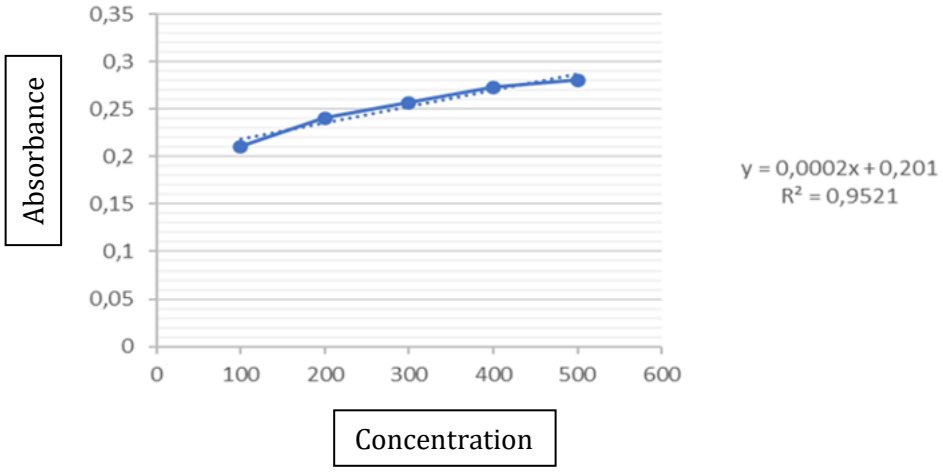

FIGURE 1. Taurine standard curve

From these measurements, a linear standard curve equation was obtained at a maximum wavelength of 288 nm, namely y=0.0002x+0.201 with a correlation coefficient (r) of 0.9521. Based on the curve obtained above, there is a correlation between concentration and absorbance where the higher the concentration, the higher the absorbance value. The results of quantitative tests using the UV-Vis spectrophotometry method on energy drink samples obtained the absorbance values in the table below.

TABLE 3. Absorbance of Energy Drink Samples

Sample	Absorbance
Sample I	0.271
	0.270
	0.271
Sample II	0.238
	0.243
	0.223

From the table above, taurine levels can be calculated by entering the sample absorbance value into the linear standard curve equation y = 0.0002x + 0.201. Then it was compared with the weight of the energy drink samples used in this study. The results of the quantitative test for Taurine levels using the UV-Vis spectrophotometry method can be seen in the table below.

TABEL 4. Absorbance, average, and taurine levels in Energy Drink Samples

Sample	Absorbance	Taurine levels (%)	Average (%)	Taurine Content in mg/kg Sample
Sample I	0.271	0.025%	0.025%	250 mg/kg
	0.270	0.025%		
	0.271	0.025%		
Sample II	0.238	0.013%	0.012%	120 mg/kg
	0.243	0.015%		

Discussion

A standard calibration curve was constructed by plotting absorbance values of taurine solutions at concentrations of 100–500 ppm. The curve showed a linear relationship, described by the regression equation **y = 0.0002x + 0.201**, with a correlation coefficient (**r**) of **0.9521**, indicating good linearity. This relationship aligns with the Beer-Lambert law, which states that absorbance is directly proportional to concentration for a given path length and wavelength.

Based on the absorbance readings and the standard curve equation, taurine concentrations in the energy drink samples were calculated. Sample I had an average taurine content of **0.025% (250 mg/kg)**, while Sample II had an average taurine content of **0.012% (120 mg/kg)**. These values are well within the maximum allowable limit set by the Indonesian Food and Drug Authority (BPOM), which allows up to **0.3%** taurine in sports or energy drinks (BPOM Regulation No. 24 of 2020). Therefore, both samples are deemed safe and compliant for human consumption from a taurine content perspective.

Assuming a maximum recommended intake of **3 g/day** based on a body weight of **60 kg** (equivalent to **50 mg/kg body weight**), the number of energy drink packages an adult can safely consume per day was calculated. Based on taurine concentrations, Sample I corresponds to a maximum of **12 packages/day**, while Sample II corresponds to **25 packages/day**. These values suggest that, in practical terms, both samples contain taurine well below harmful limits, even if multiple servings are consumed in a day.

Conclusion

This study confirms that UV-Vis spectrophotometry is a reliable and efficient method for both qualitative and quantitative analysis of taurine in powdered energy drinks. The taurine levels found in the samples were well below the maximum limit set by regulations, indicating safe consumption levels. The method demonstrated good accuracy and is suitable for routine analysis of taurine content.

Acknowledgement

The authors would like to express their sincere gratitude to all individuals and institutions who supported the completion of this research. Special thanks are extended to the laboratory staff and supervisors for their guidance, technical assistance, and access to facilities necessary for conducting the UV-Vis spectrophotometric analysis. The authors also appreciate the support from academic mentors whose insights and suggestions greatly contributed to the improvement of this study. Lastly, heartfelt thanks to family and colleagues for their continuous

encouragement and moral support throughout the research process.

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