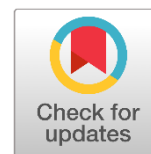




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Electrochemical Study of the Stevia as an Alternative to the Sugar in Blood Medium Using Nano-Sensor by Cyclic Voltammetry

Muhammed Mizher Radhi^{a*} Asmaa Abdulsattar Obaid^b, Lamyaa F. A. Al-Barram^c

^{a,b} Radiological Techniques Department, Health and Medical Technology College-Baghdad, Middle Technical University (MTU) – Iraq

^c Department of Physiotherapy Techniques, College of Health and Medical Technology/Baghdad, Middle Technical University (MTU), Baghdad – Iraq

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ABSTRACT

Stevia contains natural compounds that are plant herbs that estimated to be 150–400 times sweeter than saccharide. The study included the effect of different concentrations, different pH in present, and without a present ascorbic acid solution. A potentiostat was used as a cyclic voltammetric technique by a modified glassy carbon electrode (GCE) with multiwall carbon nanotubes (MWCNT) as a nanosensor (MWCNT/GCE) to enhance the oxidation-reduction current peaks of stevia compound in blood medium. The oxidation current peak of stevia appeared at 0.028 gm/ml. The study has been found the safety dose used before oxidation of the blood components from the appearing of oxidation current peak of stevia which characterized at -600 mV. Alkaline blood medium in the presence of ascorbic acid acted as an anti-oxidative reagent with present ascorbic acid by enhanced the reduction current peak at -500 mV, so, stevia compound can be used as a safe sweetener alternative of saccharide.

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1. Introduction

Recently, the focus has been on the search for alternatives to sugar, as it has a significant impact on human health; stevia was used as one of the alternatives to sugar (Radhi, Obaid & Hoidy, et al., 2021; Radhi, et al., 2015; Radhi, et al., 2017; Radhi, et al., 2016; Muhammed, Mohammed & Majid, 2020; Abdullah, et al., 2020).

Using stevia to sweeten your foods and drinks can save you a lot of calories, because this sweetener made from Stevia rebaudiana is 250 times sweeter than sugar and contains virtually no calories. However, some types of stevia preparations may affect blood sugar levels differently than others as shown in Figure 1.



Fig. 1. stevia plant

Consumption of sugar-sweetened beverages is one of the dietary causes of metabolic disorders, such as obesity. Therefore, replacing sugar with low-calorie sweeteners may be an effective weight control strategy. When taking preloads of stevia and aspartame, participants did not compensate by eating more at lunch or dinner and reported similar levels of satiety compared to when they ate the high-calorie sucrose load (Anton, et al., 2010). Stevia (*Stevia rebaudiana* Bertoni) is a natural and healthy alternative sweetener to sugar and artificial sweeteners, which has become important to human

*Corresponding author: Muhammed Mizher Radhi, Radiological Techniques Department, Health and Medical Technology College-Baghdad, Middle Technical University (MTU) – Iraq

E-mail: mmradhi@yahoo.com

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diets and food manufacturers. In this study, the effects of stevia or sucralose as tea sweeteners on blood sugar and lipids in type 2 diabetics were investigated (Ajami, et al., 2020). Diabetes mellitus is a major metabolic disease caused by defects in insulin secretion, insulin resistance in peripheral tissues, or both. Plants remained an important source of nutrition as well as medicine. *Stevia rebaudiana* Bertoni is one of the high quality zero-calorie sweetener plants against diabetes. Compounds such as steviol, rebaudioside A, stevioside, etc. can lower the sugar level several times (Jan, et al., 2021). *Stevia rebaudiana*, a natural zero-calorie sweetener, has generated a lot of interest in the scientific community due to its effects on glucose homeostasis, blood pressure and inflammation, all known consequences of obesity. In this review, we evaluate the effects of stevia on these parameters in humans as well as in animal models, highlighting its potential role as an effective intervention for the major cardiovascular risk factors associated with obesity (Ray, et al., 2020).

In this study, the electrochemical properties of alternative of sugar as stevia compound in blood medium was determined the oxidation - reduction affects by cyclic voltammetry. The electrochemical analysis is one of the methods for study by cyclic voltammetry to determining the properties in blood medium.

2. Materials and Methods

Stevia powder was purchased from Mitosh World Fzco (Indonesia), carbon nanotubes (purity 99%) were supplied by Fluka Company (Germany), ascorbic acid was bought from Technicon chemicals Co. (Oreq. Tournai Belgique); all the blood samples were diluted with deionize water by ratio 1:9 mL, 10 ml of diluted blood was placed in the cyclic voltammetric cell (volume of 15 mL). Deionized water was used for preparation the solutions.

2.1. Apparatus Instruments

EZstat (potentiostat/gvanostat) sequence (NuVant Systems Inc., USA) was adopted. All parts of the cyclic voltammetry (CV) apparatus contained the glassy carbon electrode (GCE) as a working electrode, Ag/AgCl (3 M KCl) as a reference electrode, and the platinum wire (1 mm diameter) as a counter electrode. All three electrodes were connected with the potetio-state which operated by the electro-analytical measuring program by a personal computer. GCE surface was cleaned by polishing with alumina solution and in sonic water route for around 10 min to eliminate any impurities before use in CV cell. Preparing the modification of glassy carbon electrode (GCE) with carbon nanotube (CNT). The basic mechanical attachment method used to prepare the CNT/GCE working electrode was used for the nano-sensor preparation (Scholz & Lange, 1992; Tan, Ng & Bond, 2000). The GCE modification method included abrasive application of the multiwall carbon nanotubes (MWCNT) on GCE's clean surface, forming an array of MWCNT as modified working electrode MWCNT / GCE and replacing of the diluted blood sample in a cyclic voltammetric cell in 10 mL, then connecting all the electrodes (modified working electrode, reference electrode and counter electrode) to the potentiostat.

2.2. Procedure

Three electrodes (modified glassy carbon electrode MWCNT/GCE as working electrode, Ag/AgCl as reference

electrode and platinum wire as counter electrode) were immersed in a 10 mL solution of 0.1 M KCl mounted in a voltammetric quartz cell (volume: 15 mL). The three electrodes were connected to potentiostat to determine the results using personal computers via the cyclic voltammogram (Mohsen & Hoidy, 2020).

3. Results and Discussion

A new method has been used to identify the impact of food compound such as the Stevia as an alternative of sugar compound on blood combination using nano-sensor in the cyclic voltammetry.

3.1. Effect Stevia Compound on Blood Components

3.1.1. Effect Different Concentrations

The calibration study of stevia compound at different concentrations of 0.1 - 0.4 mM in healthy blood medium using electrochemical analysis by cyclic voltammetry is very important to find the effect of the alternative of sugar in blood medium. Fig. 2 illustrated the cyclic voltammogram of stevia solution at 0.1 mM in blood medium which has only one reduction current peak at -700 mV, but when increased the concentration of stevia the oxidation current peak of stevia has been appeared at -550 mV in the concentration of 0.4 mM of stevia compound, and any extra stevia compound added to the mixture (blood and stevia) caused to enhance the anodic current peak. So, it can be used the stevia compound as alternative to the sugar in limitation of concentration, that above of 0.4 mM causes oxidation of the blood components. However, the stevia compound can be considered as anti-oxidative reagent of the blood with limited concentration (Radhi, et al., 2015).

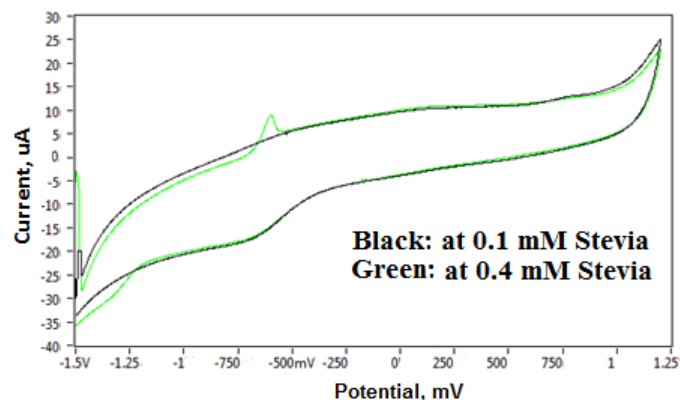


Fig. 2. Cyclic voltammogram of different concentrations of stevia solution (at 0.1 and 0.4 mM) in hole blood sample on modified working electrode.

3.1.2. Effect Different pH of Blood Medium

The different pH of blood as acidic and alkaline media was studied the stevia compound in both of different pH of blood to find the electrochemical properties of alternative of sugar as stevia compound by oxidation - reduction current peaks which illustrated in the cyclic voltammogram of Fig. 3. It was used acidic blood medium at 6 which caused oxidation affect by appeared the anodic current peak at -550 mV, while the alkaline pH of 10 value shows decrease of oxidation peak and enhance the reduction peak as show in Fig.3, so, stevia solution in acidic medium is oxidative reagent and in alkaline medium is anti-oxidative.

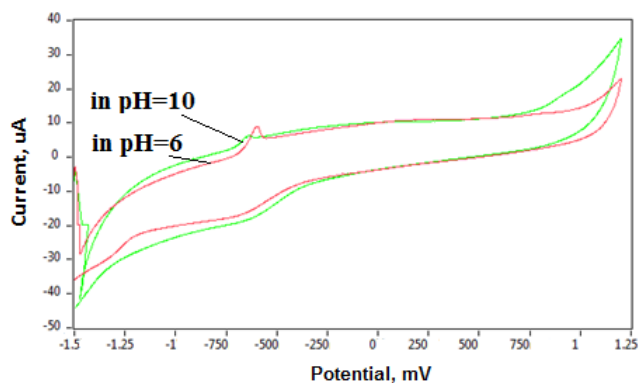


Fig. 3. Cyclic voltammogram of stevia compound in blood medium at different pH (red line at pH = 6 and green line at pH = 10) on a modified electrode.

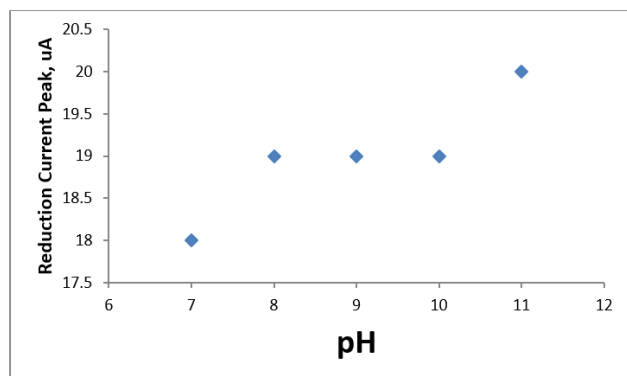


Fig. 4. Relationship between reduction current peak and different pH of the stevia compound in blood medium

3.1.3. Effect Ascorbic Acid on the Stevia Compound in Blood Medium

It is practically known that the ascorbic acid (AA) acts as alkaline medium in the blood, so the electrochemical effect of AA in present of stevia compound has good physiochemical properties, Fig. 4 illustrated the cyclic voltammogram of the reduction current peak of stevia at -600 mV was enhanced by added AA to the blood with stevia and disappeared the oxidation peaks.

Therefore, it can be said that stevia compound acts with ascorbic acid as a good antioxidant mixture in the blood medium.

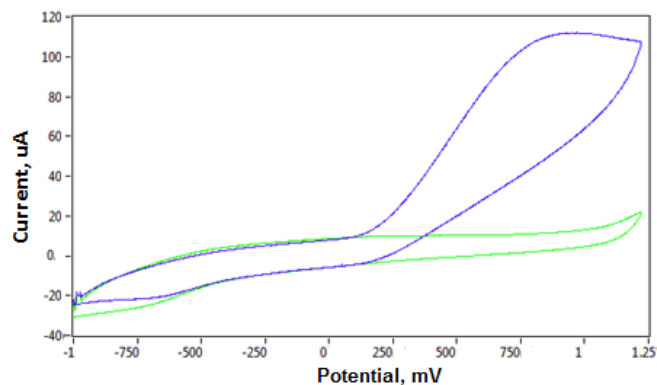


Fig. 5. Cyclic voltammogram of stevia compound in blood medium with and without ascorbic acid on a modified electrode.

4. Conclusion

In this study of using stevia compound as an alternative of sugar and effective in the blood medium by oxidation - reduction current peaks in cyclic voltammetry technique. Useful results have been obtained in the applications of using the stevia compound as a good alternative for the sugar compound, as the safest concentration for the human body was calculated of 0.4 mM the maximum safety concentration. As well as discussing the study of the effect of ascorbic acid on oxidation - reduction peaks of stevia compound in blood medium, it was found that ascorbic acid acts to enhanced the reduction peak and reduced the oxidation peak of stevia compound in blood medium, so, mixing of stevia with ascorbic acid is good formula as antioxidant reagent for blood components. In addition, the results give the alkaline medium of blood has been obtained on disappear the oxidation peak and enhancing the reduction peak, but the acidic blood medium will be oxidative by stevia compound.

Competing Interests

The authors have declared that no competing interests exist.

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