Detecting Acetaminophen Through a Simple, Saving and Accuracy Technique with a Effective Working Electrode

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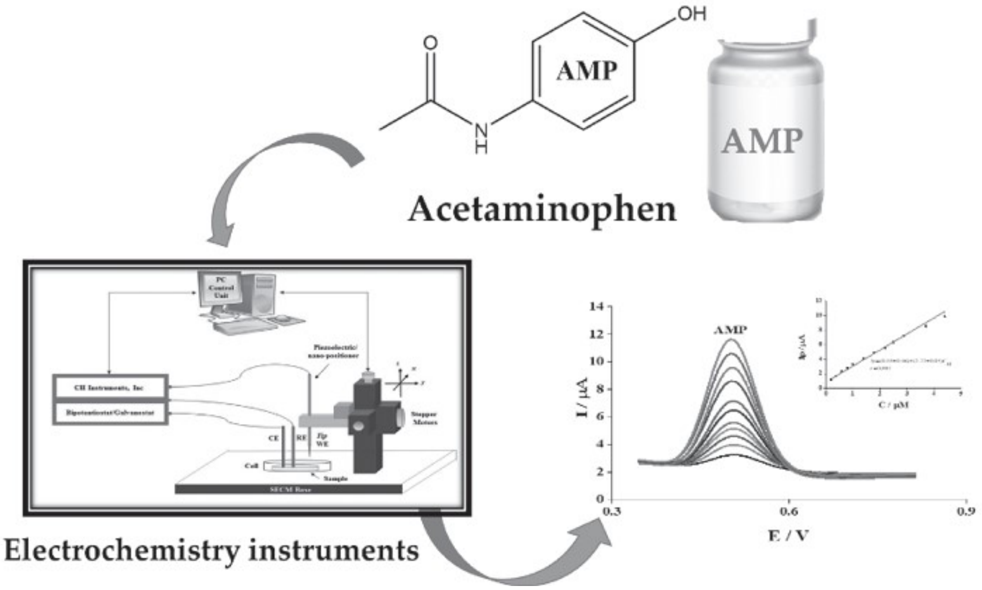
Graphical abstract (designed by the author)



Abstract:

Employing differential pulse anodic stripping voltammetry (DP-ASV), the electrochemical behavior of GCE toward acetaminophen (AMP) was investigated in the current paper. Results from differential pulse anodic stripping voltammetry demonstrate that, with a peak of 0.508 V for AMP, AMP could be selectively and sensitively detected on GCE. The detection limits for AMP are 0.250 µM, indicating that the GCE can be used to identify AMP compounds with good sensitivity and selectivity. Additionally, this work would be considered a precious ref-

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erence for several following reports of AMP as well as contributed to the information of the AMP's LOD value.

Keywords: *Electrochemistry technique, acetaminophen detection, voltammetry method, modified electrode, advanced sensor*

Abbreviation

AMP:	acetaminophen
DP-ASV:	differential pulse anodic stripping voltammetry
GCE:	Glassy carbon electrode
LOD:	Limit of Detection
LOQ:	Limit of Quantitation
PAY/nano-TiO2:	poly (acid yellow 9/nano-TiO2)
PF:	poly furan
C:	carbon
PANI-MWCNTs:	polyaniline-multi-walled carbon nanotubes

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Introduction

AMP or acetaminophen, defines a common analgesic and antipyretic medicine employed to treat common sickness diseases and muscle aches (Sanghavi & Srivastava 2010). Consuming overdose amounts of AMP would cause the build-up of toxic metabolites, which would have dangerous and occasionally deadly impacts on the kidneys cells and liver tissues (Madrakian et al., 2014).

In various publications, several analysis techniques, including spectrofluorometry (Dejaegher et al., 2008), spectrophotometry (Khaskheli et al., 2007), chromatography (Akay et al., 1999) and CZE (capillary zone electrophoresis) (Sun et al., 2008), have been reported for the investigation of AMP. The challenge is that various mentioned methods would money-consuming and intricate stages. These elements make the formation of fast, cheap and effective determination methods necessary. The formation of electrochemically modified electrodes is a part suggestion for solving this (Švorc, 2013). Low LOD (limit of detection) value, an extend linear concentration range, long durability and repeatability are just a few merits of this discussed type of modified electrode.

The modified electrode procedure (Bard, 1983) would be formed employing a variety of ways, including coating and attaching certain molecule substances (peptides (Serrano et al., 2015), complicated compounds (Pérez-Ràfols et al., 2015; Serrano et al., 2014) to the surface's zone using self-assembled monolayers (Wawrzyniak et al., 2013) or conductive ink (Cipri & Del Valle, 2014). Since this plotted and controlled modification electrode's surface area would form advanced surfaces with intriguing features employed for developed electrochemical electrodes and applications, the last method has attracted attention among electrochemical researchers in recent years.

As a result, in this research study, an enhanced developed electrode is denoted as GCE with the potential desiration to examine the analyte compound - AMP. This leads to the novelty of the research study compared to the other records because rarely reports of detecting AMP would be found through the glassy carbon electrode.

Experimental

Chemical agents

Every compound used in the work was of analytical-grade high purity: AMP, NH_4NO_3, $CaCl_2$, Na_2SO_4, dopamine, xanthine, hypoxanthine, ascorbic acid, NaH_2PO_4, Na_2HPO_4 (Sigma-Aldrich, ≥ 99 %). The PBS buffer solution 0.1 M, pH = 7.0 was produced from NaH_2PO_4 and Na_2HPO_4. Double distilled water was collected from the ultimate procedure without further purification.

Technique

The employed electrochemical techniques: differential pulse anodic stripping voltammetry (DP-ASV) studies were executed using CPA-HH5 Computerized Polarography Analyzer (Vietnam). Regarding the electrochemical tests, a conventional three electrodes trial was employed. This trial consisted a developed GCE as the working electrode (a favorable surface area of 0.0620 cm^2, a diameter of 2.80 mm), an Ag/AgCl electrode serving as a reference electrode and a platinum wire possesses a 0.520 mm diameter playing an important role as a counter electrode. The electrolyte liquid solutions were stored in a suitable place and all electrochemical devices were done at room heat.

Preparation of the working GCE

The testing surface on the working sensor was 0.0620 cm^2 (diameter of 2.80 ± 0.10 mm). In the beginning stage of the modified procedure, the surface's electrode was washed with C_2H_5OH, then polished with Al powder (0.050 µm).

Result and discussion

The investigation of AMP in the linear range

Under favorable conditions, the DP-ASV method is applied to detect AMP (Figure 1). The *Ip* increases linearly with the AMP concentration between 0.2 – 4.4 µM. The resulted regression equation for the employed concentration of AMP scoping from 0.2 to 4.4 µM is illustrated in Figure 1. This obtained regression equation is as follows:

$$dcI_{p,AMP} = (0.85 \pm 0.06) + (2.22 \pm 0.05) \times CAMP \qquad r = 0.997$$

The calculated LOD of AMP was determined based on the $3\sigma/S$ in which AMP had orderly a low LOD of 0.250 µM and a good LOQ of 0.750 µM.

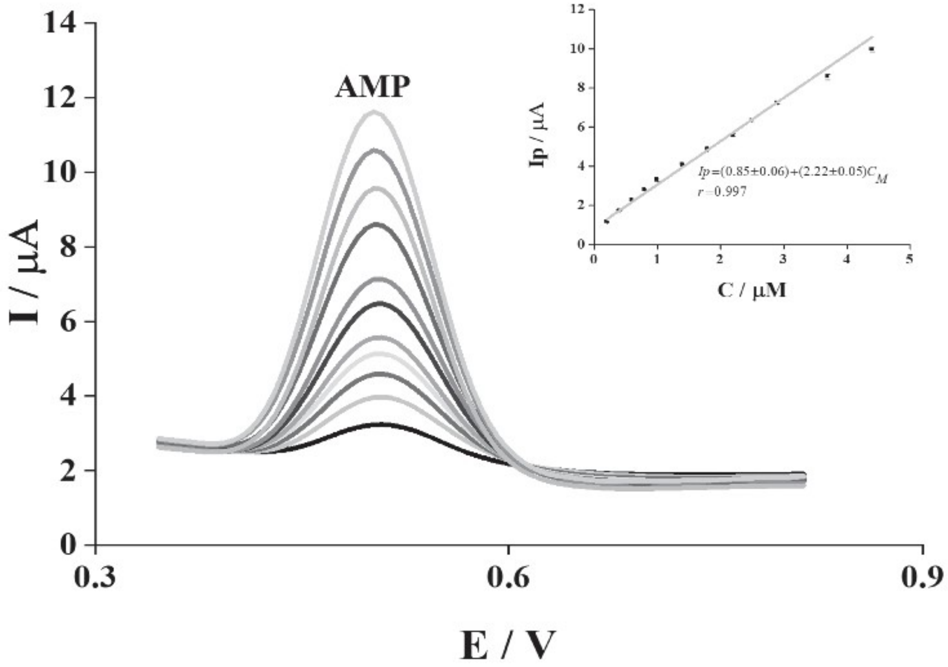

Figure 1. DP-ASV lines have resulted in GCE for AMP at several concentrations from 0.2 to 4.4 µM. Experimental conditions: potential ranges between 0.3 and 0.9 V, scan rate: 0.1 V/s, the 0.1 M PBS solution pH = 7.0

The comparison between the proposed sensor and various published sensors for detecting AMP

Table 1 compares 2 factors of the applied ranges and previous LOD values of GCE to other reports that had been reported. Table 1 describes that GCE possesses an extend linear range and a small LOD compared to the previous others, indicating that the employed electrode would be an effective electrode for examining AMP in real models for next studies in the future.

Table 1. The summarization of 3 elements: the linear range, LOD value and LOQ value between applied GCE and various used electrodes

Applied electrode	Employed technique	Linear range	LOD	LOQ	REF
PAY/nano-TiO_2	LSV	15.1 - 270.2	2.3	6.2	(Kumar et al., 2008)
PANI-MWCNT	SWV	1.2 - 100.1	2.54	7.53	(Li & Jing, 2007)
Pyrolytic C	DPV	15.2 - 225.2	1.42	4.21	(Keeley et al., 2012)
ZIF-67	DPV	2.1 - 45.2	1.44	4.23	(Tu et al., 2019)
Pt/PF/Pd	EIS	0.53 - 100.2	0.0761	0.2284	(Manjunatha et al., 2011)
GCE	DP-ASV	0.2 - 4.4	0.25	0.75	This work

Note: PAY/nano-TiO_2 (means poly (acid yellow 9/nano-TiO_2), PANI-MWCNTs (means A polyaniline-multi-walled carbon nanotubes), PF (means poly furan), C (means carbon).

Repeatability

Figure 2 illustrates the DP-ASV lines of AMP in the concentration of 5 μM with the five times continuous measurements by GCE. The obtained RSD for AMP was 3.03 %. This result was not greater than RSD_H [52]. This indicates the good repeatability of GCE. Therefore, GCE could be employed to detect AMP in either low or high concentration range with the suitable result of RSD.

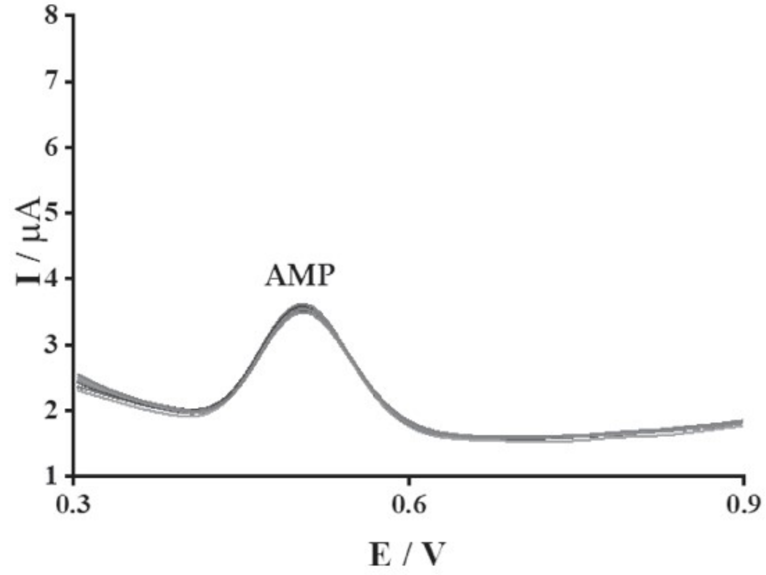

Figure 2. The DP-ASV curves of AMP with five times continuous measurements, C_{AMP} = 5 μM. Experimental conditions: potential ranges between 0.3 and 0.9 V, scan rate: 0.1 V/s, 0.1 M PBS buffer, pH = 7.0.

Conclusions

For determining AMP employing the DP-ASV technique illustrates good electrocatalytic effect. AMP has an extended content range, a small LOD of 0.250 μM and a desired LOQ of 0.750 μM. The applied method, DP-ASV, is sensitive, fast, costless and accuracy, and it would be applied to find AMP in various practical models with no issued interference from several casual organic and inorganic substances.

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