Determination of vitamin B_1 using sulfur solid-state electrode

Assoc. Prof. Dr. Sukru Kalayci

Gazi University, Technical Sciences Vocational School, Department of Chemical Technology, Ankara, Türkiye

DOI: https://doi.org/10.56293/IJASR.2024.6210

IJASR 2024
VOLUME 7
ISSUE 6 NOVEMBER – DECEMBER **ISSN: 2581-7876**

Abstract: In this study, a solid-state electrode sensitive to sulfur concentration was developed. The electrode, which is sensitive to sulfur concentration with an analytical slope of 29 ± 0.7 mV and has a composition of 25% DBDS + 55% Ag_2S + 20% CuS, was applied. For this reason, it was determined that the analytical performance values of this electrode in synthetic samples were high. Vitamin B1 was determined indirectly using a sulfur electrode. After vitamin B1 was made soluble, it was analyzed using both selective electrode and ion chromatography with the help of sulfur. The results were found to be consistent with each other.

Keywords: Vitamin B1, Sulfur, solid-state electrode, determination.

Introduction

Vitamin B1, a water-soluble vitamin, is one of the eight vitamins that make up the powerful group called the vitamin B complex. Like all of the B vitamins, this nutrient plays a major role in the good health of the body as well as in sound mental health. Vitamin B1 serves many purposes in the body [1-2].

Various analytical methods have been reported for the determination of thiamine in both pharmaceutical preparations and biological samples. These methods include spectrophotometry [3-5], spectrofluorimetric [6-12], high performance liquid chromatography [13-14], capillary electrophoresis [15], voltammetry [16] and ion selective electrode [17].

In this study, instead of these expensive methods in vitamin B1 analysis, a new solid-state electrode with high selectivity, short-time analysis, low cost and sensitivity to sulfur ions was prepared. The features that increase the sensitivity of the electrode were examined and suitable conditions were determined. Vitamin B1 analysis was performed indirectly with this electrode. In addition, the analytical performance values of the electrode were measured.

Materials and Methods

All chemicals used in this study are of high purity. Dibutyl di sulfide (Merck), silver (I) sulfide and CuS compounds were prepared in laboratory conditions. Vitamin B1 (100 mg) was used from a well-known commercial brand. Stock solutions of cations and anions salts (Merc) were prepared as 0.1 M for the interference effect. Standard solutions of the ions to be analyzed were prepared using ultrapure water (18.2 MΩ cm^{-1}).

Ultrapure water produced by Thermo Fisher brand Pacific TII model ultrapure water device (USA) was used in the preparation of sample, stock and standard solutions. For potential measurements, Orion Star A214 pH/ISE Benchtop meter, reference electrode and IKA Plate magnetic stirrer mixer were used.

Results

The sensitivity of the electrode sensitive to the 25% DBDS + 55% Ag_2S + 20% CuS composition with a total membrane mass of 0.4 g to the sulfur concentration was measured and is given in Figure 1.

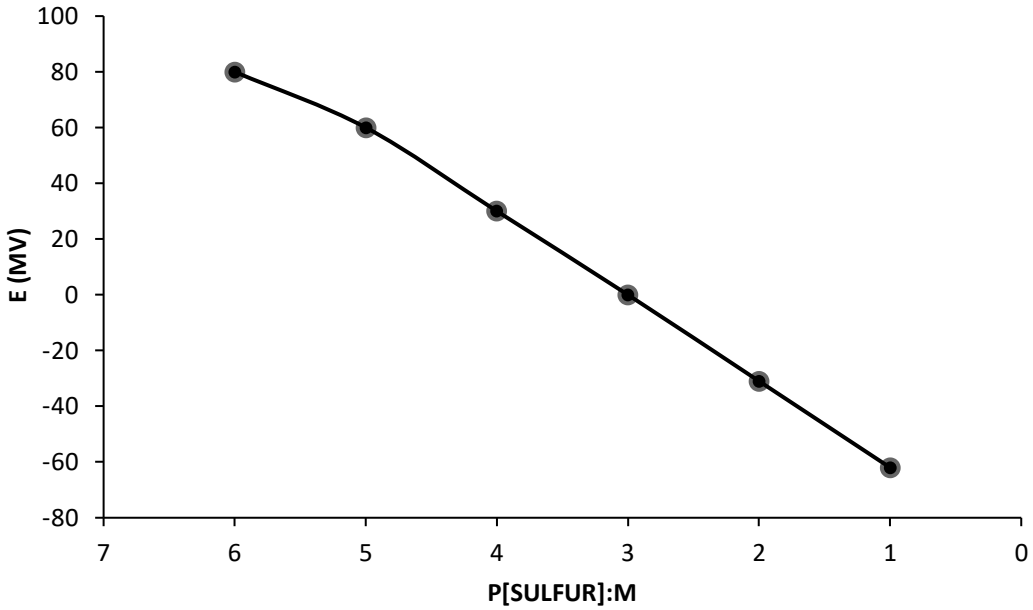

Figure 1: Sensitivity of solid-state electrode to sulfur ion

The amount of sulfur in synthetic samples was analyzed with the prepared sulfur selective solid- state electrode and the % recovery rates were measured. The results were calculated as the 95% confidence level and the average of 4 experiments. These values are given in Table 1.

Table 1. Analytical values of the sulfur electrode in synthetic samples.

Amount of added sulfur: mg/L	Sulfur measured by electrode: mg/L	% Recycling
10	9.6 ± 0.1	96
50	49 ± 1.0	98
100	98 ± 2	98
200	197 ± 4	99

A known commercial vitamin B1 was dissolved in 10 mL of ultrapure water. The amount of vitamin B1 in this sample was analyzed by both the solid-state electrode and the ion chromatography method. The results obtained are given in Table 2. As a result of this analysis, it was seen that the data obtained with both methods were compatible with each other.

Table 2: Vitamin B1 analysis results and comparison

Sample	Found with electrode mg/L	Found Ion chromatography mg/L
Vitamin B1	18 ± 0.6	19 ± 0.8

Discussion

Vitamin B1 determination was done directly or indirectly using many methods [18-19]. It was observed that the sulphur electrode is easy to prepare, has low cost, short response time, high sensitivity and no interference effect. It was found that it can be applied to both synthetic and real samples.

Conclusion

In this study, a new solid-state electrode sensitive to sulfur ions was prepared. The electrode composition was determined as 25% DFDS + 55% Ag(I)S + 25% CuS. When the sulfur concentration of this electrode was increased by 10 times, it showed a potential increase of 29 ± 0.7 mV. The membrane thickness of the electrode was measured as 0.4 g. It can be easily worked between pH 1 and 10. It is not sensitive to many anions and cations. It was recorded that the analytical performance of the electrode in synthetic samples was high. It was used in the analysis of vitamin B1. The amount of vitamin B1 was performed by both electrode and ion chromatography. The results were found to be consistent.

Source of Funding

None.

Conflict of Interest

No conflict of interest to be disclosed.

Reference

1. Goodman AG, Rall TW, Nies AS (1992). The pharmacological basis of therapeutics, 8th edn. McGraw Hill, New York, p 1530.
2. Kuriyama M, Yokomine R, Arima H, Hamada R, Igata A (1980). Blood vitamin B1, transketolase and thiamine pyrophosphate (TPP) effect in beriberi patients, with studies employing discriminant analysis. Clin Chim Acta: 108:159-168.
3. Barrales PO, Fernandez de Cordova ML, Diaz AM (1998) A selective optosensor for UV spectrophotometric determination of thiamine in the presence of other vitamins B. Anal Chim Acta: 376:227-233.
4. Barrales PO, Vidal AD, Fernandez de Cordova ML, Diaz AM (2001). Simultaneous determination of thiamine and pyridoxine in pharmaceuticals by using a single flow-through biparameter sensor. J Pharm Biomed Anal: 25:619-630.
5. Dinc E, Kokdil G, Onur F (2000). A comparison of matrix resolution method, ratio spectra derivative spectrophotometry and HPLC method for the determination of thiamine HCl and pyridoxine HCl in pharmaceutical preparation. J Pharm Biomed Anal: 22:915-923.
6. Karlberg B, Thelander S (1980). Extraction based on the flowinjection principle Part II. Fluorimetric determination of vitamin B1 (thiamine) by the thiochrome method. Anal Chim Acta: 114:129-136.
7. Perez-Ruiz T, Martinez-Lozano C, Sanz A, Guillen A (2004). Successive determination of thiamine and ascorbic acid in pharmaceuticals by flow injection analysis. J Pharm Biomed Anal: 34:551–557.
8. Perez-Ruiz T, Martinez-Lozano C, Tomas V, Ibarra I (1992). Flow injection fluorimetric determination of thiamine and copper based on the formation of thiochrome. Talanta: 39:907-911.
9. Garcia L, Blazquez S, Andres MPS, Vera S (2001). Determination of thiamine, riboflavin and pyridoxine in pharmaceuticals by Dispersive liquid-liquid microextraction 323synchronous fluorescence spectrometry in organized media. Anal Chim Acta: 434:193-199.
10. Alonso A, Almendral MJ, Porras MJ, Curto Y (2006). Flowinjection solvent extraction without phase separation. Fluorimetric determination of thiamine by the thiochrome method. J Pharm Biomed Anal: 42:171-177.
11. Vinas P, Lopez-Erroz C, Cerdan FJ, Campillo N, Hernandez-Cordoba M (2000). Flow-injection fluorometric determination of thiamine in pharmaceutical preparations. Microchim Acta: 134:83-87.

12. Baczyk S, Levandowska M, Szwajca T (1983). Fluorimetric determination of thiamine in presence of its decomposition products and of sulfaguanidine. Microchim Acta: 79:437-442.
13. Losa R, Sierra MI, Fernandez A, Blanco D, Buesa JM (2005). Determination of thiamine and its phosphorylated forms in human plasma, erythrocytes and urine by HPLC and fluorescence detection:a preliminary study on cancer patients. J Pharm Biomed Anal: 37:1025-1029.
14. Lynch RLM, Tnmble ER, Young IS (1997). High-performance liquid chromatographic determination of thiamine diphosphate in erythrocytes using internal standard methodology. J Chromatogr B: 701:120-123.
15. Mrestani Y, Neubert RHH (2000). Thiamine analysis in biological media by capillary zone electrophoresis with a high-sensitivity cell. J Chromatogr A: 871:31-356.
16. Aboul-Kasim E (2000) Anodic adsorptive voltammetric determination of the vitamin B1 (thiamine). J Pharm Biomed Anal: 22:1047-1054.
17. Ismaeel YQ, Al-Phalahy BA (2020). A New Cyproheptadine PVC Ion Selective Electrode and their Applications in Pharmaceutical Preparations and Human Fluids. Al-Nahrain Journal of Science: 23 (2): 26-32.
18. Korus A (2022). Effect of pre-treatment and drying methods on the content of minerals, B-group vitamins and tocopherols in kale (Brassica oleracea L. var. acephala) leaves. Food Sci Technol: 59(1): 279-287.
19. Antal I, Kormosh Z, Bazel Y, Lysenko S, Kormosh N (2010). Design of a Vitamin B1-Selective Electrode Based on an Ion-Pair and Its Application to Pharmaceutical Analysis, Electroanalysis: 22: 2714 – 2719.