Research Article

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THE LEVELS OF PHOSPHATES, PH AND THE BUFFERING CAPACITY OF DIFFERENT DETERGENT POWDERS SOLD AT RETAIL OUTLETS IN KAPSABET, KENYA

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Abstract: The aim of this research is to study the levels of phosphates, buffering capacity and the pH in order to provide sufficient literature for further study on the impact of phosphates on water and the environment. From the results, commercially available detergent brands Power boy had the highest level of phosphates with a concentration of 729.55mg/L, while Gental brand had a low phosphate level of 127.27mg/L. Sunlight spring had the highest pH value and Omo had the lowest compared to the eight sampled brands. In terms of the buffering capacity, Sunlight spring had the highest buffering capacity with Ushindi being the lowest buffer. High levels of phosphates in detergents have environmental impacts due to its ability to cause eutrophication of water bodies by phosphate enrichment. Buffering capacity is the molar quantity of hydrogen or hydroxide ions in relation to the water volume used. The buffering capacity arises from the use of sodium carbonate. Alkalis raise the pH of the laundry wash water which assists in breaking up oily and acidic soil components. However since high pH can also damage fabrics. The pH of laundry detergents should carefully be controlled.

Keywords: Detergent Powders, Buffering Capacity, Phosphates, pH.

INTRODUCTION

Detergents are cleaning materials that are amphipathic molecules that contain both polar and hydrophobic groups. Powder detergents consist of surfactants, fillers, builders and other auxiliary ingredients. Phosphate is widely used in detergents as a builder, an industrial term used to refer to a water softener. Phosphate in detergents is used in the form of sodium tripolyphosphate, a heavy chelating agent capable of binding dications, preventing the deactivation of the sulfonate detergents. There is a strong need to study which detergents add to water pollution and how much pollution is being caused by these detergents so that alternative remedial measures can be suggested for controlling chemical contamination of water[1]. Eutrophication in Kenya is becoming a major environmental concern due to the uncontrolled use of too much phosphate fertilizer, continued influx of untreated sewage from residential, industrial effluent and surface run off from agricultural farms. According to Golterman (1993)[2], discharge of inadequately treated effluents, and inadequate disposal facilities introduce phosphorus into water. It is estimated that 2g of PO_4^{3-} is excreted per person per day partly in urine and in feces. For developed areas another 2g of tri-phosphate phosphorus come from detergents per person per day, which will hydrolyse, to PO_4^{3-}. The use of phosphates in detergents has elicited a lot of debate all over the world; however there is no single chemical that has been discovered to perform functions comparable to phosphates in detergents.

The new powdered formulations of clothes-washing detergent included as much as 60 percent by weight of sodium tripolyphosphate (STPP) (about 15 percent by weight as phosphorus) as a builder, whose function was to remove hardness from water so that surfactants could perform properly[3]. The reason why STPP is used in a detergent is that it performs several very useful functions. STPP is alkaline so it binds the hardness ions in water and they break up large particles of dirt[4]. Builders also provide the skeleton for holding together the powder grains in a detergent[5].

The finding of this research shows that detergent phosphates may indeed lead to eutrophication and the consequent health hazards and degradation of ecosystems. However, the conditions under which these problems arise are limited and inherently site specific. The contribution of household detergents to the total phosphate load that finds its way into rivers, lakes and reservoirs varies considerably. Where phosphorus loading is dominated by waste water inputs, phosphorus from detergents might contribute up to 25% or so of the phosphorus loading[4]. Synthetic detergents and laundry practices are contributing to our ground level water pollution[6].

The pH of a cleansing product has to be regulated to be within the acceptable standards. The pH of a detergent should not be too low or too high. The hydrogen ion concentration (pH) of a cleanser certainly has an impact on skin condition[7]. pH is a measure of

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the hydrogen or hydroxyl ions concentration present in a solution. The pH of a washing detergent has an effect on the users and on the fabrics. The pH of a cleanser tends to have an impact on the skin in several ways viz., alteration of bacterial flora and pH, moisture content and irritation[8]. Detergents have a substantial amount of alkali in form of sodium carbonate and bicarbonates. According to Fergusson M.S (2008)[9], alkalis are added to laundry detergents to assist in the removal of oils, fats and waxes. Typically sodium carbonate is used, as this saponifies the animal fats, vegetable oils and waxes to form soap. The high level of alkalis has an effect on the pH of the final product.

MATERIALS AND METHODS

A total of eight samples of powder detergent were purchased from different retail outlets in Kapsabet town. The samples were kept in a cool dry place ensuring the sample packets are free from tear.

Determination of phosphate:

Preparation of the Standards: Potassium dihydrogenphosphate had been oven dried at 105°C for an hour. Phosphate standard was prepared by weighing 0.05 g of potassium dihydrogenphosphate in 1000ml by using distilled water; this is equivalent to 50mg/L phosphate.

The standard phosphate solution was serially taken by pipetting 1, 2, 4, 6, 8, and 10 ml in 100 ml Erlenmeyer flasks. The volume of each flask was diluted with approximately 40 ml distilled water and then 4 ml of potassium peroxodisulfate (0.0018M) was added. The solutions brought to simmer over medium heat for 30 minutes and concentrated to 25 - 35 ml. The solutions were cooled down; the pH adjusted with either 2M NaOH or 2M H_2SO_4 to obtain a pH value in the range of 3-10. The solution was transferred into a 100 ml volumetric flask; 1 ml of ascorbic acid was added followed by 2 ml of molybdate solution. The flasks were topped up to 100 ml with distilled water and the absorbance of the standards measured in triplicates at 880 nm between 10-30 minutes after addition of the ascorbic acid and molybdate solution.

Sample Preparation:

A sample of 2.5g of the dry detergent was weighed and dissolved in warm water (60°C) and transferred into a 250 ml volumetric flask. The solution was cooled to room temperature and the volume brought to 250 ml with distilled water.

A sample solution of 4 ml was pipetted into a 250 ml volumetric flask and diluted with distilled water. From this solution10 ml was pipetted into a 100 ml Erlenmeyer flask; 4 ml of potassium peroxodisulphate solution was added and brought to a simmer over a medium heat for 30 minutes and concentrated to 25 to 35 ml. It is then cooled down, the pH adjusted with 2M NaOH or 2M Sulphuric acid to be in the range of 3-10 (the total volume should not exceed 40 ml). The solution is then transferred to 100 ml volumetric flask.

A solution of 1 ml of ascorbic acid (0.0056M) was added to each 100 ml volumetric flask followed by 2 mL ammonium molybdate solution (a blue color was developed) and then volume made up to 100 ml with distilled water. The absorbance of the solutions was measured in triplicates at 880 nm against a water reference within 10-30 minutes.

Determination of the pH:

A sample of 10 g weighed and dissolved in 50 ml of warm water (60°C) and left for 2 hours until temperature was stable and measured using a calibrated pH meter.

Measurement of the Buffering Capacity:

Hydrochloric acid solution (0.1M) was standardized by using sodium carbonate (0.05M). A sample of 10 g was accurately weighed on an analytical balance and diluted to one liter with warm distilled water (60°C). A 25 ml of this made up solution is pipetted out into a clean conical flask, a drop of phenolphthalein indicator was added and the solution titrated against standardized HCl. The end point is the disappearance of pink colour. Titre values are noted and titrations are repeated to get concordant values.

The acid capacity (Ks) was determined using the following relationship:

$$Ks = \frac{C_{HCl}\ x\ V_2\ x\ 1000}{V_3}$$

Where C_{HCl} - Molar concentration of Hydrochloric acid.
V_2 - Volume of HCl
V_3 - Volume of Sample

RESULT AND DISCUSSION

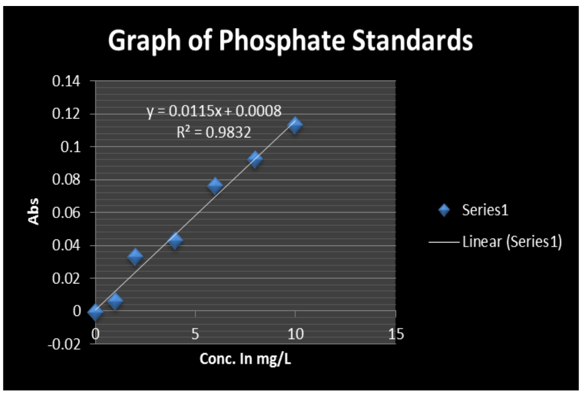

Figure.1: Phosphate Standards.

Table.1: Average Absorbance, Temperature, pH, Buffering capacity and the Concentration of Phosphates in mg/L of the different samples

Sample Name	Average Absorbance	Conc. in mg/L	% Conc.	Buffering Capacity	pH	Temp (°C)
Ariel	0.223	509.09	20.36	24.0	10.76	17.9
Gental	0.055	127.27	5.09	19.2	10.80	18.0
Omo	0.199	454.54	18.18	18.4	10.66	18.0
Persil	0.248	565.91	22.63	20.4	10.80	18.0
Powerboy	0.320	729.55	29.182	28.8	10.79	18.0
Sunlight Spring Sensation	0.215	490.90	19.64	30.0	10.82	18.0
Sunlight Tropical Sensation	0.062	143.18	5.73	22.0	10.80	18.0
Ushindi	0.129	295.45	11.12	18.8	10.81	18.0

From this study as shown in Table 1 above, detergent powders contain high levels of phosphates used as builders to improve their functionalities. Power boy brand had the highest level of phosphates with a concentration of 729.55 mg/ L. Phosphate (expressed as sodium tripolyphosphate), by mass of matter insoluble in alcohol, should have a minimum of 20%[10]. The cleaning ability of this detergent could be attributed to this high level of phosphate builders. In spite of this great cleaning power, from the analysis it could be one of the great water pollutants in terms of its ability to release a lot of phosphate to the wash water. Gental brand according to the investigation showed the lowest phosphate level of 127.27mg/L making it the least water polluting detergent. The pH measurements of the detergents showed a close relationship indicating some conformation to the required standards. Omo brand had the lowest pH of 10.66. The pH of all the detergents was in the acceptable range of 9-11 according to the (East African Community, 1999)[10]. In terms of the buffering capacity, Sunlight spring sensation brand according to the investigation had the highest buffering capacity of 30.0 while the lowest was recorded with Omo brand.

CONCLUSION

Powder detergents contain high levels of builders in the form of sodium tripolyphosphate which has an impact on the quality of water bodies through eutrophication. More research work need to be undertaken to relate the levels of phosphates in washing detergents and the impacts on the water system. There should be more legislation on the use of phosphates in detergents and a shift to the use of other environmentally safe builders.

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