# Electrochemical determination of Pantothenic acid of human blood using a sensitive film of ZnNPs/2-amino-5-cholorobenzophenone

**Noor Salim Bayat**

Kirkuk University, Email: nwersalemb@gmail.com

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**ABSTRACT**

This research is focused on the construction and design of a voltammetry platform to be used for the electrochemical measurement of vitamin B5. Considering the importance and power of the cyclic voltammetry technique in the direction of producing thin and durable electrochemical films, this technique was used for the electrochemical deposition and electropolymerization of surface modifying materials such as zinc oxide nanoparticles and 2-amino-5-chlorobenzophenone. Electrode produced with zinc oxide/2-amino-5-chlorobenzophenone nanofilm structure, at the optimal pH of 6 and under the optimal chemical and device conditions, it could have a linear behavior in the range of 20 to 200 nM and the detection limit was 6.61 and the minimum limit was 19.98 nM. Also, an outstanding electrocatalytic behavior with the obtained parameters of transfer coefficient (i.e. α equal to 0.61), the logarithm of the speed constant (log Ks equal to 3.42)

**Key words:** electrochemistry, voltammetry, square wave, modified electrode, vitamin B5, zinc oxide nanoparticle, 2-amino-5-chlorobenzophenone**.**

## 1. INTRODUCTION

The human body requires trace amounts of a complicated set of chemical molecules called vitamins in order to function at its best. With the exception of vitamins B3, D, and K, Most vitamins are not produced by the humen body and must beobtainedfromfood.. Vitamins support immune system function and aid in the maintenance of cell, tissue, and organ growth. Vitamins also play a crucial part in enzymatic reactions by functioning as cofactors, or coenzymes. [1]

### Vitamin B1 electrochemical sensors

Vitamin (B1) One of the eight vitamins that makeup the powerful of food group. vitamin(b1) can be identified using voltammetry techniques and is extremely important not only for physical and mental health, but also for the body's regular metabolism. The paper by J. Eni et al. on the electrochemical response of VB1 in alkaline solutions at carbon paste electrodes(CPE) is discussed.[2]
electrochemical sensors of vitamin B2

This water-soluble vitamin, also referred to as riboflavin, is present in a variety of foods. VB2 is essential for human physiological processes such the metabolism of lipids and carbohydrates, which in turn helps the body maintain its energy levels. Regretfully, the human body is unable to produce VB2, hence it must come from diets that include cheese, liver, and Because $MnO_2$ has a larger active surface area than CPE, $MnO_2$MCPE displayed greater redox peak currents than unmodified CPE. 15 nM was the found LOD value. The created sensor was also employed by the authors to ascertain VB2 in pharmaceutical compositions [3]. A. Zadeh Nizam Ajieh and others. [4]

### Vitamin B6 electrochemical sensors

Vitamin (VB6) is found in a Various products sach as( foods).VB6 is required for over 100 enzymes involved in protein metabolism and the production of hemoglobin(which carries oxygen to tissues).[5].

## 2. MATERIALS AND METHODS

2-1-Amino-5-Chlorobenzophenone abbreviated as "2,5BPh", vitamin B5 and other vitamins, nitrate salt, metal ions, sugars, amino acids and other consumables were purchased from Sigma Aldrich and in the steps Consumption did not require any repurification. Double distilled and deionized water was used to prepare all the solutions. Britton-Robinson solutions (0.04 mol/L) were produced from the separate mixing of 100 ml of three phosphoric acids, boric acid and acetic acid with a final volume of 300 ml and a concentration of 0.04 M. The resulting solution had a pH of 2.7, and the required pH values in the range of 3 to 11 were adjusted by 0.2 M sodium. A stock solution of 300 mM vitamin B5 was formed by dissolving an accurate amount of vitamin B5 hydrochloride in distilled water in a 100 ml flask.

2-2-Voltammetry tests were performed in a three-electrode cell (the electrode system includes a working electrode, a modified graphite pencil electrode, a platinum wire counter electrode, and a reference electrode (Ag/AgCl)saturated with potassium chloride (KCl)) connected to an "Autolab PGSTAT 302N" potentiostat/ The electrolysis was performed in an electrolysis system containing a galvanostat. Theaforementionedsystem was connected to NOVA.1.11 software for data processing. The complex and morphology of thecompositematerialsand filmsformedon thegraphite electrodesurfacewere determined by scanning electron microscopy(SEM) images of the "MIRA3-TESCAN"model. All pH measurements were performed using a Metrum model 781 pH/ion meter.

2-3-Electrochemical preparation of graphite pencil electrodesurfaces

Prior to the experiment, the surface of the bare graphite electrode wastightly covered with Teflon tape. The graphite pencil electrode tip was then rubbed on smooth paper and polished thoroughly. To achieve proper electrical connection with the graphite tip, the bare pencil was connected to an auto motivemetal electrode holder and a copper wire by soldering, in 0.2MB-Rbuffer at pH11, to an Ag/AgCl reference electrode by scanning a potential of -1.5to2 Vata scanning grate of 50 mV/s20 times in succession. The graphite electrode surface was prepared electrochemically.[6].

2-4-Synthesis of Zinc Oxide Nanoparticles Synthesis of zinc oxide nanoparticles "ZnO" was performed in the following way[33]:in atypical synthesis,0.05 M zinc acetate solution was prepared in 100m distilled water. As a result, urea was added at a concentration of 1 M under magnetic stirring. The pH of the solution was adjusted to 4 with a few amounts of concentrated acetic acid. The mixture was then hydrothermally treated at a constant temperature of 80°C for 12 hours. Finally, the precipitated Zn(OH)2 was thoroughly washed with distilled water and dried in an oven at 60°C for several hours.[7].

**Fabrication of electrode with PGE/ZnONPs/2.5BPh structure2-5-**

In this step, a viscous slurry was formed by dissolving the accurate amount of zinc oxide nanoparticles in tetrahydrofuran solvent. A few drops of the slurry were placed on the tip of the bare graphite electrode and allowed to evaporate all the solvent and make a proper physical contact. In the following, the same electrode was immersed in a solution of 5% weight-volume of zinc oxide nanoparticles in water-alcohol solution in a final volume of 25 ml, and by applying 16 consecutive cycles of cyclic voltammetry, the deposition of zinc oxide nanoparticles in the range of 1.3 V Negative to positive 0.5 V was done at a speed of 30 mV/s. In this step, "PGE/ZnONPs" electrode was produced. Next, to produce the electrode with the PGE/ZnONPs/2.5BPh structure, the modified electrode in the first step with the "PGE/ZnONPs" structure inside the 300 mM alcohol solution - Amino-5-chloroacetophenone was immersed in the final volume of 25 ml and by applying successive scans for 14 cycles in the range of negative 1.2 V to positive 1.2 V under the speed of 50 millivolts. per second, the electropolymerization/ electrosorption of 2-amino-5-chloroacetophenone was completed and the target electrode was successfully produced to be used for the purpose of electrochemical measurement of vitamin B5.

2-6-SamplePreparation.

Prior to sample analysis, middle-aged volunteers weres electrode and samples were collected with the appropriate syringe. A fixed volume (1ml) of the human serum sample was then diluted with thanol and used as a precipitant for serum proteins. The resulting serum samples were further analyzed by the standard increasing method by Sensort proposed to detect vitaminB5 at anoptimal pH of 6 and quantified by the"SWV" technique of square wave voltammetry

## 3.RESULTS

### 3.1 electrooxidation of vitamin B5 on the surface of electrodes

Figure 2-4 shows the electrochemical response of 120 μM vitamin B5 on the surface of unmodified PGE, PGE-ZnONPs and PGE-ZnONPs-2.5BPh electrodes in 0.04 M Britton-Robinson buffer solution (pH 0.6). gives The results show that vitamin B5 has an oxidation peak around the potential of 0.8V, and the intensity of its current on the surface of the 2-amino-5-chlorobenzophenone graphite electrode is the highest compared to other electrodes. which made its surface favorable and suitable for its quantitative electrochemical evaluations (Figure 4-2A-C). This ability is due to the presence of zinc oxide nanoparticles and 2-amino-5-chlorobenzophenone.

Zinc oxide nanoparticles belong to a group of minerals that have been widely studied. Nanomaterials with dimensions less than 100 nm exhibit superior size-dependent properties and morphology compared to

their bulk counterparts. These nanoparticles have found potential applications inelectronics [8,9], catalysis [10,11], biosensors [12,13], and biomedicine [14-15].
Vitamin B5 was investigated in the range of 0-120 μM and the corresponding cyclic voltammograms were recorded as shown in (Figure 3-4),provingthe catalyticactionof the"PGE-ZnONPs-2.5BPh"electrodeonthe oxidation of vitamin B5. B5wasproved tobea good candidate for the catalytic action of the "PGE-ZnONPs-2.5BPh" electrode on the oxidation of vitamin B5.

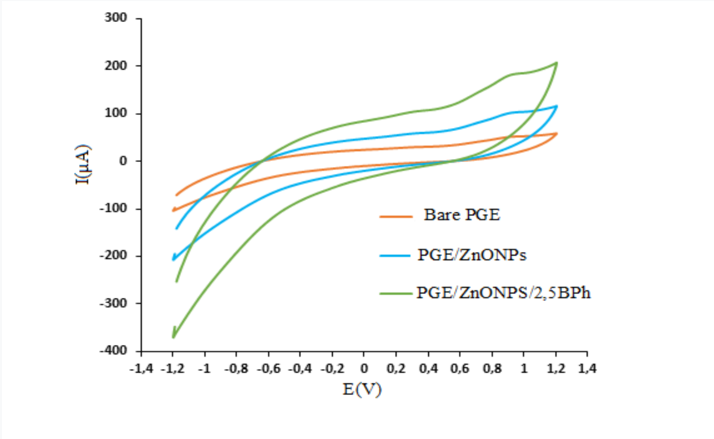


**Figure 3-1** Cyclic voltammetry related to the electrochemical behavior of 120 micromolar vitamin B5 on the surface of electrodes A) bare graphite B) graphite / zinc nanooxide C) graphite / nanooxide / 2-amino-5-chlorobenzophenone.

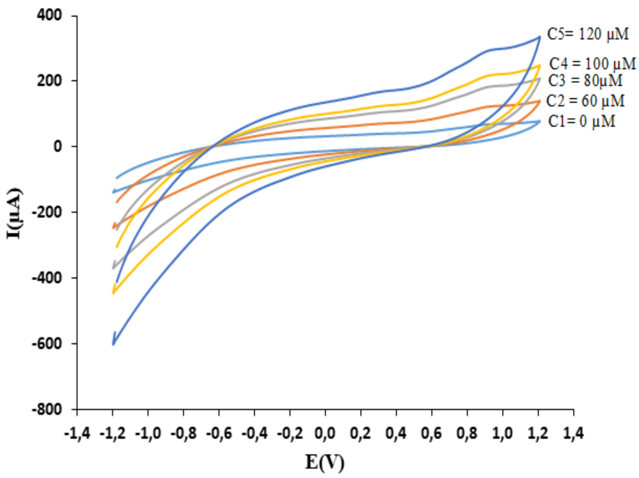


**Figure 3-2** Recording of cyclic voltammograms related to the electrochemical oxidation of vitamin B5 on the surface of the target electrode of graphite/nano-oxygen/2-amino-5-chlorobenzophenone.

### 3.2 Interference study

The ability of the sensor fabricated with a graphite/zincoxide/2-amino-5-chlorobenzophenone electrode structure is critical to distinguish interfering species from the analyte of interest. To characterize the developed sensor, the effects of various chemical species, including vitamins, biomolecules, and inorganic ions, on the determination of 120 nM of vitamin B5were investigated. The SWV of vitamin B5 was recorded in the presence of various concentrations of interfering compounds. Tables1-4 show the maximum allowable concentrations of compounds such that the relative error is greater than 5%athigher concentrations. It can be seen that many compounds have little effect on the response signal of vitamin B5even at high concentrations..

**Table 4.1** Study of the interference of different organic and inorganic species on the response of graphite/zinc nanooxide/2-amino-5-chlorobenzophenone electrode to 120 nM vitamin B5 using the SWV (triple repetition) technique.

| Interfering species | The ratio of interfering concentration to analyte concentration | Interfering species | The ratio of interfering concentration to analyte concentration |
|---|---|---|---|
| $Zn^{2+}$ | 47 | $Li^{+}$ | 93 |
| $Ni^{2+}$ | 52 | $Fe^{3+}$ | 29 |
| $Cu^{2+}$ | 59 | $Fe^{2+}$ | 33 |
| $Co^{2+}$ | 78 | Glaucous | 48 |
| Urea | 98 | Vitamin C | 57 |
| CTAB | 130 | Vitamin A, Vitamin E | ≥83 |
| L-cysteine | 87 | Vitamin B12 | 69 |

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