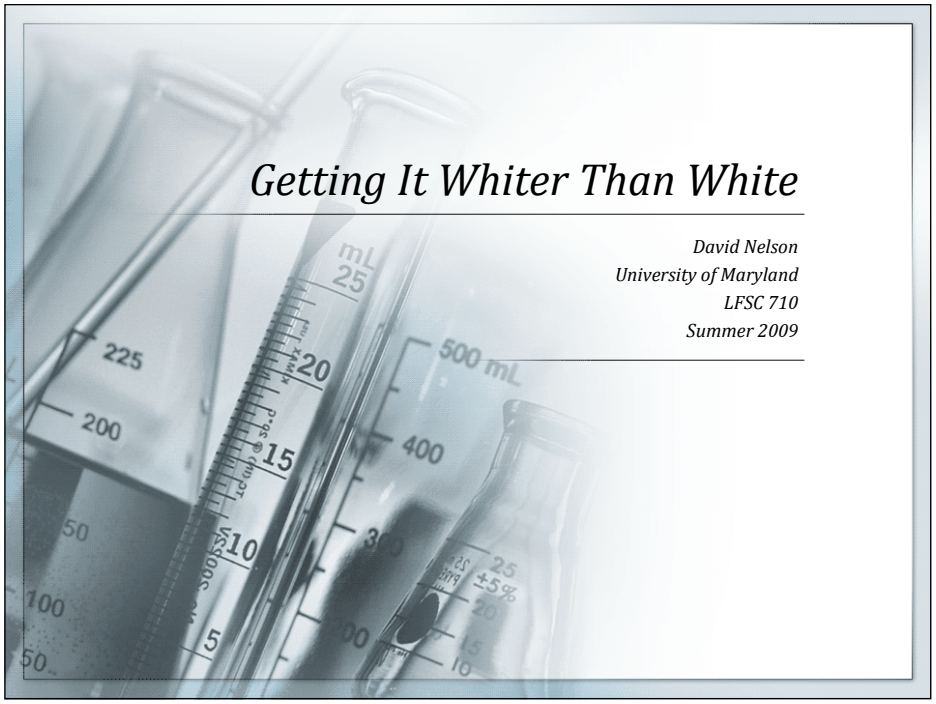

Getting It Whiter Than White

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Contents

Overview

Do store-brand and other "off-brand" bleaches have significantly different bleaching power when measured as available hypochlorite ion per gram of bleach solution when compared to widely-marketed name-brand bleaches?

Background

- Color in pigments, dyes and stains is imparted by the presence of molecules containing molecules with unique combinations of double bonds – especially carbon-carbon double bonds and carbon-oxygen double bonds.
- These regions are termed *chromophores* – they absorb certain wavelengths of the visible spectrum, which results in other wavelengths being reflected.

Background

- For example, chlorophyll-a and chlorophyll-b contain chromophores that absorb extensively at the red and blue wavelengths, but not in the green and yellow region – thus reflecting green to our eyes. (*Figure 1*)

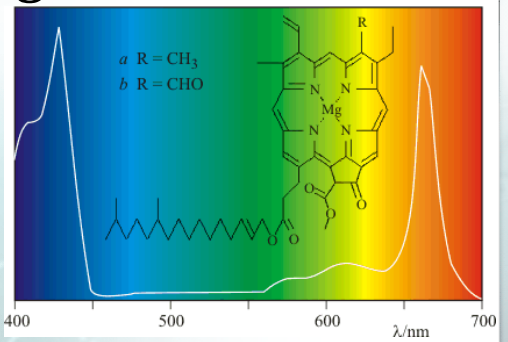


Figure 1. Visible light spectrograph shows that chlorophylls absorb strongly at blue and orange wavelengths. [Credit: University of Split, Online Chemical Glossary; Entry: *chlorophyll; http://www.ktf-split.hr/glossary/index.html]*

Background

- Strong oxidizers such as the hypochlorite ion, OCl^-, found in laundry bleach, convert the double bonds to single bonds as oxygen reacts at the electron-rich double bond.
- Oxidation at the double bonds alters the molecules' absorption of light, and causes all colors to be reflected, which we perceive as white.
- Thus, bleach doesn't eliminate stains – it just makes them invisible. If you think that's a disgusting way to make something look clean, you are correct.

Experimental Design

- The experimental design involved colorimetry analysis followed by oxidation-reduction titration:
  - The addition of iodide ion (as 0.20-molar $KI_{(aq)}$) caused the reduction of the hypochlorite ion according to*:

$$ClO^- + 2I^- + 2H^+ \rightarrow Cl^- + I_2 + H_2O$$

  - The full conversion of hypochlorite to iodine was observed when the colorimeter read a constant absorbance at 490 nm [on Spec 20]

**Following KI(aq) addition, the solution was acidified with 2 mL 3-molar H_2SO_4; 5 drops 3% hydrated $(NH_4)_6Mo_7O_{24}$ added as catalyst*

Experimental Design

- The iodide solution was treated with 2% starch solution to form a characteritic blue iodine-starch complex.
- Then, the iodine solution was titrated with standardized thiosulfate ion (as 0.150-molar $Na_2S_2O_{6(aq)}$) to reduce iodine back to iodide ion according to:

$$I_2 + 2\ S_2O_3^{2-} \rightarrow 2\ I^- + S_4O_6^{2-}$$

  - The end point was observed by the disappearance of the iodine-starch complex's characteristic blue; i.e., the solution was colorless

Experimental Design

- ~1 g samples of each bleach were used per run
- The densities of the solutions were 1.08 g/mL measured by pycnometer, so no consideration of density was required
- Each of the Clorox samples was randomly paired to a generic sample, and the ten pairs were assigned random values 1 to 10 – this is the order in which the samples were tested
  - Randomization in this manner diminished the effects of improved technique as samples were tested

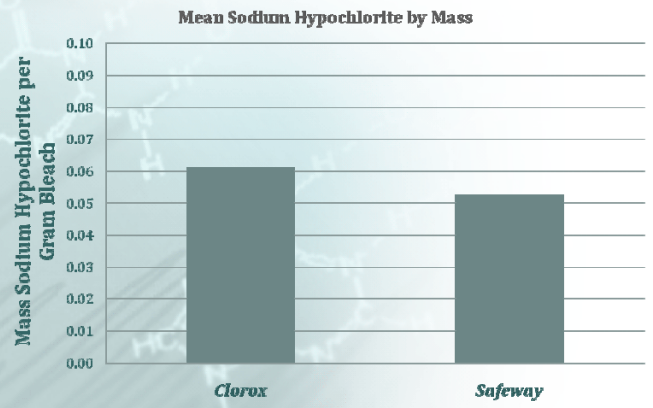
Results/Data

Table 1. Mass Available Sodium Hypochlorite Per Gram Bleach

Pair	Name Brand (Clorox), mass NaClO g^{-1} solution	Store Brand (Safeway), mass NaClO g^{-1} solution
1	0.0618	0.0527
2	0.0613	0.0526
3	0.0619	0.0529
4	0.0619	0.0526
5	0.0615	0.0525
6	0.0612	0.0528
7	0.0610	0.0524
8	0.0612	0.0528
9	0.0613	0.0523
10	0.0617	0.0528

Results/Data

Figure 2. Mean Available NaClO per Gram Bleach



Analysis

- Research Hypothesis: There is a significant difference between the amount of bleaching power between name-brand and store-brand bleach as measured by the amount of available NaOCl per gram of bleach
- Data was analyzed using a two-tailed, paired *t*-test with no transformation required
- Analysis using the two-tailed, paired *t*-test gave *t-calc* = 92.387 ($t\text{-}crit_{p<0.05}$ = 2.262; $t\text{-}crit_{p<0.01}$ = 3.250)

Conclusion

- We accept the research hypothesis that there is a significant difference between the amount of sodium hypochlorite – and thus, bleaching ability – between name-brand and store-brand bleach solutions.

Evaluation

- Additional studies might present the data using the widely-held industrial standard of available chlorine per liter.
- Colorimetric analysis might be tweaked or an alternative method of ensuring hypochlorite conversion devised.