

RESEARCH ARTICLE

Cyclic Voltammetric Studies of Benzilic Acids and their Derivatives

R. Sudha^{1*}, Nithya G¹, Charles C Kanakam²

¹Department of Chemistry, School of Basic Sciences, VISTAS, Pallavaram, Chennai, Tamil Nadu, India.

²Department of Chemistry, Formerly Presidency College, Chennai, Tamil Nadu, India.

*Corresponding Author E-mail: rajendran.sudha7@gmail.com

ABSTRACT:

This study is used to predict about the oxidation and reduction behaviour taking place in benzilic acids and their derivatives. The electrochemical reduction of different substituted benzilic acids were synthesized and studied in acidic medium by cyclic voltammetry. Platinum electrode served as the counter electrode. Ag/Ag⁺ non-aqueous electrode as the reference electrode and glass carbon electrode is used as the working electrode. In acidic solution with different concentration, shows that oxidation and reduction takes place depend on the substitution present in the synthesized compound and hydrochloric acid concentration. The reduction occurs in two reversible one-electron steps producing the anion radical. In the presence of acid, the first reduction is unaffected and the second reduction wave becomes irreversible and is shifted toward positive potentials. The compound exhibits oxidation and reduction potential in acidic medium with two different concentrations with the reversibility of the reaction.

KEYWORDS: Cyclic voltammetric studies, benzilic acid, Electroanalysis.

INTRODUCTION:

Electrochemistry is a powerful tool used for both qualitative and quantitative analysis for different concentrations of solution. Electrochemical methods propose the potential to investigate these processes directly by the determination of the number of electrons involved^[1]. Numerous standard electrochemical methods exist that can be categorized into three general classes viz., potentiometry, coulometry and voltammetry^[2,3]. The information about an electrochemical process is obtained by cyclic voltammetric method. Voltammetry is an effective electro analytical technique used to study the redox systems^[4]. It concerns mainly with the electrical quantity measurements^[5]. Due to its relative ease, this method is useful for measuring heterogeneous electron transfer rate constants.

It is used as an important tool for elucidating electrode mechanisms. It was first accomplished with hanging mercury drop electrode^[6] and it gained extensive use of solid electrodes like Pt and Au to study the anodic oxidations^[7]. Organic chemists^[8,9] have applied this technique to the study of biosynthetic reaction pathways and to study the electrochemically generated free radicals. An increasing number of chemists have been using cyclic voltammetry studies to evaluate the oxidation/reduction^[10,11] potential of functional groups and the effects of other groups attached to them. The sensitive organic molecules^[12,13] and amino acids^[14-18] are determined by electrochemical techniques. Commonly the electro active systems are characterised by cyclic voltammetry^[19,20]. The antioxidant properties of organic compounds are screened by using cyclic voltammetry and differential pulse voltammetry^[21-27].

EXPERIMENTAL:

The cyclic voltammetric experiments have been carried out with CHI760C-CH Electrochemical Analyzer. The compounds are pasted in the working electrode with the help of Nafion solution. About 5 mg of the substance was added to 0.01N and 0.1N concentration of HCl. It is then subjected to cyclic voltammetric experiments. The total volume of the solution was 10 ml. platinum

Received on 13.02.2018

Modified on 27.03.2018

Accepted on 26.04.2018

© RJPT All right reserved

Research J. Pharm. and Tech 2018; 11(7): 2947-2951.

DOI: 10.5958/0974-360X.2018.00544.9

electrode served as the working electrode, Ag/Ag⁺ non-aqueous electrode as the reference electrode.

**RESULTS AND DISCUSSION:
C.V STUDIES ON COMPOUND BA:**

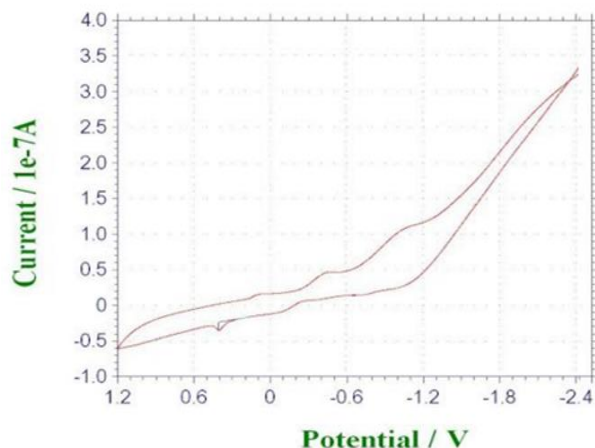


Figure 1[a] CV study for compound BA in 0.01N HCl

The cyclic voltammetric study of the compound BA in 0.01N HCl was carried out in the potential range of 1.2 to -2.4 V. In the range from 1.2 to 0.6 V, no redox process was found to take place. Three cathodic waves and three anodic waves were observed. In the forward scanning a poorly defined cathodic peak occurs at +0.15 V, with a peak current i_{p_c} of +0.2. The clear cathodic peak occurs in the negative range at -0.45 V with peak current i_{p_c} at +0.5 another peak at -1.05 V with a peak current of i_{p_c} +1.0. This indicates that a definite cathodic process is taking place at this potential. In the reverse scan clear anodic peak was observed at +0.40V with a peak current of i_{p_a} -0.35. There are two poorly defined oxidative processes found with peak potentials - 0.1V and -1.05V. Both these anodic processes occur at peak currents of i_{p_a} -0.15 and +0.30 respectively (Fig 1(a)).

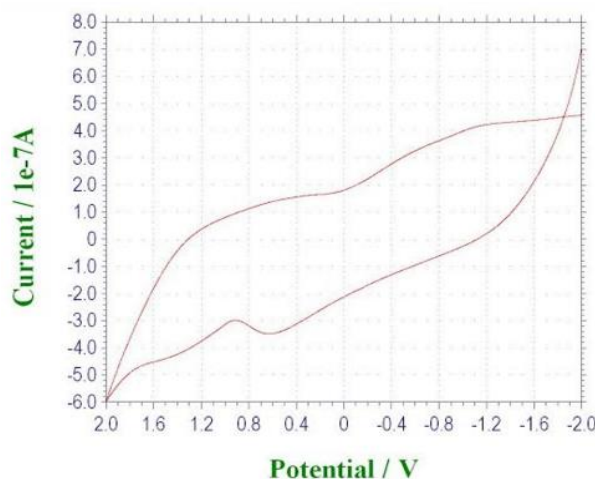


Figure 1 [b] CV study for compound BA in 0.1N HCl

The cyclic voltammetric study of the compound BA in 0.1N HCl was carried out in the potential range of +2.0 to -2.0V. In the forward scanning a poorly defined two cathodic peaks were observed, one at +1.2V with a peak current i_{p_c} of +0.2 and another peak at -1.1V with peak current of i_{p_c} +4.0. In the reverse scan, a clear anodic wave for an oxidative process was found at +0.65V with the peak current of i_{p_a} -3.7 (Fig 1(b)).

C.V STUDIES ON COMPOUND MB:

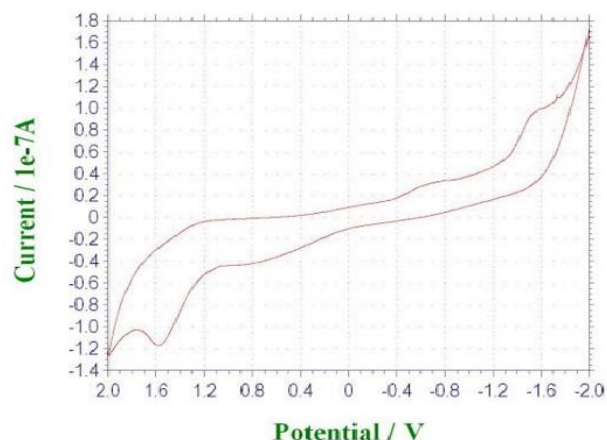


Figure 2[a] CV study for compound MB in 0.01N HCl

In the cyclic voltammogram of the compound MB in 0.01N HCl three cathodic peaks and two anodic peaks are seen. In the forward scanning the clear cathodic peak occurs in the negative range at -1.4V with a peak current of i_{p_c} +1.0. This indicates that a definite cathodic process is taking place at this potential. A poorly defined two cathodic peaks were found at +1.2 and -0.65V with a peak current of i_{p_c} -0.5 and +0.35. A clearly defined anodic peak at +1.65 V was found. This indicates that a definite anodic process is taking place at this potential. The anodic processes occur at peak current of i_{p_a} -1.25 (Fig. 2(a)). Another anodic peak is observed at +0.8V with peak current i_{p_a} -0.45.

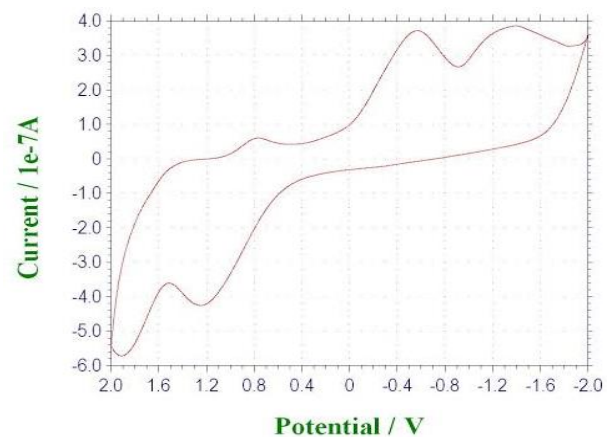


Figure 2 [b] CV study for compound MB in 0.1N HCl

The cyclic voltammetric study of the compound MB in 0.1 N HCl was carried out in the potential range of +2.0 to -2.0V. In the range from +2.0 to +1.5V there is no redox process. In the forward scanning, three definite cathodic process are found to take place at +0.8V, -0.65V and -1.45V. The peak currents i_{p_c} are found to be +0.6, +3.75 and +3.85. In the reverse scan, two anodic process taking place at -1.6V and +1.25V. The peak currents of i_{p_a} are +0.85 and -4.25 respectively (Fig 2(b)).

C.V STUDIES ON COMPOUND 2'C4MNBA:

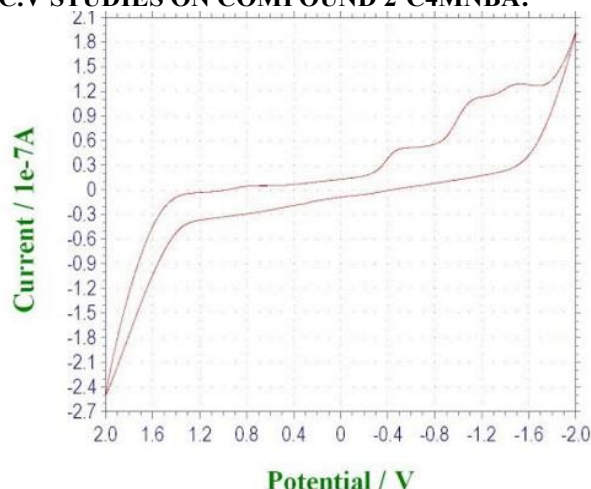


Figure 3[a] CV study for compound 2'C4MNBA in 0. 01N HCl

The electrochemical study of the compound 2'C4MNBA in 0.01N HCl was carried out in the range of +2.0 to -2.0V. In the range +2.0 V to +1.6 V no redox process found to take place. In the forward scanning three definite cathodic process are found to take place at -0.66V, -1.1V and -1.35V with peak current i_{p_c} at +0.55, 1.05 and +1.35. In the reverse scan, one oxidative process is taking place at -1.45 with peak current i_{p_a} +0.25 (Fig. 3(a)).

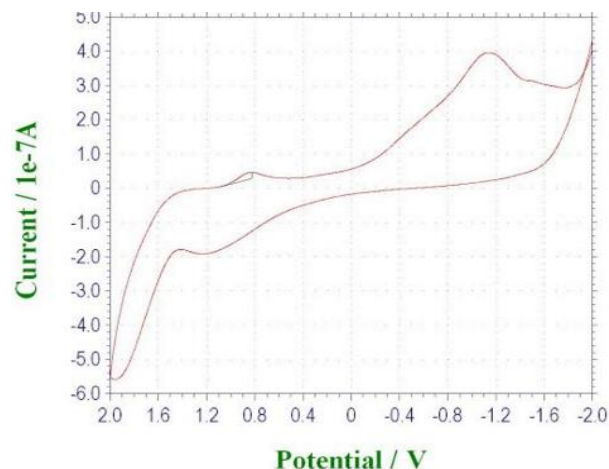


Figure 3 [b] CV study for compound 2'C4MNBA in 0. 1N HCl

The electrochemical study of the compound 2'C4MNBA in 0.1N HCl was carried out in the range of +2.0 to -2.0 V. In the range +2.0 to +1.6 V no redox process is found to take place. In the forward scanning two definite cathodic processes are found to take place at +0.9V and -1.15V at peak currents i_{p_c} +0.45 and +4.0 respectively. In the reverse scan, two anodic process were taking place at -1.45V and +1.2V respectively (Fig. 3(b)). The peak currents i_{p_a} were found to be +0.65 and -2.0.

C.V STUDIES ON COMPOUND DBBA

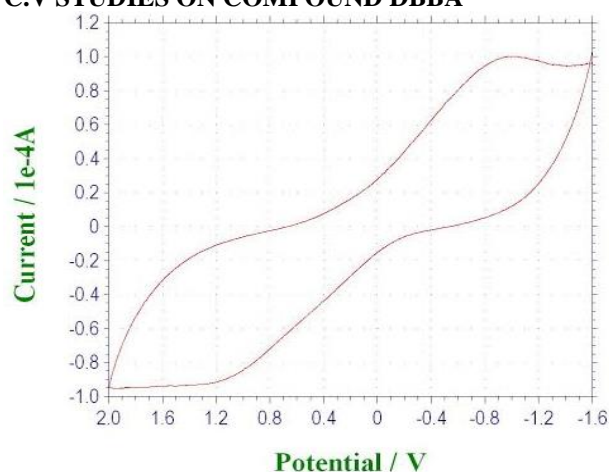


Figure 4 [a] CV study for compound DBBA in 0. 1N HCl

The electrochemical study of the compound DBBA in 0.1N HCl was carried out in the range of +2.0 to -1.6V. In the range +2.0 V to +1.5 V, no redox process is found to take place. In the forward scanning two definite cathodic processes were found to take place at +1.2V and another peak at -0.95V. The peak currents for cathodic process i_{p_c} were found to be -0.15 and +0.95 respectively. In the reverse scan, the oxidative process was taking place at -1.10 V with the peak current i_{p_a} 0.1 (Fig 4(a)).

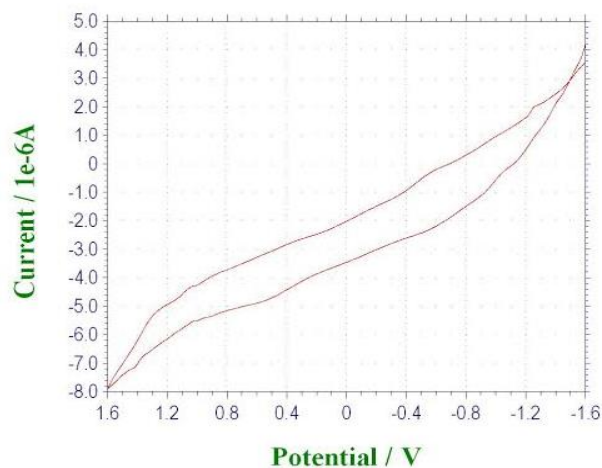


Figure 4[b] CV study for compound DBBA in 0.0 1N HCl

The electrochemical study of the compound DBBA in 0.01 N HCl was carried out in the range of +1.6 V to -1.6 V. In the forward scanning a poor cathodic process was found to take place at -1.3 V. In the reverse scan, an anodic process was taking place at +0.55 V (Fig 4(b)). The peak currents i_{pc} and i_{pa} are +2.0 and -5.0 respectively.

C.V STUDIES ON COMPOUND DCBA:

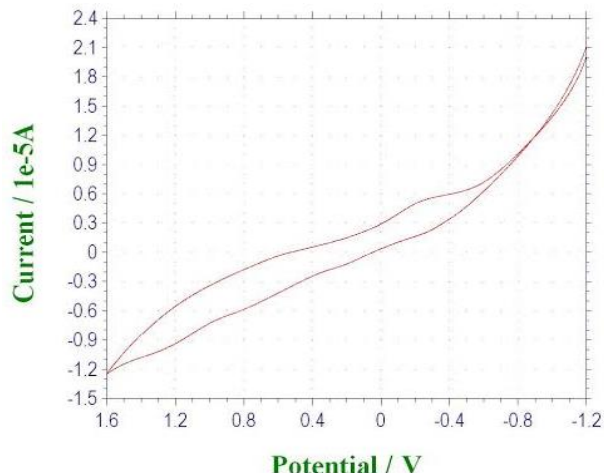


Figure 5 [a] CV study for compound DCBA in 0.1N HCl

The study of the electrochemical behaviour of the compound DCBA was carried out in the range of +1.6 V to -1.2V. In the forward scanning a definite cathodic process was found to take place at -0.2V. In the reverse scan, an anodic process was taking place at -0.72 (Fig. 5 (a)). The peak currents i_{pc} and i_{pa} were +0.6 and +0.2 respectively

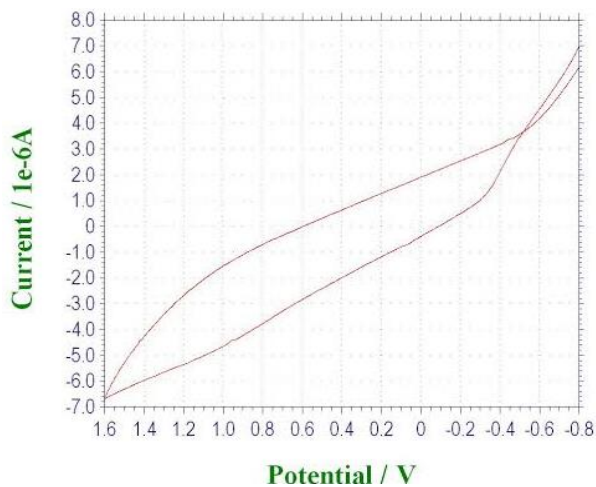


Figure 5 [b] CV study for compound DCBA in 0.01N HCl

The study of the electrochemical behaviour of the compound DCBA was carried out in the 0.1N HCl in the range of +1.6 to -0.8 V. In the range of +1.6 to +1.45 V no redox process was found to take place. In the forward

scanning cathodic process is found to take place at +0.9V with peak currents i_{pc} is -1.0. In the reverse scan, one anodic waves an oxidative process was taking place at -0.35 (Fig 5(b)). The peak current i_{pa} was found to be at +1.0.

C.V STUDIES ON COMPOUND DIPBA:

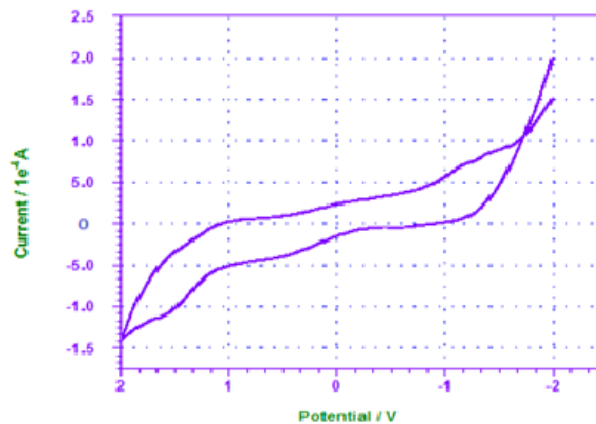


Figure 6[a] CV study for compound DIPBA in 0.01N HCl

The cyclic voltammetric study of the compound DIPBA in 0.1 N HCl was carried out in the potential range of +2.0 to -2.0V. In the range of +2.0 to +1.85V there is no redox process is found to take place. In the forward scanning a two cathodic process are found to take place at +1.05V and -1.25V. The peak currents i_{pc} are found to be +1.0 and +0.45. In the reverse scan, two anodic processes are taking place at -1.2V and +1.25V. The peak currents i_{pa} are +0.05 and -0.45 respectively (Fig 6(a)).

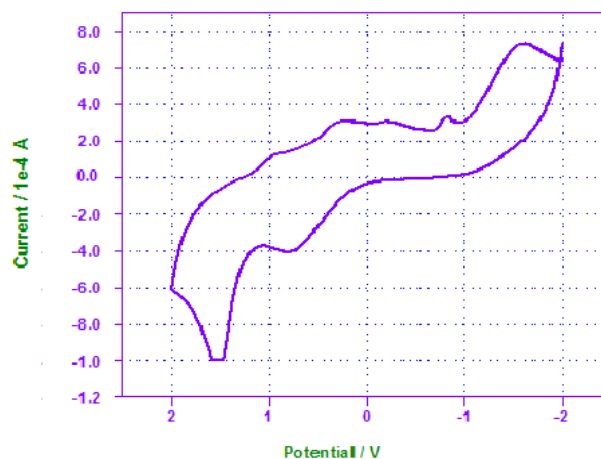


Figure 6[b] CV study for compound DIPBA in 0.001N HCl

The cyclic voltammetric study of the compound DIPBA in 0.01 N HCl was carried out in the potential range of +2.0 to -2.0V. In the forward scanning a three cathodic process were found to take place at +0.25V, -0.95 and -1.75V. The peak currents i_{pc} were found to be +2.5,

+2.95 and +7.5. In the reverse scan, one anodic process is taking place at +1.25V with the peak current i_{p_c} -4.0 (Fig 6(b)).

REFERENCES:

1. Heyrovsky J. Reproduction of. *Chemické Listy*. 16; 1922: 256.
2. Teixeira JG, Dias CB and Teixeira DM. *Electroanalysis*. **21**; 2009: 2345.
3. Bozal B, Uslu B and Ozkan SA. *Int.J.Electrochem*. **1**; 2011.
4. Uslu B, Ozkan SA and Senturk Z. *Anal. Chim. Acta*. **555**; 2006: 341.
5. Linklater, Natalie, and Banu Örmeci, *Monitoring Water Quality*. 2013.
6. Kemula W and Kublik Z, *Nature*, **182**; 1958: 793.
7. Adams RN, Published by Marcel Dekker, Inc, 1968.
8. Jacob Hooka, David Hinks and Harold Freeman color. *Technol*. 118(1); 2002: 32.
9. Boblut JM, Wills and John P, *J.Org.Chem*. 45; 1980:1978
10. Nelson, Stephan R, Kessel Carl, Brien and David J, *J. Org.Chem*. 45; 1980: 2116.
11. Powers J, Michael, Meta and Thomas J, *J. Am.chem Soc*. 102; 1980: 1289.
12. Wudarska E, Chrzescijanska E, Kusmierek E and Rynkowski J, *Electrochim. Acta*. 93; 2013: 189.
13. Masek A, Chrzescijanska E and Zaborski M, *Electrochim. Acta*. 107; 2013: 441.
14. Enache T A and Oliveira Brett A M, *Bio electrochemistry*. 81; 2011:46
15. Umuhumuza L C and Sun X, *Eur. Food Res. Technol*, 232; 2011: 425
16. Prasad K S, Muthutaman G and Zen J M, *Electroanalysis*. 20; 2008: 1167.
17. Feng Z, Li M, Yan Y, Jihai, T, Xiao L and Wei Q, *Tetrahedron, Asymmetry*, 23; 2012:411.
18. Abbaspour A and Ghaffarinejad A, *Electrochim. Acta*. 53; 2008: 6643.
19. Masek A, Chrzescijanska E and Zaborski M, *Food Chem*. **148**; 2014: 18.
20. Yardim Y, *J. Food Sci*. **77**; 2012: C408.
21. Safavi A, Ahmadi R and Mahyari F A, *Amino Acids*. **46**; 2014: 1079.
22. Chrzescijanska E, Wudarska E, Kusmierek E and Rynkowski J, *J. Electroanal. Chem*. **713**; 2014: 17.
23. Krishnan C V and Garnett M, *Int. J. Electrochem.Sci*. **6**; 2011: 3607
24. Komorsky-Lovric S and Novak I, *J. Food Sci*, **76**; 2011: C916.
25. Luo R, Zhang W, Cheng W, Zhao D, Li Y, Lin X, Dong F and Ding S, *Int. J. Electrochem. Sci*. **8**; 2013: 3186.
26. Telsnig D, Terzic A, Krenn T, Kassarnig V, Kalcher K and Ortner A, *Int. J. Electrochem. Sci*. **7**; 2012: 6893.
27. Skrzypek S, Mirčeski V, Ciesielski W, Sokolowski A and Zakrzewski R, *J. Pharm. Biomed. Anal*. **45**; 2007: 275.