A Comparative Study on the Cost Effectiveness and Whiteness Effect of Homemade Bleach Mixture Vs. Industrial Bleach

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Abstract. Chlorine is used in the manufacture of a wide range of consumer products, about two-thirds of them organic chemicals such as polyvinyl chloride, and many intermediates for production of plastics and other end products which do not contain the element. As a common disinfectant, elemental chlorine and chlorine-generating compounds are used more directly in swimming pools to keep them clean and sanitary. It was reported by the World Health Organization that Bleach is one of the leading substances for accidental poisoning amongst children. Thus, in this work, the authors conducted comparative study whether this homemade alternative for bleach will turn out to be as effective as it’s Industrial Chlorine-Based. The researchers are also looking to compare both mixtures in terms of Costs, as well as Health & Safety risk. In this study, the researchers focused only on the quantitative method of research involving numerical data analyzed using statistical tests. Key results showed that the researchers determined that the homemade mixture of Hydrogen peroxide bleach was more cost effective while being almost as effective as the Industrial bleach.

1. Introduction

Chlorine is a high oxidizing material which has to the improvement of business fades and disinfectants, and a reagent for some procedures in the synthetic business [1]. Chlorine is utilized in the make of a wide scope of purchaser items, around 66% of them natural synthetic compounds, for example, polyvinyl chloride, and numerous intermediates for generation of plastics and opposite final results which don’t contain the component [2]. Hypochlorite, the most widely recognized specialist utilized in family unit or home dying. Most blanches utilizing sodium as opposed to the calcium hypochlorite (dying powder)[3].

The drawback of utilizing Sodium hypochlorite is its hazard to human wellbeing [4]. Sodium hypochlorite is viewed as poisonous to people. Its danger is subject to fixation, course, and length of presentation [4]. Accessibility in family units credits to visit exposures. Lethal impacts fluctuate from mellow aggravation to critical tissue harm [5]. Most accidental exposures result as minor bothering. Deliberate ingestions can cause huge consumes or strictures of the gastrointestinal tract. Dermal and visual exposures can cause aggravation and destructive wounds. Sodium hypochlorite joined with a corrosive or smelling salts shapes chlorine and chloramine gases, which cause upper respiratory bothering to substance pneumonitis [6].
An examination announced that chlorine-fade containing family unit items were seen to create Halogenated VOCs because of responses of sodium hypochlorite with natural item segments [7]. As per Odabasi [8] the utilization of these family items brought about lifted indoor air halogenated VOC fixations. Plain blanch was seen to have the least Halogenated VOC fixations pursued by the somewhat higher focus found in fragranced items and the most elevated [8].

Concurring an examination [9]the 37% of 607 ladies that were partaking in the investigation of the ladies that were accounted for to utilize dye in a week by week premise. 11% of which were bound to have current asthma when contrasted with non-clients. Ladies with asthma that were as often as possible utilizing blanched was altogether connected with higher blood neutrophil cell checks [9].

Hydrogen peroxide is favored now in light of the ecological worry of utilizing hypochlorite as it was noted to accomplish a high level of whiteness [10]. Solid soluble conditions and high temperature are frequently utilized. Notwithstanding, protein filaments could be harmed in these conditions. Thusly, it was prescribed by the creator that milder conditions, for example, bring down pH (8–9) combined with lower temperature (49–54°C) utilizing hydrogen peroxide are ideal in utilizing to dye fleece and silk filaments [10]. Washing textures with chlorine blanch assumes a job in wellbeing and cleanliness and also style [11]. Be that as it may, clothing fading may make chlorinated results with conceivable unfriendly human wellbeing impacts [12]. Studies have appeared dangerous chlorinated gases are delivered in the headspace of clothes washers when hypochlorite-containing dye is utilized [13]. In 2013, it was accounted for that Chlorine-based Bleach is likewise a solid aggravation to the eyes and skin [14].

Thus, with that concern, the researchers sought alternatives to chlorine-based bleach and found a mixture that utilizes 3% concentration of hydrogen peroxide as its main cleaning component. The researchers then conducted a comparative study whether this homemade alternative for bleach will turn out to be as effective as it’s Industrial Chlorine-Based. The researchers are also looking to compare both mixtures in terms of Costs, as well as Health & Safety risk. The proponents of this study concentrated on the comparison of the two bleaching mixes, specifically a chlorine-based commercial bleach and the peroxide-based mix, deduced to also be capable to bleach clothes. Hence, other factors such as fabric softness and color retention were not considered to be factors important to the study. Moreover, the factors of comparison along with its corresponding evaluation of the two bleaching mixtures include its effectiveness, costs, and operator safety.

2. Methodology

2.1. Research Design

The researchers used a comparative research approach which aims to make a comparison between different variables. In this study, the researchers focused only on the quantitative method of research involving numerical data analyzed using statistical tests. The researchers performed several trials during an experiment in order to compare the two bleaches: NaClO and the homemade H2O2 mixture. The concentration of both bleaches as well as the water used will be carefully measured and controlled. The researchers submerged white cotton cloths simultaneously. The containers containing the cloth and one of the bleaches used will then be left for a specified time of 30 minutes to take effect. External conditions will be purposefully controlled by the researchers so as to prevent external factors from influencing the result of the experiment and as an attempt to minimize error and bias. These data were then evaluated using various statistical and engineering economy tools in order to objectively compare the two for both traits of cost and effectiveness. However, several factors were considered as well in this study, such as its life span, and cost, in determining which among the two is more cost-effective.

2.2. Subjects and Study Site

The main test subjects of this study will be 100% knitted cotton fabric. This test subject is common across the Philippines and can be bought almost anywhere. The study was focused in determining if
H2O2 is as effective of a bleaching agent as NaClO or better. H2O2 breaks down color through oxidation and reduction. Sodium hypochlorite bleach increases whiteness by NaOH and the pH condition that control the nascent oxygen release. The base whiteness index of the cloth is at Stensby WI of 80. For the experiment the proponents found a lot of different homemade formulations in various online articles. However, they used the formulation from the online article found in DontWasteCrumbs.com. ¾ cups of hydrogen peroxide was then added to ¾ cups of sodium bicarbonate (Baking soda). Then, ¼ cups lemon juice was added to the mixture and finally 7 cups water was added. In order to have a fair comparison, the following concentrations of NaClO bleach was balanced to have a concentration level of the homemade bleach which the proponents calculated to be .27% or 2,700 ppm. Thus the bleaches were prepare as follow, 0.11 liters of NaClO to be diluted in 1.89 liters of water and Using 3% concentration of H2O2, 0.19 liters of H2O2 to be diluted in 1.81L of water was done and compared. In order for the two bleaches to be compared, the researchers decided to do test the whiteness index of the cloth that was submerged in one of the two mixtures. This test was done in a open setting with a illumination level of D65(CIE, 2006). A sample 100% knitted cotton cloth will be submerged in one of the two mixtures at the same time and will be left there for 30 minutes to take effect. The sample cloths will then be squeezed and left to dry for 1 hour. After which the cloths were both measured.

2.3. Data gathering procedure
Gathering the data for this experiment was especially difficult as a simple change of lighting temperature can drastically affect color accuracy. A lot of the Related Literature used in this experiment used Color Spectrophotometer this reduces variation in the color measurements. With that said, the proponents of this study was not able to consider special spectral considerations unique to the Philippines at the moment of recoding the data and assumed a standard illumination setting of D65 which represents the average daylight.

The group firstly mixed both bleaches in separate containers. Since temperature is an important factor the all of their testing used the recommended temperature of 88-98 deg. Celsius.1 whole cup of each mixture was then placed in a smaller containers and then the cotton cloths were placed in the mixture for 30 minutes. The cloths where then squeezed to remove the mixture and then dried out for 1 hour and 30 minutes. The cloth was then taken a picture in open daylight conditions and the picture was then processed in Photoshop to determine their corresponding L, a, b colors. The measurement of L, a, b colors was directed at the center of the knitted portion cloth by the group in the experiment. The resulting L, a, b will then be computed using the whiteness index of Stensby WI [15].

2.4. Mode of data analysis
The data gathered from the experiment was compiled and analyzed through the use of data analysis available in Microsoft Excel. These will be considered first hand data, ensuring that the researchers’ inputs in the analysis software accurate to guarantee that the results would be reliable. Cost-benefit analysis was also used to analyze and evaluate the two bleaches considering several variables. T-Test was used primarily due to the sample size which was less than 30 and used T-Test Assuming Unequal Variances. In addition, F-test was used to identify the type of T-Test that is to be used by the group. The f-test was performed before t-test.

3. Result and discussion
In each trial, both test subjects were simultaneously treated with bleach at a soaking time of 30 minutes to take effect and an additional 1 hour and 30 minutes for drying. Thus, the trials resulted in varying values of Stensby Whiteness index. To be considered an effective bleach the stensby whiteness index must at least be 75 (MHRD, Govt. of India, 2013). Thus, the group highlighted all the results that did not pass the 75 mark. This maybe due to the change in the lighting. The proponents of
this study deemed it necessary to input the results for a t-test analysis in order to compare the mean values for each group. The Results of the t-test analysis used the sample size and treat it to represent the whole. Since, the testing was simultaneously performed for both groups, there was no before-after effect which deemed the test unfit for T-test for paired two means. The researchers first tested the data using an F-test in checking if the two groups had equal variances or unequal variances. Table 1 shows the F-test result. The researchers obtained a p-value of 0.3888 which was greater than the Alpha value of 0.05. This indicated that the variances of both mixtures were not equal. T-test assuming unequal variances was then performed.

**Table 1. Result of F-testing**

| Variable     | H2O2 Solution   | NaClO Bleach   |
|--------------|-----------------|----------------|
| Mean         | 77.30769231     | 77.46153846    |
| Variance     | 26.06410256     | 43.43589744    |
| Observations | 13              | 13             |
| df           | 12              | 12             |
| F            | 0.600059032     |                |
| P(F<=f)one tail | 0.194385696     |                |
| F Critical one tail | 0.372212531 |                |
| H0           | The mean whiteness index of the homemade mixture is equal to that of the bleach |
| H1           | The mean whiteness index of the homemade mixture is not equal to that of the bleach |
| Alpha        | 0.05            |                |
| P value      | p > 0.19438569647152 | 0.3888 |
| *2=          | 0.3888          |                |
| Conclusion   | Reject H0       |                |

Based on Table 2, since the p-value is more than the alpha (significance level), H0 was accepted. Since, the results of the T-test analysis was the basis of the researchers in measuring the effectiveness of both bleaches as a whitener, the mean value of Homemade Bleach containing H2O2 was less than or equal to the value of Commercial Bleach containing NaClO. However, the mean value of the Homemade Bleach was really close to the mean value of the Commercial Bleach containing NaClO. With this test, the researchers was not able to achieve one of the objectives of this study which was create bleach that is better in whitening than its commercial counterpart.

**Table 2. Result of T-Test**

| Variable        | H2O2 Solution    | NaClO Bleach     |
|-----------------|------------------|------------------|
| Mean            | 77.30769231      | 77.46153846      |
| Variance        | 26.06410256      | 43.43589744      |
| Observations    | 13               | 13               |
| df              | 23               |                  |
| tStat           | -0.066537414     |                  |
| P(T<=t) one tail| 0.47376249       |                  |
| t Critical one tail | 1.713871528    |                  |
| P(T<=t) two tail| 0.947524981      |                  |
| t Critical two tail | 2.06865761      |                  |
| H0              | The mean whiteness index score of the homemade bleach mixture of H2O2 is less than or equal to the mean whiteness index score of Household NaClO |
bleach

H1 The mean whiteness index score of the homemade bleach mixture of H2O2 is greater than the mean whiteness index score of Household NaClO bleach

Alpha 0.05
p-value 0.47376249
Critical region t>-1.71387152774705
Test-Stat -0.066537414
Conclusion Accept H0

One of this study’s primary objectives is to prove the cost-effectiveness of the homemade bleach mixture as compared to that of the industrial bleach. To accomplish the said objective, it is necessary to breakdown the various costs incurred in acquiring the mixture ingredients. It is just as important to show how the homemade mixture is just as effective as its industrial counterpart. A Cost-Benefit Analysis quantifies all positive factors. These are the benefits, and it subtracts all the negatives, the costs. Depending on the Net Result of a cost benefit analysis a project could be deemed impractical. Benefits and Costs are considered at every phase. The researchers compared the two Bleaches not just based on their effectiveness in whitening knitted cottons, but also on their life span, financial cost, health impact, and other factors deemed by the researchers as necessary to be included in the comparison. As shown in the Table 3, the researchers have broken down the costs incurred in the creation of the proposed bleach alternative mixture. The researchers laid out the costs according to available market prices in available stores within NCR as of 2017. The homemade mixture only costs 240.76 Php to produce 2L of said mixture. In retailers within one can purchase 500ml bottles of 3% Hydrogen Peroxide for 50.00 Php per bottle. In public markets available around NCR, a piece of lemon costs 30.00 Php and to create the mixture, 4 pieces of lemon is required which sums up to 120.00 Php to buy the required lemons. Furthermore, Baking Soda costs 36.25 Php per pack of 400g. However, the mixture only requires 112.5g to produce 2L. With all the prices laid out above, costs total to only 240.76 Php in order to produce 2L of the said mixture with leftover ingredients to create more of the said mixture if desired. Moreover, the researchers based the price of (NaClO based) Bleach from supermarkets and determined the cost to be 480.00 Php per Gallon (3.78L). The researchers converted the said price per gallon to price per 2L in order to be able to compare more accurately the prices of both. As it turns out, the homemade mixture proved to be more cost effective while being nearly as effective as the traditional bleach sold in markets today.

Table 3. Total cost of Materials

| Ingredient       | Cost         | Qty Required to yield 2L | Total Cost (2L) |
|------------------|--------------|----------------------------|-----------------|
| 3% Hydrogen Peroxide | 50.00Php/500ml | ¾ cup (200ml)              | 50.00 Php       |
| Lemon Juice      | 30.00 Php/Lemon | ¼ cup (4pieces of Lemon) | 120.00 Php     |
| Baking Soda      | 36.25 Php/400g | ¾ cup (112.5g)             | 36.25 Php       |
| Water            | 34.51 Php/cubic meter (1000L) | 7 cups (1.65L) | 34.51 Php       |

Cost incurred to produce 2L of the Mixture

| Price | Price per liter | Price per 2L |
|-------|-----------------|--------------|
| 480 Php/1 Gal (3.78L) | 126.98 Php | 253.97Php |
4. Conclusion
As the study concludes, the researchers determined that the homemade mixture of Hydrogen peroxide bleach was more cost effective while being almost as effective as the Industrial bleach. Given the results of the tests and trials, the homemade bleach offered great effectiveness in whitening the cloth just like its counterpart, the industrial bleach. The study confirmed that the use of cheap and easy-to-buy materials is almost as effective as the industrial or factory made materials.

5. References
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