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Determination of Lipstick Authenticity Parameters

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Introduction:

Counterfeit medicine and cosmetics are available on the market despite the joint effort of corporations, e-commerce platforms, and the regulatory authorities to "fight the fakes". Techniques that perform physicochemical characterisations are the most reliable way to detect counterfeit cosmetics [1]. However, this is costly and time-consuming therefore a more efficient approach to determine counterfeit cosmetics is beneficial. MAC lipsticks purchased from different vendors were chosen to be investigated in this study. The aim of the study was to show how mechanical characterisation parameters such as hardness and yield stress could be used as a tool to authenticate lipsticks.

Materials & Methods:

Materials

MAC Retro matte lipsticks of the Ruby Woo shade, **Figure 1,** were purchased from seven different vendors. The MAC retail store (London, UK) (ST) and MAC Cosmetics official website (OR) were considered authentic. The remaining lipsticks were obtained from the following online platforms: Notino (NO), eBay (EB), Onbuy (OB), Ali Express (AE), and DH Gate (DH).

Figure 1. MAC lipsticks: in packaging **(a)** and bullets **(b)**.

Methods

Thermogravimetric Analysis (TGA) was performed at a rate of 10 °C/min; T= 25–120 °C.

Differential Scanning Calorimetry (DSC) was conducted at a heating rate of 10 °C/min; T= -30–110 °C.

Fourier Transform Infrared Spectroscopy (FT-IR) spectra were obtained in the 65–4000 cm^{-1} range and a resolution of 8 cm^{-1}.

Figure 2. A lipstick sample on TA platform with a needle probe.

Texture Analysis (TA) penetration tests were performed by applying a needle probe (d = 2 mm) **Figure 2**. An average hardness was the parameter analysed.

Rheological tests were conducted using a parallel, serrated plate geometry, **Figure 3**. The method applied was an isothermal (T = 32 °C), oscillatory stress sweep at *f*=1 Hz. The rigidity (G*) and yield stress (τ) for the linear visco-elastic region (LVR) were the parameters analysed.

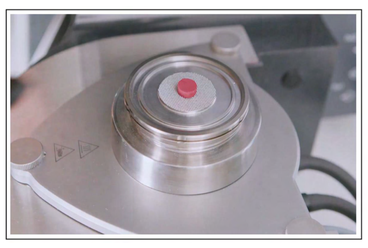

Figure 3. A lipstick sample on the serrated plate of the rheometer.

The data for hardness and yield stress were analysed using descriptive and inferential **statistics** in SPSS software.

Sample preparation

Each sample was prepared for analyses by placing it onto a 3D printed object called 3Dcut, **Figure 4a**. Four individual elements (E) were formed after slicing a single lipstick with a sharp blade, **Figure 4b**. E1–Top TA; E2–Rheology; E3–FT-IR, DCS, and TGA; E4 – Bottom TA.

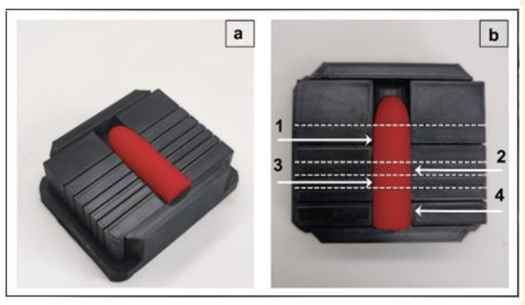

Figure 4. Lipstick preparation for chemical and mechanical lipstick analysis. A lipstick on the 3DCut **(a)** and lipstick elements 1-4 for analyses **(b)**.

Results & Discussion:

Chemical characterisation

Thermal properties such as melting temperature have been proven to be affected by the composition of lipsticks [2]. TGA confirmed there is no significant mass loss. DSC and FT-IR both showed that OR, ST, and NO had almost identical thermograms (**Figure 5**) and spectra (**Figure 6**), while AE, DH, EB, and OB were significantly different. Chemical analysis confirmed that NO lipsticks were likely to be authentic while the lipsticks obtained from other vendors could be a counterfeit.

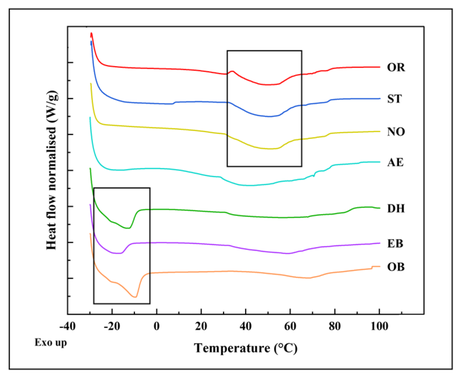

Figure 5. DSC thermograms of all lipsticks.

Mechanical characterisation

The length of the LVR is a measure of the stability of the sample and was determined for all rheology profiles as the data point (τ, G*) when rigidity falls by 10% of its initial value [3]. Rheological and textural analysis confirmed that OR, ST, and NO samples had significantly similar rigidity values (**Figure 7**), as well as the average hardness and yield stress values (**Table 1**). The mechanical characterisation findings were in accordance with chemical characterisation

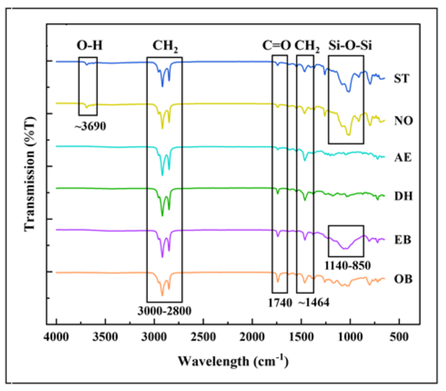

Figure 6. FT-IR spectra of all lipsticks.

Table 1. Hardness and yield stress values, n=10.

Vendor	Average Hardness Tops (g)	Average Hardness Bottoms (g)	τ (Pa)
ST	344 ± 8	336 ± 21	245 ± 20
OR	315 ± 29	290 ± 3	281 ± 21
NO	303 ± 10	283 ± 19	229 ± 22
EB	231 ± 11	237 ± 2	210 ± 17
AE	229 ± 6	169 ± 3	159 ± 15
DH	205 ± 14	175 ± 20	135 ± 13
OB	126 ± 6	123 ± 7	92 ± 9

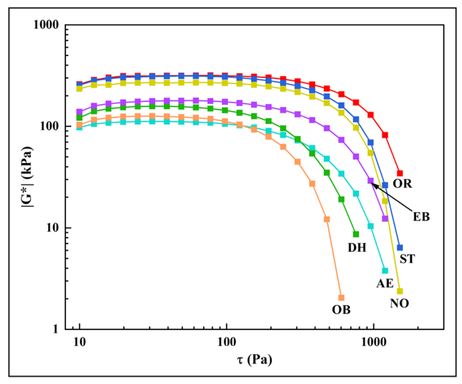

Figure 7. Rheograms of all lipsticks.

Statistical Analysis

Statistical analysis was applied to assess whether the mechanical analysis parameters, hardness and yield stress, could be used to predict the authenticity of the lipsticks. The overlap between the parameters investigated for authentic (ST, O, NO) and non-authentic (EB, AE, DH, OB) was 17.7% for yield stress (**Figure 8a**) and 9.9% for hardness (**Figure 8b**).

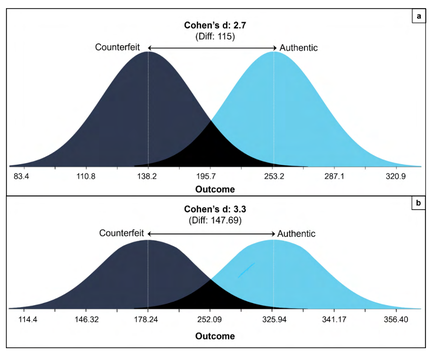

Figure 8. The effect size between authentic and counterfeit lipsticks: yield stress **(a)** and hardness **(b)**.

Conclusions:

This study intended to explore the possibility of applying mechanical parameters, yield stress and hardness, to authenticate lipsticks. Statistical analysis supported that yield stress and hardness were accurate predictors of authenticity and showed findings compatible with chemical analysis. Mechanical characterisation can be used as an overall reliable substitute for chemical analysis to determine the likelihood of a lipstick to be authentic.

References:

[1] S. Singh, V. Saran, M. Mishra and A. Gupta, "Forensic examination of lipstick by the various physio-chemical and instrumental method," International Journal of Social Relevance & Concern, vol. 3, no. 9, pp. 1-7, 2015.
[2] A. Bono, H. Mun and M. Rajin, "Effect of various formulation on viscosity and melting point of natural ingredient based lipstick," Studies in Surface Science and Catalysis, vol. 159, pp. 693-696, 2006.
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