



## Polarographic Studies of Ascorbic Acid and Estimation in Pharmaceutical Formulations and Fruit Juices

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### ABSTRACT

DC polarographic method was developed for estimation of ascorbic acid (vitamin C) in pharmaceutical formulations. Parameters like concentration of supporting electrolyte, maximum suppressor, pH, mercury flow rate and drop time were optimized. Under optimum conditions, a well-defined sigmoid curve was observed with diffusion current proportional to the concentration of ascorbic acid. Analytical quality control was carried out with determination of relative mean deviation, standard deviation and regression studies. The method was found to be simple, rapid and reproducible. The optimized method was applied to various pharmaceutical formulations available in local market. The results obtained were found to be in agreement with the certified values.

**Keywords:** Ascorbic acid, Polarography, Pharmaceutical formulations.

### INTRODUCTION

Ascorbic acid is naturally occurring organic compound with anti-oxidant properties. It is commonly known as Vitamin C. Ascorbate usually acts as an antioxidant. Typically it reacts with oxidants such reactive oxygen species, such as the hydroxyl radical formed from hydrogen peroxide. Such radicals are damaging to animals and plants at the molecular level due to their possible interaction with nucleic acids, proteins, and lipids. Sometimes these radicals initiate chain reactions. Ascorbate can terminate these chain radical reactions by electron transfer.

Common analytical techniques being used for the determination of ascorbic acid include spectrophotometry<sup>1,2</sup>, HPLC<sup>3</sup>, flow injection analysis<sup>4,5</sup>, ion exchange<sup>6</sup>, turbidimetry<sup>7</sup> and fluorimetry<sup>8</sup>. Polarographic and voltammetric techniques have been widely used in pharmaceutical analysis.<sup>9,10</sup> This paper describes the polarographic investigations of ascorbic acid and its estimation in various marketed formulations and fruit juices.

### MATERIALS AND METHODS

#### Apparatus

Polarographic studies have been carried out using Elico polarograph CL 25D attached with Elico XY-recorder. The electrode system consisted of dropping mercury electrode (DME) as working electrode and saturated calomel electrode (SCE) as a reference electrode. Saturated KCl salt bridge has been used for connecting the electrode systems. Height of mercury column was adjusted to get a flow rate of about 20 drops per minute. Nitrogen gas was used for deaeration and micropipette was used for addition of ascorbic acid solution. Mercury was purified by aeration method and then distilled under

reduced pressure. The pH of the solutions were measured with the help of ELICO (Model LI-10) pH meter operating on 220 V stabilized AC mains. The electrode assembly was a glass-calomel supplied by the manufacturer. The pH meter was standardized every time before use with potassium hydrogen phthalate buffer (pH 4.0). Suitable temperature compensation adjustments were made. An electrically operated single pan balance, Mettler model H51AR, with least count of 0.01 mg was used for weighing purposes.

#### Reagents and Solutions

All the chemicals used were of AR grade and the solutions were prepared in double distilled water. Stock solution ascorbic acid was prepared by dissolving appropriate weight and desired dilutions were made as per the requirements. Stock solutions of maximum suppressor and various buffers were prepared by dissolving required amounts in double distilled water.

#### General procedure

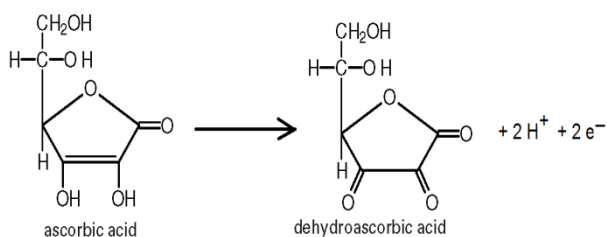
In each determination, 25 mL of biphthalate buffer with 0.25% oxalic acid solution was taken and 1 ml maximum suppressor was added. pH was adjusted using dilute NaOH and HCl solutions. Desired volume of ascorbic acid solution was added and deaerated with nitrogen gas for 15 minutes. Polarograms were recorded using optimized conditions.

### RESULTS AND DISCUSSION

Polarographic studies were carried out using different buffer systems as supporting electrolytes. It was found that the value of half wave potential as well as diffusion current changes with change in supporting electrolyte (Table 1). Among these buffer systems, the biphthalate buffer was found to give a well-defined polarographic wave with half wave potential of 0.150 V.



The oxidation wave of ascorbic acid is due to two-electron oxidation to dehydroascorbic acid as:



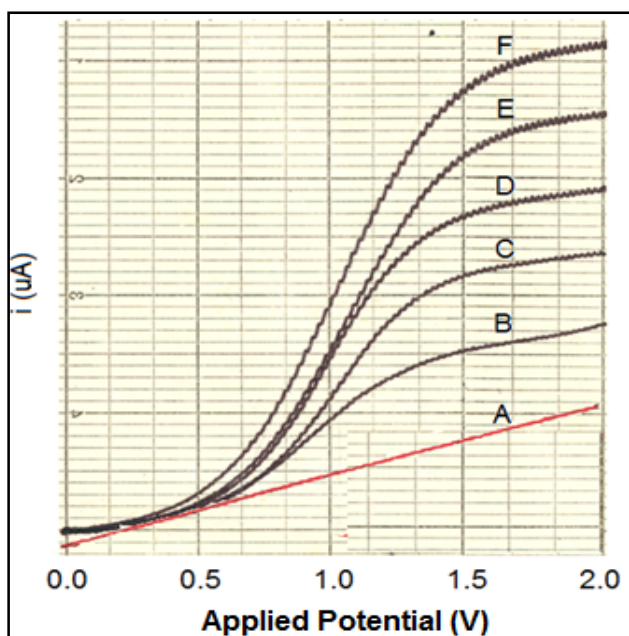
The pH of the buffer system was varied from 2.25 to 9.5. It was observed that the half wave potential goes on decreasing with increase in pH resulting in cathodic shift with increase in pH. No polarographic wave was observed above pH 4.5. A well-defined polarographic wave with half wave potential 0.105 V was observed at pH 4.1 which was selected for further studies.

Effect of maxima suppressors like gelatin, triton-X 100, bromocresol green, methyl thymol blue, methyl red, etc was studied. It was observed that the current wave is highly reproducible when 0.008% gelatin solution is used as a maximum suppressor.

Instrumental conditions like mercury flow rate, scan rate etc were adjusted to get a sharp single wave with high reproducibility. Under optimum conditions of pH, maxima suppressor, mercury flow rate and scan rate, the diffusion current was found to be directly proportional to the concentration of ascorbic acid. The regression coefficient was found to be 0.9996 with equation of regression line  $y_{(\mu A)} = 0.0748x_{(mg/L)} - 0.0259$ . The  $3\sigma$  detection limit was found to be  $2 \text{ mg L}^{-1}$ . Typical polarograms obtained under optimum conditions have been shown in Figure 1.

**Table 1:** Polarographic Behaviour of Ascorbic Acid in different media

Supporting Electrolyte	$E_{1/2}$ against SCE (V)	Diffusion Coefficient ( $\text{cm}^2 \text{sec}^{-1}$ )	Diffusion current constant ( $i_d/\text{cm}^{2/3} \text{t}^{1/6}$ )
Biphthalate buffer	+ 0.105	$5.7 \times 10^{-6}$	3.00
Phosphate buffer with 1.5% metaphosphoric acid	+0.217	$6.2 \times 10^{-6}$	3.04
Biphthalate buffer with 0.25% oxalic acid and 50% ethanol	+0.060	$3.6 \times 10^{-6}$	2.34
Biphthalate buffer with 3% HPO3	+0.240	$5.3 \times 10^{-6}$	2.88



**Figure 1:** Typical polarograms of ascorbic acid at different concentrations (A) Blank (B)  $26 \text{ mg L}^{-1}$ , (C)  $35 \text{ mg L}^{-1}$ , (D)  $44 \text{ mg L}^{-1}$  and (E)  $53 \text{ mg L}^{-1}$  ascorbic acid

#### Application

The developed method was applied to the determination of ascorbic acid in various pharmaceutical formulations in the local market and three fruit samples. The quoted and

observed values for the pharmaceuticals have been shown in Table 2 while those for the fruit samples have been presented in Table 3. The observed values agree with the reported values in most of the samples. Also, presence of other components does not interfere with estimation of ascorbic acid.

**Table 2:** Determination of Ascorbic Acid in pharmaceutical formulations

Medicinal Sample	Amount of Ascorbic Acid (mg)	
	Reported value	Observed value*
Polybion Tablet	150	$146.3 \pm 3.2$
Basiton Forte Tablet	150	$140.1 \pm 4.8$
Beplex Forte Tablet	150	$128.6 \pm 3.9$

\*(Avg $\pm$ SD) of 3 values

**Table 3:** Determination of Ascorbic Acid in Fruit Juices

Fruit	Amount of Ascorbic Acid ( $\text{mg L}^{-1}$ )
Lemon	$372 \pm 8$
Orange	$458 \pm 6$
Grapes	$390 \pm 11$

\*(Avg $\pm$ SD) of 3 observations

## CONCLUSION

The developed method was rapid, simple, reproducible and accurate. It could be applied to various pharmaceutical formulations and fruit samples. The Standard deviation, relative mean deviation and coefficient of variation are found to be 0.97, 3.2% and 3.5% respectively. An important advantage of the method is that it is possible to determine concentration of ascorbic in the presence of other commonly occurring ingredients.

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