RESEARCH ARTICLE

Electrocatalytic Reduction and Voltammetric Determination of Curcumin by Blood Medium

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ABSTRACT

Curcumin is a chemical produced from the *Curcuma longa* family. Curcumin compounds can be used in various types of cancers. The study focused on the electrochemical properties of curcumin in the blood medium. The redox reaction of curcumin in blood was studied by cyclic voltammetry (CV) using a glassy carbon electrode (GCE) to find each of the electrochemical parameters such as different concentrations, pH, scan rates, and reliability (stability). In-vitro experiments found that the activity of curcumin in the blood has good behavior against disease through the interaction of curcumin molecules with blood components that have only one peak reduction current that appeared at a voltage of -0.750 V. A good indication for these reactions is to serve as an antioxidant reagent enhanced by the alkaline medium (pH = 8) of the blood medium. Also, the curcumin compounds present in the alkaline medium can be used for patients suffering from cancer diseases.

Keywords: Anti-oxidative, Blood medium, Curcumin, Cyclic voltammetry, Glassy carbon electrode.

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INTRODUCTION

Currently, scientists focus on the electrochemistry study of the natural materials in life to study the oxidation effect on the blood components.[1-5]

Curcumin is turmeric's primary bioactive yellow component with polyphenolic compound as shown in figure 1. It has biological applications in a different range of anti-inflammatory, antioxidant, and anticancer reagents. The electrochemical behavior of curcumin in a platinum electrode was studied by cyclic voltammetry (CV). Oxidation and reduction in curcumin is an irreversible reaction. The oxidation process and its kinetics were investigated.[6,7]

Graphene-modified with glassy carbon electrode (GR/GCE) acted as a highly sensitive sensor in CV study for curcumin compound. The investigation of the electrochemical properties of curcumin at the GR/GCE has good results in the study.[8]

The new method for study curcumin in food using modified working electrodes has a good recovery rate[9]

A new modified working electrode of graphene oxide in carbon paste electrode (RGO/CPE) was used to find curcumin in human blood serum. Curcumin was measured with a CV, so the new modified working electrode has a high sensitivity for calculating the curcumin in the serum which can be promising in the quantitative analysis study.[10]

Curcumin compound was detected in a sample of spices marketed for turmeric powder using the method of electrochemical analysis. The pure turmeric powder was calculated to have the highest concentration of curcumin with an average of 4.317 ± 0.175% by weight.[11]

A new modified electrode with high sensitivity for studying curcumin compound in serum of humans is nickel chloride solution (NiCl2/GCE). The study mentioned of the quantitative analysis of curcumin in serum with high quality to investigate the electrochemical properties.[12]

Curcumin may protect patients at risk for cardiovascular disease by improving blood lipid levels. Curcumin can be used as a well-tolerated dietary supplement to conventional medicines. More information is needed on how to handle curcumin, dosage and frequency of treatment[13,14]

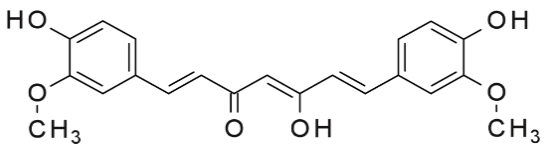

Figure 1: the structure of enol form of curcumin

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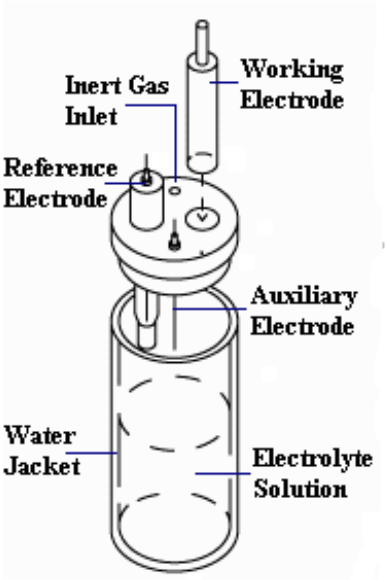

Figure 2: cyclic voltammetric cell

EXPERIMENTAL

Materials

Curcumin powder was bought from Emad Herb Company, Mosul (IRAQ), normal saline from Adwic Pharmaceuticals Division (Egypt), samples of human blood samples were received from the Iraqi Blood Bank in the medical city, Baghdad, Iraq and distilled water to prepare the solutions.

Instruments

Cyclic voltammetric apparatus was used from NuVant Systems Inc. EZstat series (potentiostat/galvanostat), Pioneering electrochemical technologies (USA).

The cyclic voltammogram analysis was played with three electrodes as shown in figure 2, glassy carbon electrode (GCE), silver chloride on silver electrode in potassium bromide solution (3M KBr) was used as reference electrode and a wire of platinum with a dimension of 1 mm as an auxiliary electrode which connected with potentio-station of bioanalytical integral system and with a personal computer.

Figure 3 shows the setup of the potentiostat type EZstat series potentiostat/galvanostat, NuVant Systems Inc. USA. Three electrodes (PANI NPs/GCE as a working electrode, silver/silver chloride as a reference electrode (Ag/AgCl in 3 M KCl), and a platinum wire with a diameter of 1-mm as an auxiliary electrode) were connected to a potentiostat and with the cell of CV also connected with a personal computer. Before modification of the GCE, it must be cleaned with polishing and treated with ultrasonic path water for ten minutes.

Procedure

Three electrodes of cyclic voltammetric system were immersed in a 10 mL of blood sample (diluted 1-mL blood: 9 mL deionized water) in a voltammetric quartz cell (15 mL volume). All electrodes were connected to potentiostat to found the results by personal computers via the cyclic voltammogram.[15,16]

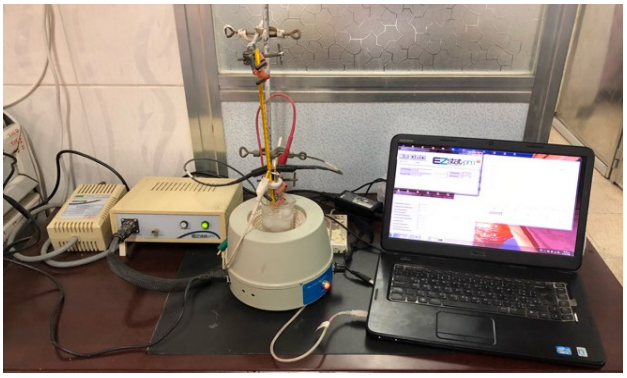

Figure 1: Cyclic voltammetry experimental setup

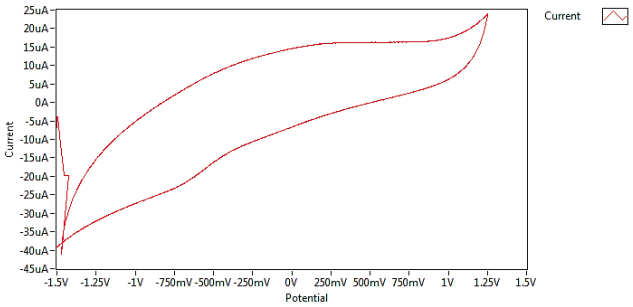

Figure 3: cyclic voltammogram of curcumin compound in blood sample at SR of 0.1 $Vsec^{-1}$

Effect Different Concentrations

Curcumin compound was studied to find the effect for the electrochemical behavior in the electrolyte (blood sample) by the redox reaction in cyclic voltammogram . Figure 4 illustrated the cyclic voltammogram of curcumin solution in 1:9 ratio of blood sample to deionized water, which appeared a reduction peak at a potential of -0.740 V. So, curcumin compound is very important for studying cancer cases as treatment by gaining the electrons and avoid the free radicals in blood medium.[17,18]

Enhancement of Reduction Peak of Curcumin

In this study different scan rates (SR) from 0.01 to 0.1 $Vsec^{-1}$ was determined for curcumin compound in blood medium, Figure 5 discuss the enhancement of cathodic current peak of curcumin proportional with increasing scan rate. The straight line of the relation between the cathodic current peak with SR was found in the equation of Y=0.0054 X-0.0492 with high sensitivity of R^2=0.9614 as shown in Figure 6.

Reliability and Stability Study

The cyclic voltammogram of curcumin compound in blood samples at multiplay times scanning (ten times) to prove the stability of the surface of GCE in blood reliability and. It was found a good overlapping of the reduction current peak which can be dependent on the experiment of the study as shown in Figure 7.[19]

Effect pH Medium

The effect of different pH mediums of blood was studied on the current reduction peak of the curcumin compound to find the electrochemical behavior. Figure 8 shows the alkaline

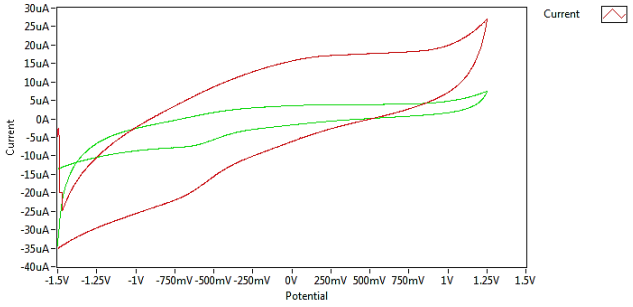

Figure 5: voltammogram of curcumin compound in blood sample the green line at SR of 0.01 mVsec-1 and red line at 0.1 mVsec-1.

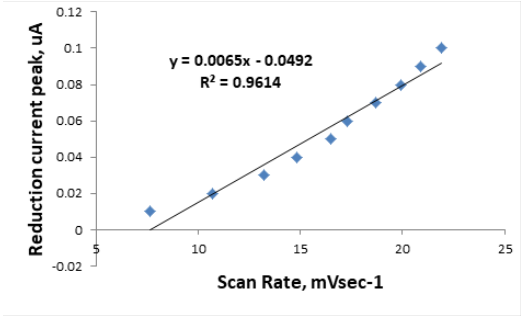

Figure 6: Relationship between reduction current peak of curcumin versus different scan rates.

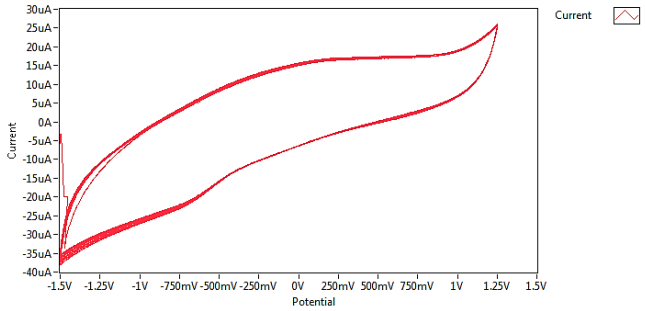

Figure 7: Cyclic voltammogram of curcumin in blood sample at multiplay times of scanning.

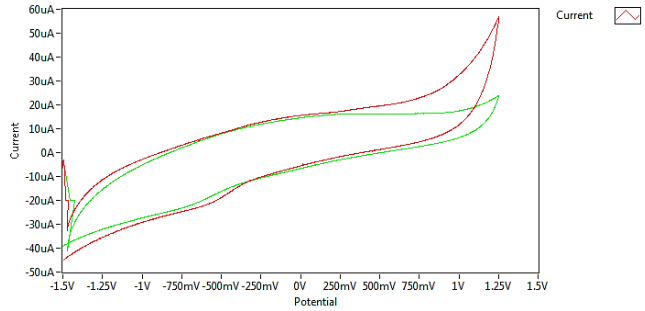

Figure 8: Cyclic voltammogram of curcumin compound in blood medium, Green line in acidic pH, and red line in alkaline pH.

blood medium at pH 8, which enhanced the cathodic current peak at -0.740 V, while the acidic blood medium of pH 4 has a negative effect on the reduction process of curcumin in blood sample. So, curcumin compound is active as anti-oxidative compound in alkaline blood sample, it can be concluded that curcumin at alkaline medium is very important for treated for different diseases especially, all infections and different cancer diseases.[20]

CONCLUSIONS

Curcumin is one of the famous anti-oxidative reagents used in various infections and cancer diseases that can be studied by CV technique as a good method of electrochemical analysis. It can be used as a safe treatment without any side effects. It was found the curcumin is active in an alkaline blood medium. The cathodic current peak of curcumin in blood sample was appeared at -0.740 V and enhanced by alkaline pH so, it can be said is a good medicine for treated to inflammatory and cancer cases.

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