

# Promethazine an Environmental Friendly Reagent for Novel Spectrophotometric Method Estimation of Hypochlorite in Different Environmental Samples



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**Submission:** July 18, 2019; **Published:** November 05, 2019

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## Abstract

A simple, rapid and accurate spectrophotometric method has been developed for the determination of hypochlorite using promethazine. The proposed method reports the reaction of hypochlorite with promethazine in acid medium to form a red colored product with an absorption maximum at 517 nm. Beer's Law was obeyed in the range of 1-10  $\mu\text{g/ml}$  with molar absorptivity of  $0.382 \times 10^4 \text{ L.mol}^{-1}\text{.cm}^{-1}$  and sandell sensitivity  $0.0195 \mu\text{g/cm}^2$ . The relative standard deviation of the method was less than 2% and accuracy (average recovery) was  $100 \pm 1.7\%$ . The optimum conditions for all color development are described and the proposed method has been successfully applied for the determination of hypochlorite in drinking tap water and household bleaching samples.

**Keywords:** Hypochlorite ion; Spectrophotometric; Drinking tap water; Household bleaching samples; Iodimetric; Potentiometric; Promethazine; Water chlorination; Microorganisms; Beam spectrophotometer

## Introduction

Sodium hypochlorite ( $\text{NaOCl}$ ) is a compound that can be effectively used for water treatment and purification. It is used on a large scale for odor removal, bleaching, disinfection, and surface purification [1]. Water chlorination has been the most common disinfectant methods used by waters suppliers [2]. Chlorine is an efficient agent for inactivating several types of microorganisms, it has been preferred as a disinfecting agent to assure the bacteriological quality of the drinking water [3]. The water bacterial contamination also occur in the distribution network; therefore, to prevent this occurrence, a free chlorine residual in excess of  $0.2 \text{ mg L}^{-1}$  must be maintained throughout the distribution lines [3]. Various analytical methods have been utilized for the determination of  $\text{NaOCl}$ . Some of the examples were colorimetric [4]. iodimetric [5-7]. chemiluminisces [8,9]. potentiometric [10]. spectrophotometric methods [11-14]. potentiometric [15]. and flow injection methods [16,17]. In this work, we intend to develop a spectrophotometric procedure for the determination of residual hypochlorite in drinking tap water and household bleaching samples using promethazine.

## Experimental

### Apparatus

Spectro Uv / visible dual beam spectrophotometer [UVS-2700, Labomed, INC] with 1.0 cm quartz cells and Genway 3310 pH meter were used.

### Reagents

All chemicals used were of analytical purity grade and all solutions were prepared in distilled water. A sodium hypochlorite stock solution (0.01%) was prepared by dilution of 0.25 ml of 4 % sodium hypochlorite to 100 ml by distilled water, store in a dark bottle and standardized every 4-5 days. This solution stored in a dark bottle [18,19]. Standard solution of sodium hypochlorite (10ppm). This solution was prepared by diluting 10 ml of the stock solution to 100 ml by distilled water in a volumetric flask. Promethazine hydrochloride solution 0.01% was prepared by dissolving 0.01g of Promethazine hydrochloride in 100ml distilled water in a volumetric flask. Sulfuric acid 0.1M, this solution was prepared by diluting 1.4 ml of 18 M  $\text{H}_2\text{SO}_4$  solution to 250 ml by distilled water in a volumetric flask.

### Recommended Procedure

Aliquots of standard solution of hypochlorite (1-10 $\mu$ g) were transferred into a series of 25 ml calibrated flasks, added 1 ml of 0.1M sulfuric acid solution and 5 ml of 0.01% Promethazine hydrochloride solution, dilute the solution to the mark with distilled water. The absorbance of the red-colored product was measured at 517 nm against a reagent blank.

### Sampling

Drinking water samples were taken from tap water in Mosul city. After the water samples were transported to the laboratory, hypochlorite ion analyses were performed immediately. The household bleach samples of different brands were purchased from local markets.

### Procedure for the determination of hypochlorite in tap water samples

An aliquot of tap water samples containing not more than 10 $\mu$ g of hypochlorite was transferred to a 25 mL calibrated flask

and the hypochlorite content was determined as mentioned under recommended procedure.

### Procedure for the determination of hypochlorite in household bleach

1.0 ml of the household bleach solution was transferred to a 100 mL calibrated flask, dilute the solution to the mark with distilled water. From this solution take 1 mL and diluted to 100 ml by distilled water in a volumetric flask, and aliquot of this solution was treated as described above for recommended procedures.

### Results and Discussion

Promethazine hydrochloride is oxidized in sulfuric acid medium with sodium hypochlorite solution instantaneously at room temperature to form a red-colored product which is believed to be a radical cation and is irreversibly oxidized to a colorless sulfoxide with loss of electron [20], as shown below.

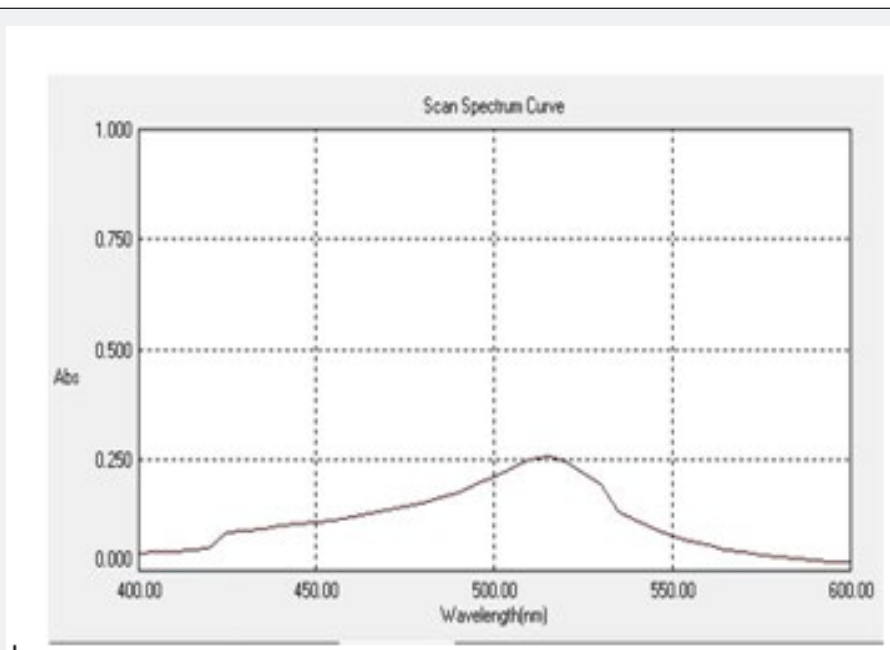
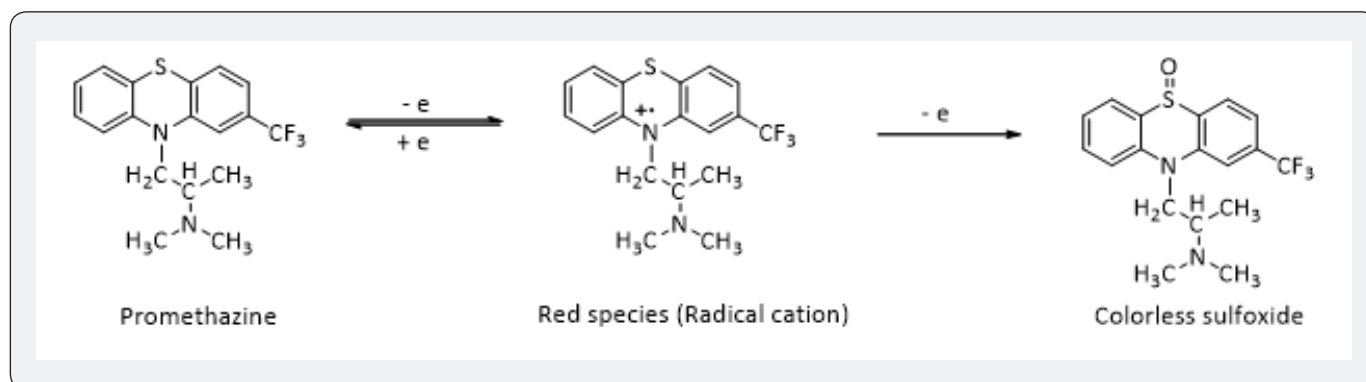
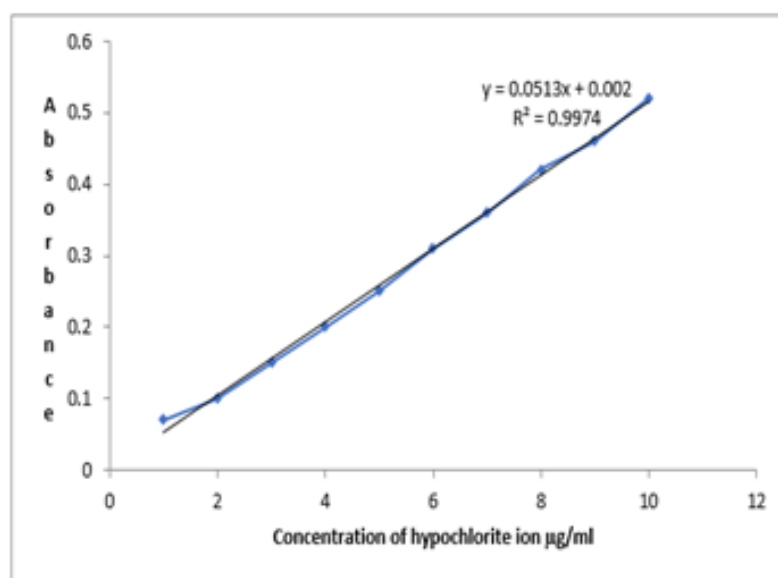


Figure 1: Absorption Spectra of 5 $\mu$ g/ ml of Hypochlorite-promethazine Product Against Blank.

The red-colored radical cat ion shows maximum absorbance at 517 nm, where the blank does not absorb appreciably, as shown in (Figure 1).

The reaction variables were optimized by varying each variable while keeping others constant for obtaining maximum absorbance. The oxidation reaction was found to be quantitative in acetic acid medium. It was found that 1 ml of 0.1 M sulfuric acid solution give high sensitivity and this amount has been used for subsequent experiments. The effect of the amount promethazine on the absorbance was investigated. A maximum and constant absorbance was found with 3 to 6 ml of 0.01% promethazine solution and 5 ml has been used for subsequent experiments. The color reaction occurred at room temperature

immediately and remained stable for at least 24h. and a reaction time of 5 min was selected for reproducible results. under the experimental conditions described, Beer's law is obeyed over the concentration range 1-10 µg/ml (Figure 2). with correlation coefficient of 0.9974, intercept of 0.002 and slope of 0.0513. The conditional molar absorptivity of the product formed and sandell's sensitivity was found to be  $0.382 \times 10^4$  L.mol<sup>-1</sup>.cm<sup>-1</sup> and 0.0195µg/cm<sup>2</sup> respectively. The accuracy and precision of the method was established by analyzing the standard hypochlorite solution at three different levels. The average recovery which is a measure of accuracy is  $100 \pm 1.7$  revealing high accuracy of the method. The relative standard deviation (RSD), which is an indicator of precision is better than  $\pm 2\%$ . The results are compiled in (Table 1).



**Figure 2:** Calibration Graph of Hypochlorite.

**Table 1:** Optical Characteristics and Statistical Data of the Proposed Method.

Parameters	Value
$\lambda$ max (nm)	517
Beer's law limit ( $\mu\text{g} \cdot \text{ml}^{-1}$ )	1-10
Molar absorptivity (L.mol <sup>-1</sup> .cm <sup>-1</sup> )	$0.382 \times 10^4$
Correlation coefficient ( $r^2$ )	0.9974
Regression equation ( $Y = a \times + b$ )	
Slope (a)	0.0513
Intercept (b)	0.002
Recovery %	$100 \pm 1.7$
Relative standard deviation (%)	$< \pm 2\%$

### Application to Real Samples

To demonstrate the practical applicability of the proposed method, drinking tap water samples collected from left station

of Mosul water-supply network of Mosul city. The samples were collected in plastic canes of 1 Liter capacity without of any air bubbles. The results were also compared statistically by student

t-test with those obtained by standard method at 95% confidence level. The calculated t- values did not exceed the theoretical values indicating that there were no significant differences between the precision of the proposed and literature method as cited in (Table 2). For the determination of hypochlorite ion

in household bleach samples. twelve type of household bleach samples of different brands were purchased from local markets and analyzed by the proposed and standard methods; the results were cited in (Table 3).

**Table 2:** Determination of Hypochlorite Ion in Drinking Tap Water Samples.

Sample	Amount of Hypochlorite $\mu\text{g/ml}$ *		
	Proposed Method	(DPD) Standard Method	T-Value
Tap water	4.5	4.3	1.45

\*Average of Ten Determinations.

T values (n=10, at 95% Confidence Level Tabulated Value 2.101).

**Table 3:** Determination of Hypochlorite in Different Household Bleach Samples.

Sample	Amount of Hypochlorite % *		
	Proposed Method	DPD Standard Method	T-Value
1-Aylux/Turkey/Atasy kamy Com.	4.89	4.91	1.68
2- Sehat bleaching liquid /Iran /Industrial and commercial Com	3.9	3.95	0.99
3-Fas / bleaching liquid /Iraq / Detergent babil Com.	4.1	4.08	0.88
4-Top Rox/Syria/Sugar company for chemical industries	3.88	3.9	0.96
5- Noura /Syria/Madar for chemicals Com	4.06	4.08	0.63
6- Altunsa/ Turkey / (SYA) Com.	5.12	5.14	0.99
7-Chlormax/U.A. E/Sunshine Com	5.22	5.23	1.12
8- Chlorox/Saudi Arabia/ National cleaning product. Com	5.22	5.19	1.65
9-Peros/Turkey/Shopy produc Com	4.14	4.12	1.84
10- Clorite/U.A. E/Pana star. Com	4.88	4.91	0.66
11-Shoof/Iraq /Shoof Com	4.1	4.12	1.93
12-Al-Jazeera/Iraq/Super almas. Com	4.42	4.44	0.87

\*Average of Ten Determinations.

T values (n=10, at 95% Confidence Level Tabulated Value 2.101).

### Conclusions

For the first time, promethazine has been used as a chromogenic reagent for the spectrophotometric determination of hypochlorite. The proposed method, which is simple and rapid, offers the advantages of sensitivity and wide range of determinations without the need for extraction or heating. The method does not involve any stringent reaction conditions and can be compared favorably with the other methods. The proposed method has been successfully applied to the determination of hypochlorite in various samples.

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DOI: [10.19080/RAPSCI.2019.06.555700](https://doi.org/10.19080/RAPSCI.2019.06.555700)

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