Differentiation of Drugstore Lipsticks using Organic Markers Measured by Gas Chromatography-Mass Spectrometry

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Abstract

The organic components of the pigment in three drugstore lipstick brands were detected by GC/MS for the purpose of using their differences to discriminate among the brands. Maybelline™, Revlon ™, and L'Oréal ™ were the three brands chosen. The pigment were extracted in petroleum ether and analyzed by GC-MS. After obtaining the chromatograms for all of the samples, it was noted that there was a difference in pigment composition between brands. It was also observed that samples within a brand could be differentiated based on the specific line within the brand it was from. These unique chromatograms will aid forensic analysts in their investigations by eliminating potential suspects.

Introduction

Trace evidence is useful in criminal investigations to link a suspect to a scene or victim. Cosmetic evidence, such as lipstick traces, can aid investigators in making these links. Lipstick traces can be found on a variety of objects such as glasses, bottles, cigarette butts, and even clothing. Establishing a method for analyzing lipstick traces and identifying common components within brands will aid crime labs in criminal investigations.

Lipstick has three main ingredients: wax, oil, and coloring agents[1]. The wax provides the structure for the lipstick and the oil is added to aid in the shine and glide quality. Various pigment dyes are added to achieve the proper shade[1]. Titanium and iron oxides are the most common mineral pigments used as color additives in lipsticks. True pigments, toners, and lakes are organic pigments that may also be used[1]. These color additives provide the wide range of shades that are observed in lipsticks. Lipstick colors that are visually the same may contain various coloring agents. This can lead to the differentiation of lipstick based on pigment formula.

This study focused on brands that are widely sold at drugstores in the United States. Lipsticks sold in drugstores are typically more affordable and accessible to a variety of people. Revlon, Maybelline, and L'Oréal are three top selling drugstore brands that will be analyzed. All lipstick samples had a visually similar shade of red. In this study, a GC-MS technique will be used to differentiate these lipstick samples by examining the chromatograms and spectrums obtained after analysis.

Materials

Lipstick Samples

Three brands, listed in Table 1, were chosen based on availability and popularity among consumers.

Table 1- Drugstore Lipstick Samples

Maybelline	*L'Oréal*	*Revlon*
Color Sensational in Red Revival (645)	Colour Riche in True Red (315)	Super Lustrous Lipcolor in Certainly Red (740)
Color Sensational in Very Cherry (635)	Colour Riche in Blazing Lava (303)	Super Lustrous Lipcolor in Cherries in Snow (440)
Color Sensational in Red Revolution (630)	Colour Riche in British Red (350)	Lip Butter in Candy Apple (035)
Color Sensational in Are You Red-dy? (625)	Infallible Lipcolor in Ravishing Red (312)	Ultra HD Lipcolor in Poinsettiea (840)

GC/MS

Agilent Technologies 7890A GC equipped with a series injector (Model 7683B) and coupled with an Agilent Technologies 5975 C inert MSD with Triple-Axis MSD. The GC column was a Restek Rtx-5MS capillary column 30 m x 0.25 mm coated with AT-1 (0.25 µm film). The GC/MS parameters are given in Table 2.

Table 2 – GC/MS Parameters

Injector Temp.	65 ˚C
Initial Oven Temp.	65 ˚C held for 3 mins
Oven Temp. Program	20 ˚C/min
Final Oven Temp.	280 ˚C held for 10 mins
Injection Volume	0.2 µL solvent
Transfer Line Temp.	250 ˚C
Gas Flow	1.0 ml/min

Methods

Preparation of Samples

- Swabbed lipstick tube on tissue
- Cut a piece of tissue for extraction
- Extraction using 1 mL petroleum ether, vortexed, centrifuged 30 mins
- Supernatant transferred to clean GC vial

Extraction procedure in accordance with Abdullah et. al.[1]

GC-MS Analysis

- All samples run through GC-MS at parameters listed in Table 2
- Chromatograms analyzed after separation

Results

Proper separation was observed in the chromatograms of the lipstick samples. Distinct peaks were shown at acceptable abundancies. The internal standard peaks were present at low abundancies, most likely due to derivatization of the sample. In all of the chromatograms, a distinct benzene peak was present at a retention time of 8.39 minutes. This compound was used as the internal standard for the comparison of the rest of the data. Below is a sample of components that were found in all samples within a brand:

- Maybelline ™ - cyclopentaneactetic acid
- Revlon ™ - Butylated hydroxytoluene
- L'Oréal ™ - pentdecyl ester tricholoroacetic acid

The chromatograms of all Maybelline ™ samples were overlayed to observe similarities. As noted in Figure 1, the chromatograms for the Maybelline ™ samples look the same. The same peaks are present with slight variations in abundance. When the chromatograms of the Revlon ™ samples were overlayed, it was noted that sample R3 and R4 had the most similarities. The chromatograms of the L'Oréal ™ samples were overlayed like Maybelline ™ and Revlon ™. It was noted that samples L1-L3 had the most similarities, while L4 had the most distinct chromatogram.

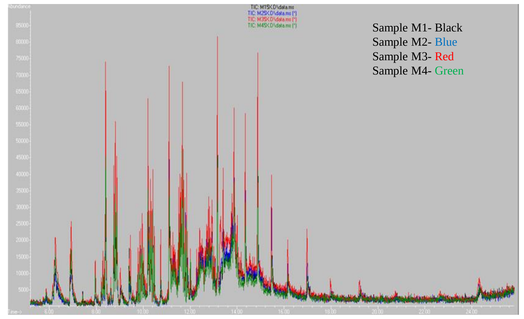

Figure 1: Chromatograms of Maybelline Samples M1-M4

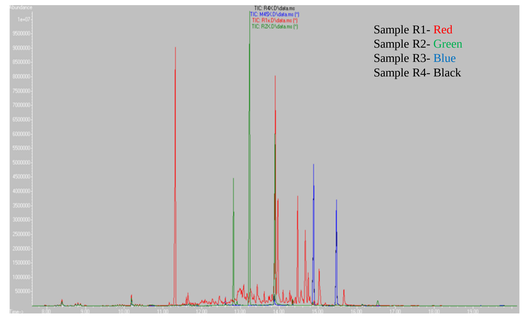

Figure 2: Chromatograms of Revlon Samples R1-R4

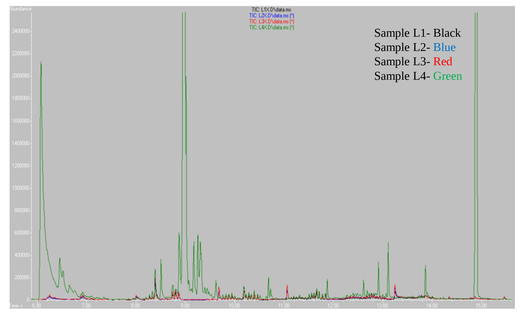

Figure 3: Chromatograms of L'Oréal Samples L1-L4

Discussion

In each lipstick brand, differences in organic components produced a different chromatographic pattern. This shows variation in the chemical composition of the pigment in the samples, despite all samples having a similar shade of red. Figures 1-3 show the chromatograms of all samples in the three drugstore brands.

The figures above show the similarities within the three brands tested. In Table 2, Revlon ™ had the most similarities in samples R3 and R4 because they are both in the Superlustorous line. L'Oréal had the most similarities in samples L1-L3 because they are all part of the Colour Riche line. There were few differences observed in the Maybelline samples because they were all from the Color Sensational line.

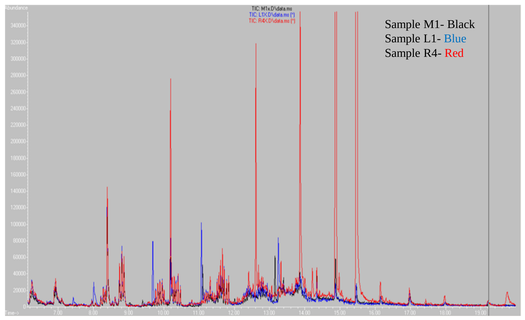

Figure 4: Chromatograms of Samples M1, R4, and L1

Differences within brand are due to the samples being from different lines within the brand. Makeup companies will often come out with different lines within their brand. These lines may offer different "benefits", such as better staying power, different finish (glossy, matte, satin, etc.), or more intense pigmentation. These benefits have slight variations in formula.

Figure 4 shows the difference in chromatograms between Sample R4, L1, and M1. This further illustrates the differences between brands. The differences within these brands can aid in forensic investigations by further differentiating samples that may be found during an investigation.

Conclusions

The results of this study showed that there are differences in pigment composition of the three major drugstore brands, Maybelline™, Revlon ™, and L'Oréal™. The study also showed differences within each brand existed. The differences within brand are based on the formulas of the line in which the lipstick is from. With this information, crime labs can use this technique to differentiate lipstick samples that may be found during an investigation.

References

1. **Abdullah, A., Marimuthu, Y., Haw, C., Said, N., Muslim, N., Hassan, N., Yaacob, M., Hooi, Y. (2011). Forensic discrimination of lipsticks by thin layer chromatography and gas chromatography-mass spectroscopy. *Malaysian Journal of Forensic Science, 2(1).* 22-28**

Acknowledgements

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