

# Estimation of Available Oxygen in Powder Form of Oxygen Releaser in Henna Based Hair Dyes

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## Abstract

*Cream based hair colour offers the hydrogen peroxide as an oxidizing agent, it promote the oxidation of hair dyes and helps to deliver the desired colours. Henna based powder of hair dyes containing the inorganic peroxides. Inorganic peroxides namely barium peroxide, calcium peroxide, magnesium peroxide, sodium perborate mono hydrate, sodium perborate penta hydrate etc., used as an oxidizing agent; whenever the inorganic peroxides reacts with water it releases the oxygen. Inorganic peroxide reaction mechanisms are similar to hydrogen peroxide. Articles deals about the estimation of available oxygen in barium peroxide, sodium perborate and calcium peroxide in powder hair dyes. Theoretical value and estimated values are match together and having higher regression coefficient values. Calcium peroxide releases more amount oxygen when compared to the sodium perborate and barium peroxide. Around 10% of calcium peroxide incorporation henna based hair dye formula it releases the 1.6 % of available oxygen; however, around 20% of barium peroxide incorporated in the formula releases 1.5% of available oxygen. This study is a viable tool for the formulator for adjusting the available oxygen content. This article confirms that among the powder form of oxidizing agent, calcium peroxide releases higher amount of oxygen and also having the high purity. Therefore the incorporation of calcium peroxide in henna based formula delivers the superior colour and produces the long lasting colour with low price.*

**Keywords:** *Iodimetric method, calcium peroxide, barium peroxide, sodium perborate, available oxygen, henna based powder hair dyes*

## I. INTRODUCTION

Henna based powder colors very much pronounced by people, because of herbal connectivity and safety aspects. In normal market leading cream colours offers the hydrogen peroxide as an oxidizing agent and cream colour containing two components; one is a cream and it containing dyes material,

emollient, anti oxidant and alkali (ammonia). Another component called as a developer, the name itself indicates that function, it helps to develop the reaction; cream and developer mixed together for the colour development. During mixing time, the oxygen released from the hydrogen peroxide and promotes the dye material oxidation and initiates the coloring reaction step. Henna based hair colour containing the powder form of oxygen releaser like potassium perborate, sodium perborate and ammonium perborate, other perborate, potassium percarbonate, sodium percarbonate and other percarbonate, potassium persulfate, sodium persulfate and other persulfates, potassium percarbamide, sodium per carbamide and other percarbamide; barium peroxide, calcium dioxide and others salts of oxides etc. Estimation of releasable oxygen is essential for the colour delivery process. The iodimetric titration easily determines the available oxygen content in hydrogen peroxide. Hydrogen peroxide titrated against the  $\text{KMnO}_4$  and the end point is appearance of pink colour. However in henna based hair colour is complicated one, herbal material obstruct the end point of regular iodimetric titration. Herbal materials obstruct/hinder the end point appearance. This article aim to develop the new methods of available oxygen estimation in henna based powder colours. Articles deals with three powder form of oxygen releaser namely barium peroxide; sodium perborate mono hydrate and calcium peroxide. Estimation of available oxygen will be immense useful to adjust the formula against the colour delivery and frame the dosage of powder form of oxygen releaser. Many scientists worked the estimation of hydrogen peroxide and powder oxygen releaser in detergent filed ([1], [2], [3],[4]). Many researcher work the inorganic peroxides in agriculture field because the inorganic oxides releases the oxygen and it help to cure the contaminated soil ([5],[6] [7],[8]). However, the data available for henna based hair colour is meager and need to be documented. This article completely patches up the grey area of estimation of available oxygen in henna based hair colour system.

## II. MATERIALS AND METHODS

### A. Estimation of available oxygen in barium peroxide based henna hair colour

Take accurately 0.2 gm of henna hair colour in volumetric flask and dissolved with 20 mL of water and then add 10 mL of concentrated hydro chloric acid added for initiating the reaction. Add 2 gm of potassium iodide to the mixture and shake thoroughly and kept for 15 minutes for reaction in dark place. The solution titrated against sodium thio sulphate (0.1 N), the solution turn in to pale yellow colour, at that time add 2 ml of freshly prepared starch solution and continue the titration against sodium thio sulphate (0.1N); the solution turn into the blue colour. The end point is disappearance of blue colour.

### B. Estimation of available oxygen in sodiumperborate based henna hair colour

Take accurately 0.2 gm of henna hair colour in volumetric flask and dissolved with 20 mL of water and then add 10 mL of concentrated sulphuric acid added for initiating the reaction. Add 2 gm of potassium iodide to the mixture and shake thoroughly and kept for 15 minutes for reaction in dark place. The solution titrated against sodium thio sulphate (0.1 N), the solution turn in to pale yellow colour, at that time add 2 ml of freshly prepared starch solution and continue the titration against sodium thio sulphate (0.1N); the solution turn into the blue colour. The end point is disappearance of blue colour.

### C. Estimation of available oxygen in calcium peroxide based henna hair colour

#### 1. Acid mixture preparation:

12.5 % of orthophosphoric acid (85%) and 12.5 % of concentrated hydro chloric acid (37%) mixed and then add 75% of water to mix together. The concentrated acid mixture used for the catalyst for the calcium peroxide.

Take accurately 0.2 gm of henna hair colour in volumetric flask and dissolved with 25 mL of above mentioned acid mixture for initiating the reaction. Add 2 gm of potassium iodide to the mixture and shake thoroughly and kept for 10 minutes for reaction in dark place. The solution titrated against sodium thio sulphate (0.1 N), the solution turn in to pale yellow colour, at that time add 2 ml of freshly prepared starch solution and continue the titration against sodium thio sulphate (0.1N); the solution turn into the blue colour. The end point is disappearance of blue colour.

## III. RESULTS AND DISCUSSION

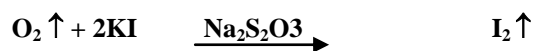
### A. Estimation of available oxygen in barium peroxide

Barium peroxide falls under the inorganic oxide group and it having the atomic weight of 169.33; it completely decompose/dissolve in presence concentrated hydro chloric acid solution. It further reacts with water liberates the oxygen molecule. Liberated oxygen molecule estimated by iodimetric titration. Reaction steps are as below;

Step 1:



Step 2:



In step 1, barium hydroxide reacts with water in the presence of acid medium it liberates the oxygen and forms a barium hydroxide. Commercial grades of barium are available with 80 % purity and liberates the 7.0 – 8.0 % available oxygen; initially we have tested the 20% of barium peroxide in the formula with iodimetric titration and it liberates 1.5% of available oxygen; the accuracy level done with five different weights and we get the standard deviation of available oxygen estimation is  $1.542 \pm 0.0414$

Liberated oxygen estimated against the iodimetric titration. The amount of iodine liberated directly proportional to the amount of oxygen liberation. Concentration of barium peroxide increases the releasable oxygen increases. The experiment was carried out with different percentage barium peroxide and gets the different available oxygen and it plotted in below mentioned graph. Study results indicated that the methods are having high accuracy and got the regression coefficient is  $r=0.9986$ . Below mentioned formula used for the estimation of available oxygen; Available oxygen (%) = 0.8 X burette reading X Normality of thio / weight of the sample 0.8 correction factor included for the oxygen

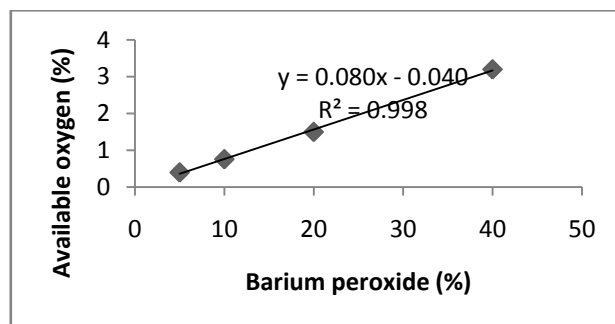
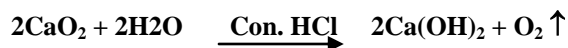


Figure 1. Estimation of available oxygen content in henna based hair colour (Barium peroxide)

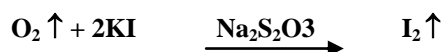
**B. Estimation of available oxygen in calcium peroxide**

Calcium peroxide fall under the inorganic oxide group and it having the atomic weight of 72.077; it completely decompose/dissolve in acid mixture described in materials and method section. It further reacts with water liberates the oxygen molecule. Liberated oxygen molecule estimated by iodimetric titration. Reaction steps are as below;

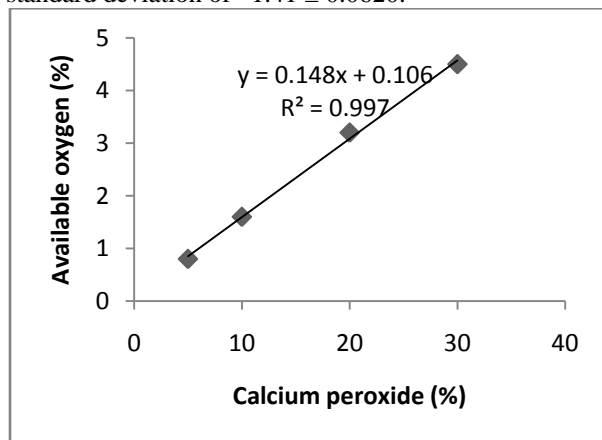
Step 1:



Step 2:



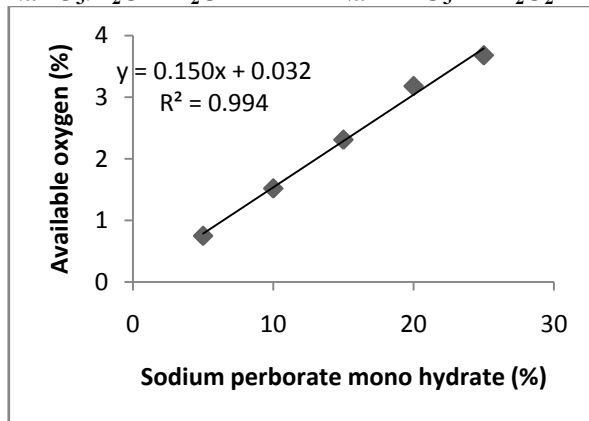
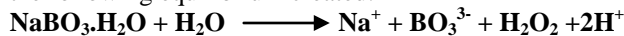
In step 1, calcium peroxide reacts with water in the presence of acid medium it liberates the oxygen and forms a calcium hydroxide. Liberated oxygen estimated against the iodimetric titration. The amount of iodine liberated directly proportional to the amount of oxygen liberation. Concentration of calcium peroxide increases the releasable oxygen increases. The experiment was carried out with different percentage calcium peroxide and gets the different available oxygen and it plotted in below mentioned graph. Study results indicated that the methods are having high accuracy and got the regression coefficient is  $r=0.9974$ , and formula containing around 10% of calcium dioxide and it release around 1.4% available oxygen, the same experiments conducted with different weights and the different titration value having the standard deviation of  $1.41 \pm 0.0620$ .



**Figure 2. Estimation of available oxygen content in henna based hair colour (Calcium peroxide)**  
*Estimation of available oxygen in sodium perborate monohydrate*

Sodium perborate is a reservoir of available oxygen /active oxygen supplier in detergents, laundry products, cleaning products, bleaches and hair colour dyeing segment. In recent years sodium perborate monohydrate also used in oral care for tooth bleaching / whitening agent. It having the atomic weight of 99.815 g and the chemical structure is  $\text{NaBO}_3 \cdot \text{H}_2\text{O}$ . The experiments carried out with different percentage of sodium perborate monohydrate and get the different available oxygen and it plotted in below mentioned graph. Study results indicated that the methods are having high accuracy and got the regression coefficient is  $r=0.994$ , and formula containing around 15% of sodium perborate and it release around 2.3% available oxygen, the same experiments conducted with different weights and the different titration value having the standard deviation of  $2.34 \pm 0.0531\%$ .

Sodium perborate monohydrate (CAS No. 10332-33-9) is a dimer that is bonded together by genuine peroxygen bonds. In an aqueous solution at pH7, hydrogen peroxide and sodium borate created and the following equilibrium created:



**Figure 3. Estimation of available oxygen content in henna based hair colour (sodium perborate mono hydrate).**

Many scientist proved that the concentration of peroxide content increases directly proportional to the increment value of available oxygen ([9], [10], [11]). Calcium peroxide is an environmentally friendly oxygen generator for the many organic synthesis reaction mechanism [9]. Recent studies revealed that calcium peroxide is more effective oxygen releaser than hydrogen peroxide it, release more amount of oxygen when compared to barium peroxide and sodium perborate [10]. Similar kind of observations noticed, in this study calcium hydroxide releases more amount oxygen when compared to the sodium perborate and barium peroxide. Theoretical value and estimated values are summarized in the below table;

**Table 1. Theoretical and estimated available oxygen comparison in powder oxidizing agent used in henna hair colour**

| Oxidizing agent              | Available oxygen (%) | Addition % in henna based product | Theoretical value of available oxygen | Estimated value of available oxygen (%) |
|------------------------------|----------------------|-----------------------------------|---------------------------------------|---|
| Barium peroxide              | 7.0 – 8.0            | 10.00                             | 0.75                                  | 0.771 ( $\pm$ 0.0281)                   |
| Barium peroxide              | 7.0 – 8.0            | 20.00                             | 1.50                                  | 1.542 ( $\pm$ 0.0414)                   |
| Calcium peroxide             | 14.0 – 16.0          | 5.00                              | 0.70                                  | 0.73 ( $\pm$ 0.0240)                    |
| Calcium peroxide             | 14.0 – 16.0          | 10.00                             | 1.4-1.5                               | 1.41 ( $\pm$ 0.0620)                    |
| Sodium perborate monohydrate | 14.0 – 16.0          | 10.00                             | 1.4-1.5                               | 1.42 ( $\pm$ 0.0549)                    |
| Sodium perborate monohydrate | 14.0 – 16.0          | 15.00                             | 2.30                                  | 2.34 ( $\pm$ 0.0531)                    |

Values in the parenthesis value indicated the standard deviation of five titrations with different weights

Around 10% of calcium peroxide incorporation henna based hair dye formula releases the 1.6 % available oxygen; however, around 20% of barium peroxide formula releases 1.5% of available oxygen. In addition to that, the purity of calcium dioxide is higher than barium peroxide and sodium perborate, 80% of purity calcium peroxide are available commercially ([5], [12]); due to the high purity, it releases higher amount of oxygen when compared to the barium peroxide and also less expensive. This study is a viable tool for the formulator for adjusting the available oxygen content. This article confirms that among the powder form of oxidizing agent, calcium peroxide releases higher amount of oxygen and also having the high purity. Therefore the incorporation of calcium peroxide in henna based formula delivers the superior colour and produces the long lasting colour.

#### IV. CONCLUSION

Estimation of available oxygen in henna based hair colour by iodimetric titration is simple one. It is a rapid and accuracy method; sophisticated instruments & specialty chemicals not needed for the estimation. It is cost effect method for the determination of available oxygen and also easy implementation in factory level, and it will be immense useful for formulator for adjusting the oxidizing agent in the formula.

#### ACKNOWLEDGEMENT

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