

# Determination of Sulphate and Phosphate Levels in Selected Toothpaste Found on the Ghanaian Market

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**Abstract:** From the analysis of the various brand toothpaste samples, it was found that the level of sulphate concentration in the toothpaste sample tends to be the same with slight variation. The highest level of sulphate level was 150mg/L for pepsodent. HI. HI senior, Hi.Hi Junior, Orafresh, Aquafresh, Crest and Close up had sulphate concentration of 100mg/l. Colgate Herbal had sulphate concentration of 80mg/L. The level of sulphate concentration decreased to 40mg/L in Colgate. The concentration of sulphate in various toothpaste samples fell far below detection point on the calibration curve, which implies they were relatively lower concentration of sulphate dissolved in various selected brand but, according to research reports zero concentration is preferable. It was also found that the level of phosphate in the toothpaste sample tends to be the same with slight variation. The highest level of phosphate level was 0.25mg/L for Colgate herbal. Hi-Hi Senior had phosphate concentration of 0.20mg/L. Pepsodent, Orafresh Aquafresh and Close up were 0.19mg/L each. The level of phosphate decreased to 0.14mg/L in Hi-Hi Junior and crest. The level of phosphate in various brand of toothpaste in within 0.14mg/L to 25mg/L may be acceptable but the level can still be brought down to reduced abrasiveness. level of phosphate from the various brand toothpaste was between 0.14mg/L to 0.25mg/L. From the world health organization (WHO) standard level of phosphate concentration in water is 0.3mg/L and this implies that the toothpaste from selected brand toothpaste is not rich with respect to phosphate.

**Keywords:** Tooth paste, Sulphate, Phosphate, Concentration, Ghanaian market. Close-up, Colgate.

## I. INTRODUCTION

Toothpaste is one form of dentifrice preparation and others being powder, cake, or liquid. It is a paste or gel used to clean and improve the aesthetic appearance and health of teeth. It is almost always used in conjunction with a toothbrush. Toothpaste use can promote good oral hygiene: it can aid in the removal of dental plaque and food from the teeth, it can aid in the elimination and/or masking of halitosis, and it can deliver active ingredients such as fluoride to prevent tooth and gums (Gingiva) disease. Most people consider toothpaste a necessity and use it at least once a day. Toothpaste has also been reported to be useful for the treatment of scratches on the plastic surface of a CD. As it is

a mild abrasive, the toothpaste buffs away the scratch so that the laser is able to read the information without interruption. [2]

Toothpaste can also be used quite effectively to remove fake tan streaks, especially from hands. Early writings of the Greeks, Buddhists, the Hebrew refer to the use of toothpicks, chewing sticks and sponges in hygienic teeth-cleansing rituals. For many years materials known to have been destroying the teeth, irritating the oral mucosa or detrimental to health were used. Among these were sulfuric and acetic acids, lead ores and impure, excessively abrasive materials. The cleaning of teeth has two facets. These are clinical and cosmetic aspects [1]. Clinically, it is beneficial to remove all the plaque or dental caries, material debris strongly adhered to the teeth and gums at least once a day. From the cosmetic viewpoint, it is required that the teeth be kept free of stain and other visible deposits. Apart from fulfilling these cleansing requirements, toothpaste may be also be used as carriers of therapeutic ingredients such as fluorides, phosphates, calcium and of flavoring agents which act as breathe fresheners which may, in some cases, slow down plaque formation and prevent dental disorders. Toothpastes typically contain abrasives (to remove debris and residual stain), humectants (to prevent loss of water), thickening agents or binders (to stabilize tooth-paste formulations and prevent separation of liquid and solid phases), and flavoring and foaming agents (a preference of consumers). Therapeutic agents include fluoride (contained in all ADA-Accepted toothpastes for reducing caries), potassium nitrate (to treat dentinal hypersensitivity), and triclosan or stannous fluoride (to reduce gingival inflammation). Other agents that may be added to toothpastes to provide esthetic benefits are pyrophosphates or zinc citrate (to prevent tartar buildup) and various abrasives or enzymes (to help whiten teeth). Toothpastes that whiten teeth work by chemically or mechanically removing stain. The outcome is stain removal without damage to the underlying tooth structure. Whitening toothpastes that remove surface stain should not be confused with bleaching agents that work by breaking down pigment to remove color from teeth [2].

The main objective of this work is to analyze and determine the sulphate and phosphate levels in toothpaste and to compare the various results with standards.

## II. MATERIALS AND METHODS

### A. Equipment and Apparatus

Beakers, Turbidometer, Conical flasks, Glass rod, Graduated flasks, Measuring cylinder, pipettes (25ml), test tubes, weighing balance, glycerol, 10 ml dropping pipettes, Funnel, Hot plate, Colorimeter.

### B. Reagents and Phosphate Determination

Dilute sulphuric acid, potassium antimony ttrate, ascorbic acid solution (0.1M), combined reagent, hydrolyzing acid solution, phosphorus standard solution, ammonium molybdate solution, Sodium tetraoxosulphate (vi) salt ( $\text{Na}_2\text{SO}_4$ ), Barium Chloride ( $\text{BaCl}_2$ ), Magnesium Carbonate  $\text{MgCO}_3$ .

### C. Preparation of Solutions for Phosphate

i. Dilute Sulphuric and Solution: 70ml of concentration  $\text{H}_2\text{SO}_4$  was dissolved in 400ml using distilled water. It was then cooled to room temperature and then diluted to 500ml using distilled water and stored in a glass bottle.

ii. Potassium Antimonyl Tartrate Solution 1.37g of ( $\text{KSbOC}_4\text{H}_4\text{O}_6$ ) was dissolved in 400ml distilled water and then diluted to 500ml using distilled water. It was stored in a dark bottle.

iii. Ascorbic Acid Solution (0.1M)

1.76g of ascorbic acid was dissolved in 100ml of distilled water and stored in stopped glass bottle.

iv. Ammonium Molybdate Solution

20g of  $(\text{NH}_4)_6\text{MO}_7\text{O}_{24}\text{H}_2\text{O}$  was dissolved in 500ml of distilled water.

v. Combined Reagent

Reagents (ii.) - (iv) were warmed to room temperature and were added in the following order 50ml. 5N  $\text{H}_2\text{SO}_4$ , 5ml K antimonyl tartrate solution, 15ml  $\text{NH}_4$  molybdate solution and 30ml ascorbic acid solution replaced just before use.

vi. Hydrolyzing acid solution: 310ml  $\text{H}_2\text{SO}_4$  was added drop by drop to 600ml distilled water. The solution was the cooled and then diluted to 1 litre.

### D. Preparation of Reagents for Sulphate

Barium Chloride Solution: This solution was prepared by dissolving 5g of anhydrous Barium Chloride in 1000ml distilled water in a graduated flask.

0.1M Hydrochloric acid solution: This solution was prepared by diluting 10ml of 1M HCl to 100ml with distilled water using a measuring cylinder and a 1-litre graduated flask.

Sodium Sulphate Solution: The  $\text{Na}_2\text{SO}_4$  solution was also prepared by dissolving 3g of anhydrous sodium sulphate in 500ml of distilled water in a conical flask.

### E. Sample Treatment

1g of each toothpaste were dissolved in 100ml of distilled water and then 0.5g of activated charcoal were added to remove the colour.

### F. Procedure for the analysis of Standard calibration curve for Sulphate.

In determining this, 3.0g of anhydrous sodium sulphate were dissolved in 500ml distilled water. Then, various concentrations of the sulphate were prepared from the stock solution by taking the following volumes and diluting them to 10ml each using test tube and 10ml pipette [i.e. 10, 9, 8, 7, 6, 5, 4, 2, 2, 1)/ml]. And to each of these solutions 1ml of 0.1M HCl was added followed by 1ml of freshly prepared  $\text{BaCl}_2$  solution. The solutions were each shaken and were allowed to stand for few minutes and their various absorbance's were measured using the colorimeter at 520nm. A calibration curve of absorbance against concentrations was then plotted.

### G. Determination of various Sample Concentrations.

In determining the levels of sulphate in each water sample, 10ml of each of the water samples were pipetted into test tubes and were treated as in the standard calibration curve analysis (as above). Their various absorbencies were measured at 520nm using the colorimeter and their corresponding concentrations were determined from the standard calibration curve.

### H. Preparation of Phosphorus Standard Solution. (Stock Solutions) 50mg/L.

$\text{KH}_2\text{PO}_4$  was dried at 105°C, dissolved and diluted to 1 litre using distilled water.

10ml of stock solution was diluted to 1 litre to prepare a solution of 0.5mg/litre known as the intermediate solution.

0.0, 5.0, 10.0, 20.0, 30.0, 40.0, 50.0ml of the intermediate was diluted to 50ml to prepare a standard solution containing 0.0, 0.01, 0.05, 0.10, 0.02, 0.30, 0.40, and 0.50mg p/litre.

### I. Determination of Phosphate

1ml of hydrolyzing acid solution was added to each 50ml of samples from various halls.

0.4g  $\text{NH}_4\text{SO}_4$  was added and boiled gently on pre-heated hot plate for 30 minutes. The samples were therefore cooled under running water and two drops of phenolphthalein indicator were added. The solutions were then adjusted to pink with 1N NaOH and then to colorless with 1 drop hydrolyzing acid solution. The solutions were then cooled and diluted to 50ml using distilled water. 8.0-ml of the combined reagent solution was therefore added.

## III. RESULTS AND DISCUSSION.

CONCENTRATION	ABSORBANCE	ABSORBANCE	AVERAGE ABSORBANCE
0.00	0.00	0.00	0.00
0.01	0.158	0.158	0.158
0.05	0.249	0.247	0.248
0.10	0.390	0.390	0.390
0.20	0.480	0.480	0.480
0.30	0.760	0.760	0.760
0.40	1.100	1.100	1.100
0.50	1.260	1.260	1.260

Table 1: Results for standard calibration curve of Phosphate.

Concentration	Absorbance 1	Absorbance 2	Average Absorbance
6000	0.33	0.33	0.33
5400	0.33	0.31	0.32
4800	0.29	0.29	0.29
4200	0.28	0.26	0.27
3600	0.25	0.25	0.25
3000	0.24	0.24	0.24
2400	0.22	0.22	0.22
1800	0.20	0.20	0.20
1200	0.19	0.19	0.19

Table 2: Results for standard calibration curve of Sulphate.

Brand PRODUCT	Absorbance 1	Absorbance 2	Average Absorbance	CONCENTRATION mg / L
PE PSODENT	0.048	0.048	0.048	150
HiHi Junior	0.052	0.052	0.052	150
Colgate Herbal	0.013	0.013	0.013	80
Orafresh	0.070	0.070	0.070	150
Aquafresh	0.130	0.130	0.130	150
Colgate	0.009	0.009	0.009	40
Close UP	0.039	0.039	0.039	100
Crest	0.131	0.131	0.131	150
HiHi senior	0.100	0.100	0.100	150

Table 3: Results of sulphate concentration in various toothpaste.

Brand PRODUCT	Absorbance 1	Absorbance 2	Average Absorbance	CONCENTRATION mg / L
Pepsodent	0.48	0.48	0.48	0.19
HiHi Junior	0.31	0.31	0.31	0.14
Colgate Herbal	0.71	0.71	0.71	0.25
Orafresh	0.48	0.48	0.48	0.19
Aquafresh	0.41	0.41	0.41	0.19
Colgate	0.67	0.69	0.68	0.22
Close UP	0.47	0.47	0.47	0.19
Crest	0.31	0.31	0.31	0.14
HiHi senior	0.52	0.50	0.51	0.20

Table 4: Results of phosphate concentration in various toothpaste.

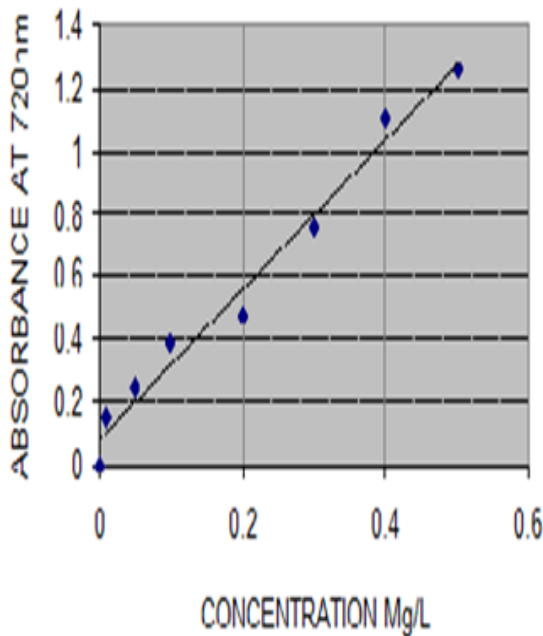


Fig.1. Standard Calibration Curve of Phosphate.

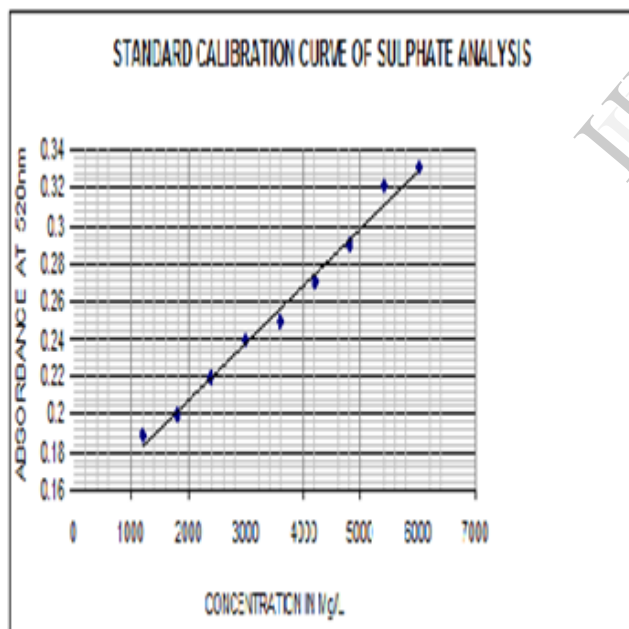


Fig.2. Standard Calibration Curve of Sulphate.

From the table of results obtained in table 4, it was found that the level of phosphate in the toothpaste sample tends to be the same with slight variation. The highest level of phosphate level was 0.25mg/L for Colgate herbal. Hi-Hi Senior had phosphate concentration of 0.20mg/L. Pepsodent, Oralfresh Aquafresh and Close up were 0.19mg/L each. The

level of phosphate decreased to 0.14mg/L in Hi-Hi Junior and crest

Although the level of phosphate in various brand of toothpaste in within 0.14mg/L to 25mg/L may be acceptable but the level can still be brought down to reduced abrasiveness.

With reference to the world Health Organization (WHO) standard for phosphate concentration is 0.3mg/L in drinking water, the level of phosphate in various brand toothpaste is quite low

Over the years pepsodent has been the most recommended on the local market and a lot of awareness has been created both on the print media and electronic media of the value of pepsodent Doctors for long time recommended pepsodent as the dental paste of choice. However, with the influx of other varieties of dental paste a slight shift is being made to milder substitution such as crest and Colgate. It may therefore not be right to assume pepsodent as the yardstick of comparison. To the extreme of pepsodent we have 0.25mg/L for Colgate and to the lower ebb we have 0.14mg/L for crest and Hi.Hi Junior. This indicates the desire for producers to vary the phosphate concentration not to be too far away from pepsodent

From the table 3 of the results obtained from the analysis of the various brand toothpaste samples, it was found that the level of sulphate concentration in the toothpaste sample tends to be the same with slight variation. The highest level of sulphate level was 150mg/L for pepsodent. Hi.Hi senior, Hi.Hi Junior, Oralfresh, Aquafresh, and Crest. Closeup had sulphate concentration of 100mg/L. Colgate Herbal sulphate concentration of 80mg/L. The level of sulphate concentration decreased to 40mg/L in Colgate. Although the level of sulphate in various brand dental paste is within 40mg/L to 150mg/L, may be acceptable, but the level can still be brought down, even to zero concentration to reduce the yellowing of the tooth.

The sulphate salt can readily undergo substitution or hydrolysis in the presence of water, under room temperature. This show that sulphate salt eventually produces some neutral condition in the mouth and may not be entirely harmful. Extreme presence of sulphuric acid and its related base may cause some form of dental corrosion and emphasis has been placed on the level of sulphate in toothpaste, this account for the constant value of 150mg/L observed in most of the dental paste analyzed. A value large than 150mg/L was not recorded but values lower was recorded. Such dental paste with lower concentration of sulphate may form the bases for direct dental prescription.

#### IV. CONCLUSION

According to the recommended levels of sulphate by the World Health Organisation (WHO) and the analysis conducted by the EPA, The maximum permission levels of sulphate for drinking water is 400mg/L. Averagely, the concentration of sulphate in various toothpaste sample fell far below detection point on the calibration curve, which implies they were relatively lower concentration of sulphate

dissolved in various selected brand but, according to research reports zero concentration is preferable

The level of phosphate from the various brand toothpaste was between 0.14mg/L to 0.25mg/L. From the world health organization (WHO) standard level of phosphate concentration in water is 0.3mg/L this implies that the toothpaste from selected brand toothpaste is not rich with respect to phosphate.

## V. RECOMMENDATION

It is suggested that the organic phosphate concentration should be determined because it also attributed to too much abrasiveness. Also further research should be conducted to get exact concentration of phosphate that makes toothpaste too abrasive. It is also suggested that other ions interference should be determined. Also further research should be conducted to get exact concentration of sulphate that may be harmful to tooth structure.

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