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Recent Improvements in Electrochemical Sensors for Predicting Caffeine

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DESCRIPTION

The capacity to recognize target analytes at incredibly low concentrations is crucial to the pharmaceutical, environmental and food industries. Caffeine is a common ingredient in drinks and pharmaceuticals since it is a natural alkaloid. It is crucial to know the caffeine content in different media because, in addition to the benefits for which it is employed, caffeine also has drawbacks. Because they are efficient, speedy, and relatively easy to produce and measure, electrochemical methods with the right sensors stand out among other analytical techniques. Due to its inexpensive cost, broad potential range, relative electrochemical inertness, and electrocatalytic activity in a variety of redox reactions, carbon-based electrochemical sensors are commonly utilized in this kind of study.

A naturally occurring purine is caffeine, which is 1,3,7-trimethylxanthine. Humans have been consuming caffeine for a very long time. It is a distinctive alkaloid present in many plant species, including guarana berries, cocoa beans, tea leaves, and espresso beans. Additionally, caffeine can be found in pharmaceuticals and energy beverages (CF). Due to its benefits for physical endurance, enhanced focus, reduced oxidative stress, and relief from weariness and headaches, caffeine is ingested in large amounts. However, consuming excessive amounts of caffeine can result in issues including anxiety, hypertension, and cardiovascular disease.

Due to the extensive use of items containing caffeine, caffeine enters municipal wastewater through urine. About 20 known metabolites are produced during the biotransformation of caffeine in the liver. The most prevalent dimethylxanthines are paraxanthine, theobromine, and theophylline. Dimethyl and monomethyluric acid derivatives and uracil derivatives are next in popularity. Urine excretes 1% to 5% of the caffeine that is still present.

For both model solutions and chosen real samples, the content of caffeine has been measured using a range of electrochemical sensors and improved voltammetric techniques. According to the study that was examined, differential pulse voltammetry with the appropriate sensors was the most widely used technique. The researchers used a number of modifiers, including multi-walled carbon nanotubes, metal nanoparticles, and synthetic nanocomposites, to build sensors that are appropriate for the detection of caffeine in a variety of media and achieve low detection limits.

It is possible to draw the conclusion that additional parameters should be improved based on the electrode itself by looking at how the experimental parameters impact the sensor's capability. The experts discovered that adding nitrogen and polymers to the carbon-based material as well as incorporating nanoparticle use improved the electron transport energy. The creation of a stable sensor, however, is one of the challenges researchers encounter when utilizing metal nanoparticles as a modifier because of the potential for their aggregation. The majority of studies on the use of electrochemical sensors for caffeine measurement have been conducted in an acidic environment.

Additionally, the majority of authors believed that four protons and four electrons were involved in the caffeine oxidation process. Based on the data published in the literature, it is feasible to see the successful application of the developed sensors for the determination of caffeine. Future study should concentrate on ecologically friendly practices and the utilization of recyclable materials.

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CONFLICT OF INTEREST

The author declares there is no conflict of interest in publishing this article has been read and approved by all named authors.

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