

Analysis of Chemicals in Beauty Products and its Impacts on Customers

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ABSTRACT

The cosmetic industry is a market of 80.73 billion USD worldwide. The share of makeup in the cosmetics industry is 16%. The predicted worth of skincare in this industry is around 145.2 billion USD. In 2020, the worldwide Cosmetic Chemicals market was estimated to be worth USD 19.38 billion. Cosmetic chemicals combine synthetically created chemical compounds that are the most often utilized components in personal care and cosmetic goods. Popular cosmetic chemicals are colorants, surfactants, rheology control agents, emulsifiers, emollients, and preservatives. Increased consumer awareness of beauty and skincare products and rising demand for goods containing active ingredients are assisting market expansion. The industry is also likely to profit from increased customer demand for natural components, which will open opportunities for technological innovation. We will analyze the chemicals most found in cosmetics today and gather data from product reviews to determine the effects of these chemicals on consumer skin.

INTRODUCTION

Today, more than 10,000 chemicals are used to create cosmetics, with only 11 being restricted by the FDA (Food and Drug Administration). With critical ingredients being water, thickeners, colors, and fragrances, there are significant impacts on the skin by the impact these chemical compounds. Understanding the many chemicals used daily, we can see their impact on people and figure out alternatives and better chemicals to include in skincare.

DATA OVERVIEW

The dataset we will be using is sourced from the 'California Health and Human Service Agency' (CHHS). The agency oversees federal and state programs. The dataset is in the form of a CSV file containing 114,635 entries and is updated regularly. The second dataset we will be using is a dataset we created web scraping product reviews from the following websites: Ulta, Sephora, Walmart. Throughout the second data set all the products include specific chemicals found in the first dataset. Throughout the analysis, we will label the dataset from CHHS as 'Cosmetic Chemicals' and our web scraping dataset 'Cosmetic Reviews'.

Figure 1: Cosmetic Chemicals

Label on Table	Description
Product Name	The name of the product seen on the shelves and online for sale
Company Name	The name of the company that created the product
Primary Category	The specific category of the product like nail care, hair care, makeup etc.
Subcategory	Specific categories in the umbrella category such as eye shadow, artificial nail etc.

Label on Table	Description
Chemical Name	The name of the primary chemical in the product
Chemical Created	The date that the chemical was created
Chemical Updated	The data the chemical was last updated or changed

Figure 2: Cosmetic Reviews

Label on the Table	Description
Star Rating	The rating given by the consumer on a 5-point scale
Review	The written response given by the consumer
Category	Category of the products
Product Type	The type of the product being reviewed

MISSING VALUES

We have first analyzed the dataset manually to understand the variables. After that, we used R studio to analyze the missing values. After replacing the missing values, we have 114,299 rows.

BUSINESS QUESTIONS DERIVED FROM THE DATASETS

After reviewing the datasets and getting an idea of the connections we can make based on the evidence we will find throughout the analysis, we have come up with business performance in the Cosmetic Industry.

- What is the most common chemical found in cosmetic products and the product that most uses that specific chemical?
- Which brand uses the most chemicals in their products?
- What can reviews tell us about the products and their connection to the chemicals and compounds used in them?

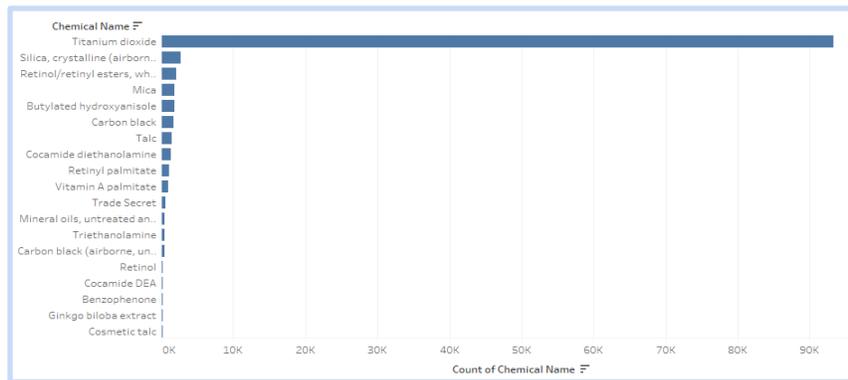
METHOD AND PLAN

Making connections from the Cosmetic Chemicals and Cosmetic reviews, we are looking to know what people think about the products they use daily. Having many negative reviews would give us an output and ideas for companies to be more sustainable and aware of the harm their products can have long term. We want to help companies decrease the number of chemicals in their products or have product diversification like organic products created for people who have skin irritations. From the research we have conducted, we have found that people who use such chemical-infused products can have increased cholesterol levels, risk of testicular and kidney cancer, enzyme changes in the liver, and risk of high blood pressure.

Cosmetic Chemical Analysis

In our preliminary analysis of the datasets, we wanted to first look at the most common chemical found in the products. The graph below shows the Top 20 chemicals used.

Figure 3: Top 20 chemicals

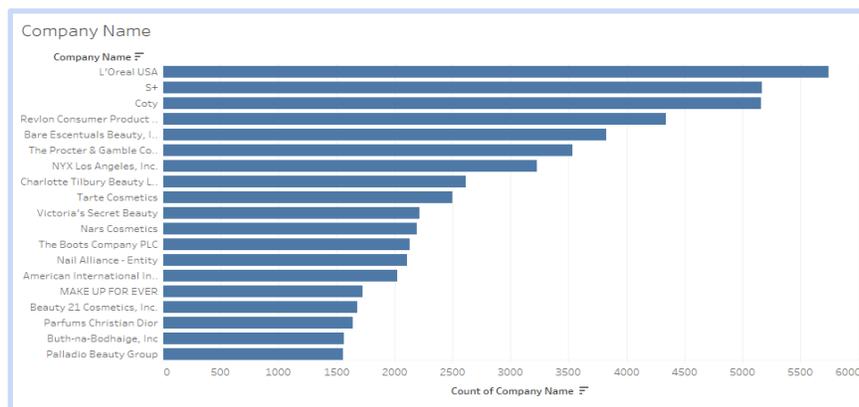


The most common chemical is Titanium Dioxide, followed by Silica, Retinol, Mica, and Butylated Hydroxyanisole. Afterwards, we conducted further research to get an idea of the top five chemicals.

Titanium Dioxide comes from Titanium, a metal that interacts with Oxygen. This chemical acts as a UV ingredient found in sunscreen and is used in printing ink, rubber, cosmetics, toothpaste, and fabrics. The benefit of Titanium Dioxide is its high coverage power. At the same time, the cons have been found to irritate sensitive skin, cause lung cancer in animals and humans, and may cause reproductive damage.

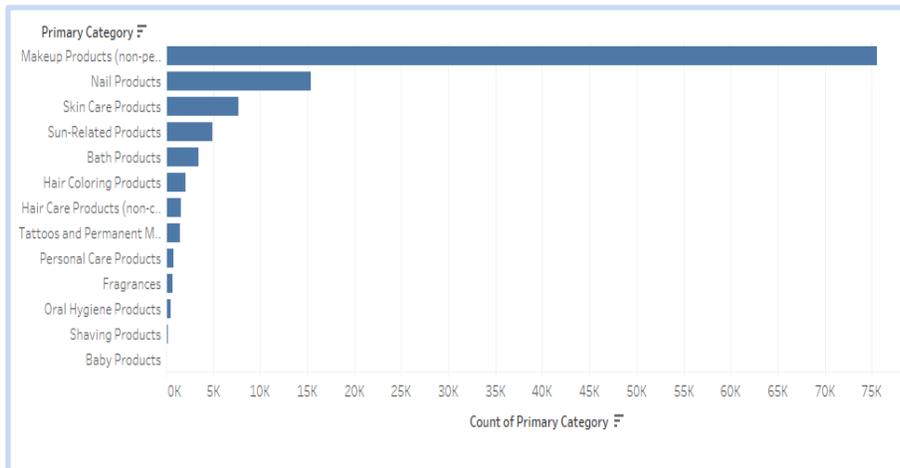
The next step of the analysis is to find what brand has used the most chemicals in their products. We found L’Oreal USA has used the most percent of chemicals in their products. Here we have added a few other top companies with the maximum usage of chemicals in the graph.

Figure 4: Top companies that uses maximum number of chemicals



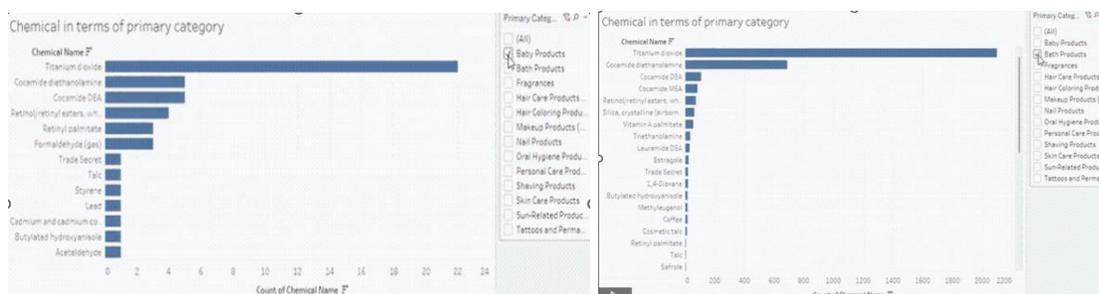
Next, we investigated the Primary Categories to find which category uses the most chemicals; we learned the top category was Makeup Products, followed by Nail Products, Skin Care Products, and Sun-Related Products. Now if we see the makeup products are mostly used on the face which have a higher chance of getting all the skin disease and illness caused by titanium dioxide mentioned earlier in the paper.

Figure 5: Top Primary Category with Chemical



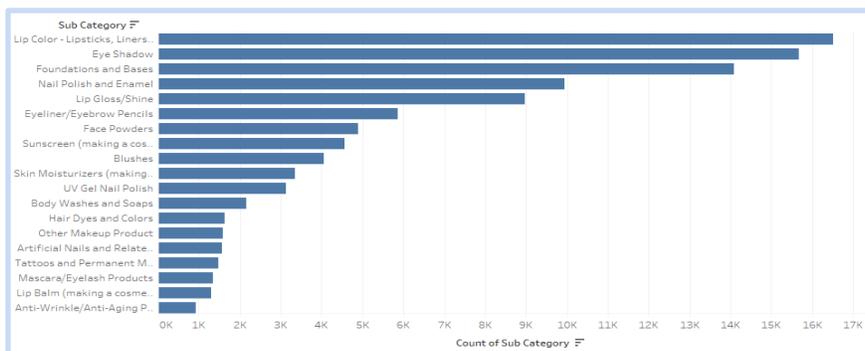
Here we have the measure of chemical count in the top 2 primary category with the name of the chemical. We discovered that all the primary categories have the same top chemical name, titanium dioxide; the 2nd chemical name differs for all the categories.

Figure 6: Top Chemical in top 2 Primary Category with Chemical



We are going toward to the specifications; we need to know which subcategory has what content of chemicals in it. As we go through the list in this graph, we see that most makeup products have a very high amount of chemicals in them, followed by the other top 20 subcategories. The top products would be Lip Products, Eye Shadow, Foundation, and Base Products.

Figure 7: Top Subcategory with Chemical



Cosmetic Review Analysis

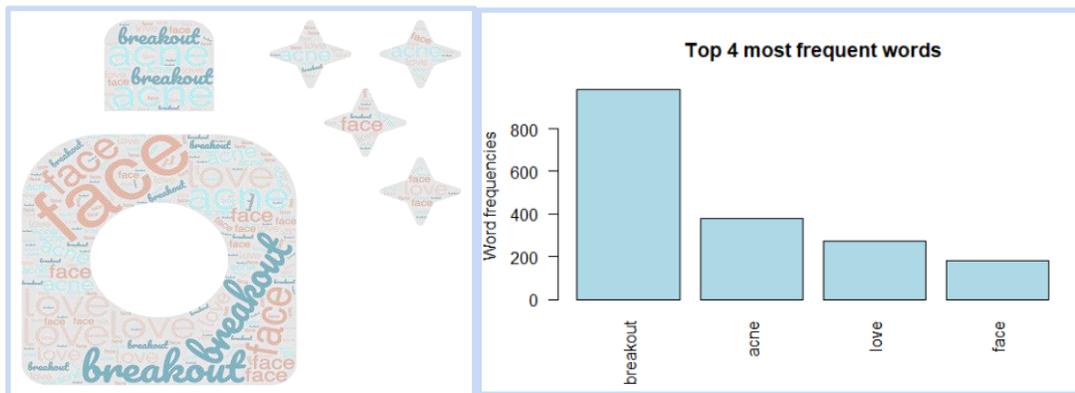
After scraping the web, inputting data into Excel we conducted a text analysis. The dataset contains 700 rows of reviews ranging from all categories found in the Cosmetic Chemical dataset.

Within the data we scrape reviews from the following categories:

- Baby Products
- Oral Hygiene
- Shaving Products
- Fragrances
- Hair care/Hair Coloring
- Nail Products
- Makeup Products
- Skin Care

We focused mainly on getting as much makeup and skincare products as possible to help keep the focus on cosmetics. To clean the data, we used tm_map to clear the special characters, remove stop words and customize the words we considered stop words. We then went and looked at the top four frequent words, which are breakout, acne, love and face. As we can see from the word cloud, we can summarize that people are having more negative reviews about the products, like having breakouts on their skin from the makeup products that they use. The word love is among the top 4 words but the other 3 do define in one way that the customers have skin allergy issues as well.

Figure 8: Word Cloud



We then went to look at the correlation between the terms and script.

Figure 9: Correlation

Sbreakout	use	sensit	feel	Sacne	lotion	focus	now	time	Sface	wash	coarsefeel	comebreakout	cousin
breakbreakout	0.44	0.42	0.41	0.41	0.43	0.37	0.35	0.33	0.48	0.37	0.37	0.37	0.37
hydrat	0.37	0.37	0.37	0.35	prone	short	scrub	inflan	glossier	plan	scalylbreakout	serious	serious
breakoutcar	0.35	0.35	0.34	0.34	0.33	0.33	0.32	0.32	0.37	0.37	0.37	0.37	0.37
breakoutsbreakout	0.35	0.35	0.34	0.34	start	aveeno	myskin	stress	feel	tight	forget	burn	burn
0.34	0.33	0.33	0.33	0.33	acnefre	ancefre	cleanserbreakout	improvedbreakout	cleanser	0.34	0.33	0.33	0.31
start	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.29	0.29	0.27	0.27
0.32	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.29	0.29	0.27	0.27
essenc	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.29	0.29	0.27	0.27
0.32	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.29	0.29	0.27	0.27
tri	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.29	0.29	0.27	0.27
0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.29	0.29	0.27	0.27
clear	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.27	0.27	0.27	0.27
0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.27	0.27	0.27	0.27
stress	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.27	0.27	0.27	0.27
0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.27	0.27	0.27	0.27
facial	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.27	0.27	0.27	0.27
0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.27	0.27	0.27	0.27
scent	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
treatment	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
cleans	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.27	0.27	0.27	0.27
brighten	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.27	0.27	0.27	0.27
0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.27	0.27	0.27	0.27

When the number is 0.25 that is the lower limit, we have set, and we can set it lower to see more words and higher to see less.

Overall, the Cosmetic review dataset results indicate that consumers are having issues with breakouts and acne. There can be many reasons why a person develops acne and begins to break out, such as hormonal changes, diet, medication, or stress. Yet, other causes can be synthetic perfumes, essential oils, alcohol-based cosmetic products, sodium chloride, and many sodium products. Titanium Dioxide is a factor that has been proven to cause issues that ravage your skin and cause irritation, acne, and rosacea.

EXTENDED RESEARCH

When looking at the two datasets, we thought of what other countries think of the chemical titanium dioxide. It is more common for other countries to have a ban on chemicals, unlike the United States. We found that in 2022 Europe (EU) banned titanium dioxide in food and supplements. In the United Kingdom, the chemical is still under review. It is standard worldwide that there are more regulations on the chemicals in food. We also found that the International Agency for Research on Cancer found that titanium dioxide increases lung cancer and they recommended to avoid cosmetics that are a loose powder like blushes that contain this chemical and be cautious with pressed powders. Yet, companies, committees, and administrations allow chemicals to continue to be in supplements and cosmetics. Although our scope of the analysis is within the United States, we felt it was essential to look at other countries' opinions on these chemicals. We want to help shine a light on regulations on chemicals in the United States to bring more organic and chemical-free products to benefit people's skin. Many chemicals that are FDA approved are not looked at again or changed for the better once approved. There needs to be a constant search for better, more sustainable, and clean ingredients for American customers to consume, whether in makeup, nail care, hair care, baby products, etc.

ALTERNATIVES FOR TITANIUM DIOXIDE

When conducting research, we also found natural alternatives that can be used rather than chemicals like titanium dioxide. These alternatives include starches from rice, corn and tapioca. Corn starch comes from corn kernels, rice starch is from broken white rice, and tapioca starch is from a root vegetable. The benefits of these alternatives for cosmetics can help moisturize the skin, help improve acne, dry skin and help smooth the skin. The last thing is makeup expires and there are no indications on when to throw out products, with the use of starch it can help extend the shelf life of makeup products.

CONCLUSION

To conclude the analysis, we found the most common chemical found in products, titanium dioxide. We have also found that products with these chemicals tend to have skin issues such as acne and breakouts found from the reviews we extracted. Lastly, we extended our research and found countries have banned the top product in US Cosmetics. Our recommendations are for people to become aware of the ingredients in their products and advocate for safer and more pure cosmetic products. This recommendation is a change that takes time and money, but we feel if others have strong opinions on the potential harm of titanium dioxide, then we in the US should too. Our last recommendation is for companies to use natural alternatives or have an organic chain of products for customers to have an option to use a better version of makeup for their daily usage.

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