Junior Science Communications
Faculty of Applied Sciences, UiTM Shah Alam
https://journal.uitm.edu.my/ojs/index.php/JSC

E-ISSN 2637-0689
Vol 64 2026

Colloquium on Applied Sciences 2 2026
19-22 January 2026, Faculty of Applied Sciences, UiTM Shah Alam, Malaysia

Quantitative Determination of Caffeine in Commercial Energy Drinks using High-Performance Liquid Chromatography

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Structure Abstract

Background: Energy drinks are widely consumed for their stimulant effects, primarily due to caffeine. Caffeine has beneficial effects on the human brain, blood vessels, heart-related illnesses, and skin, all of which contribute to long-term wellness. However, exceeding the recommended intake can produce negative effects, particularly in Malaysia where no specific regulatory limit exists. Mislabelling or absence of labelling increases the risk of associated health effects such as insomnia, tachycardia, and nervous system overstimulation. Therefore, it is important to measure the amount of caffeine in different types of energy drinks, which are generally consumed by people in this country.

Methods: The stock solution of caffeine was prepared by dissolving 0.0133 g of pure caffeine. From this stock solution, a series of diluted working standards was prepared at 2, 4, 6, 8, and 10 ppm. Each energy drink sample was prepared by degassing 10 mL of the beverage using an ultrasonic bath. Then, the treated sample was transferred into a volumetric flask and diluted to the mark with the mobile phase. An aliquot of the diluted sample was then filtered through a 0.45 μm nylon syringe filter. Each sample was prepared in triplicate.

Results: The calibration curve showed good linearity over the studied concentration range, with a regression equation of $y = 44096x - 3.1717$ and a correlation coefficient (R^2) of 0.9992. The caffeine contents in Brands A, B, C, D, E, and F were determined to be 61, 57, 57, 75, 59, and 61 mg per serving, respectively. The developed HPLC method was successfully validated and demonstrated acceptable linearity ($R^2 = 0.9992$) and accuracy, with recovery values ranging from 98.2% to 101.5%. The method also exhibited good sensitivity and precision, as indicated by %RSD values of less than 7%.

Conclusion: In conclusion, this study successfully quantified the caffeine content in selected commercial energy drink products available in the Malaysian market using HPLC, ranging from about 57 mg to 75 mg per serving. The relative caffeine content in different energy drink brands based on peak area analysis was successfully compared with good linearity, accuracy, sensitivity, and precision.

Keywords: Energy Drink, Caffeine, High-performance liquid chromatography

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