Lipsticks Elemental Analysis by Energy Dispersive X-Ray Used as Criminal Evidence

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Abstract

Since ancient times, man has been interested in showing his appearance in the best shape and has used make-up materials including lipstick for this purpose. Four lipstick samples were selected for one brand with different colors (Lipstick-03, Lipstick-23, Lipstick-29 and Lipstick-51) as well as two different colors for the so-called magic lipstick (Luxe orang and Luxe yellow). Energy-dispersive X-ray spectroscopy (EDX) is an analytical technique was used for the elemental analysis for the selected six samples. These tests aims to explain that there are clear elemental differences for the selected samples which can be used to define the identity of each sample. Lipstick-51 has been selected to contaminate some substances that can be commonly used in homes, offices and others. The selected substances were (Plastic bottle, Plastic cup, Glass, Cigarette filter and Tissue paper). The elemental results indicate a partial match for the types of elements in lipstick contaminated with substances taken from the crime scene compared to the original Lipstick-51. Results could be more accurate when identifying the contaminated material and select the most concentrated positions for samples taken from the crime scene and for conducting tests.

Keywords: *Lipstick, EDX, Crime scene, Element.*

Introduction

Since the dawn of civilization cosmetics have constituted a part of routine body care not only by the upper strata of the society but also by middle and low class people(1).

A cosmetic product is any substance or preparation intended to be placed in contact with the various external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or applied to the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly for the purpose of cleaning, perfuming, protection, changing their appearance, correcting body odors' and keeping the surfaces in good condition(2,3).The demand for cosmetic products has increased recently, resulting in massive production by the cosmetic industry. Different products are marketed under the name of cosmetics, such as creams, beauty soaps, talcum and facial powder, lotions, shampoos, hair products such as haircolors, baby products, bath oils, personal hygiene products,perfumes, lipsticks, skin care products, makeup products,shaving creams, body lotions, fingernail polish and polishremoval(4-8). In addition, the use of herbal medicinal preparationsis common in most developing countries due to poverty and disillusionment with conventional medical care(9,10).

Heavy metals are found naturally in the environment in rocks, soil and water, and therefore exist in the manufacture of pigments and other raw materials in all industries including the cosmetics industry. Some of these metals have been used as cosmetic ingredients in the past. Examples include the preservative thimerosal (mercury), the progressive hair dye lead acetate and a

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number of tattoo pigments such as red cinnabar (mercuric sulfide), Cadmium is a deep yellow to orange pigment and mostly present in lipsticks and face powders. The use of cadmium in cosmetics products are due to its color property as it has been used as a color pigment in many industries[11].

For more than two thousand years humankind has been attempting to solve crimes through the application of scientific knowledge. Physical evidence often plays a pivotal role in reconstructing the series of events surrounding a crime, and may be used to prove or disprove a point in question based upon its discernible characteristics.[12] In addition, trace physical evidence can be instrumental in providing evidence of association. This value stems from the exchange principle developed by Edmond Locard, who posited that physical contact between two surfaces will likely result in a cross-transfer of matter between them[13,14]. Zadora and Brozek-Mucha applied cluster analysis with scanning electron microscopy (SEM)-EDX to differentiate glass samples into use-type groups based on their elemental content[15]. An emerging area of interest in forensics is the examination of cosmetic products. Kulikov *et al.* employed wavelength-dispersive X-ray fluorescence spectrometry for the elemental analysis of 39 cosmetic powders[16]. Cluster analysis and PCA were able to clearly discriminate between samples possessing traditional ingredient or mineral-based formulations, and also distinguish specific manufacturers of the latter. Salahioglu *et al.* later demonstrated the use of Raman spectroscopy to discriminate lipstick samples deposited on textile fibers, cigarette butts and paper tissues. The combined SEM/EDX techniqueis indispensable for fast, nondestructive, physicochemical analysis of trace evidence and solid objects of anysize.The SEM/EDX isnot ideal for quantitative analysis of elements presentas traces. The ability of the SEM/EDX to detect an element below aminimum detection limit (MDL) (0.1–0.3% w/w)[17].

Experimental Part: Sampling: Four lipstick samples were selected for one brand with different colors (Lipstick-03,Lipstick-23, Lipstick-29 and Lipstick-51) as well as two different colors for the so-called magic lipstick(Luxe orang and Luxe yellow).

Elemental Analysis: Energy-dispersive X-ray spectroscopy (EDS, EDX, or XEDS) Bruker model XFlash6I10, is an analytical technique we used for the elemental analysis for the selected six samples (Lipstick-03, Lipstick-23, Lipstick-29, Lipstick-51, Luxe orang and Luxe yellow).

Simulation of samples taken from the crime scene: One type of lipstick (Lipstick-51) has been selected to contaminate some substances that can be commonly used in homes, offices and others. The selected substances were (Plastic bottle,Plastic cup,Glass,Cigarette filter and Tissue paper) as shown in figure 1(pictures 1-5).

Picture 1: Plastic bottle

Picture 2:Plastic cup

Picture 3: Glass

Picture 4:Cigarette filter

Picture 5: Tissue paper

Figure 1: Simulation of contaminated samples with lipstick taken from the crime scene

Result and Discussion

EDX Analysis for the selected samples: EDX analysis was carried out for the four lipstick samples (Lipstick-03, Lipstick-23, Lipstick-29 and Lipstick-51) as well as for the two different colors for the so-called magic lipstick (Luxe orang and Luxe yellow). These tests aims to explain that there are clear elemental differences for the selected samples which can be used to define the identity of each sample. Figures 2, shows EDX analysis for the selected sampleLipstick-03.

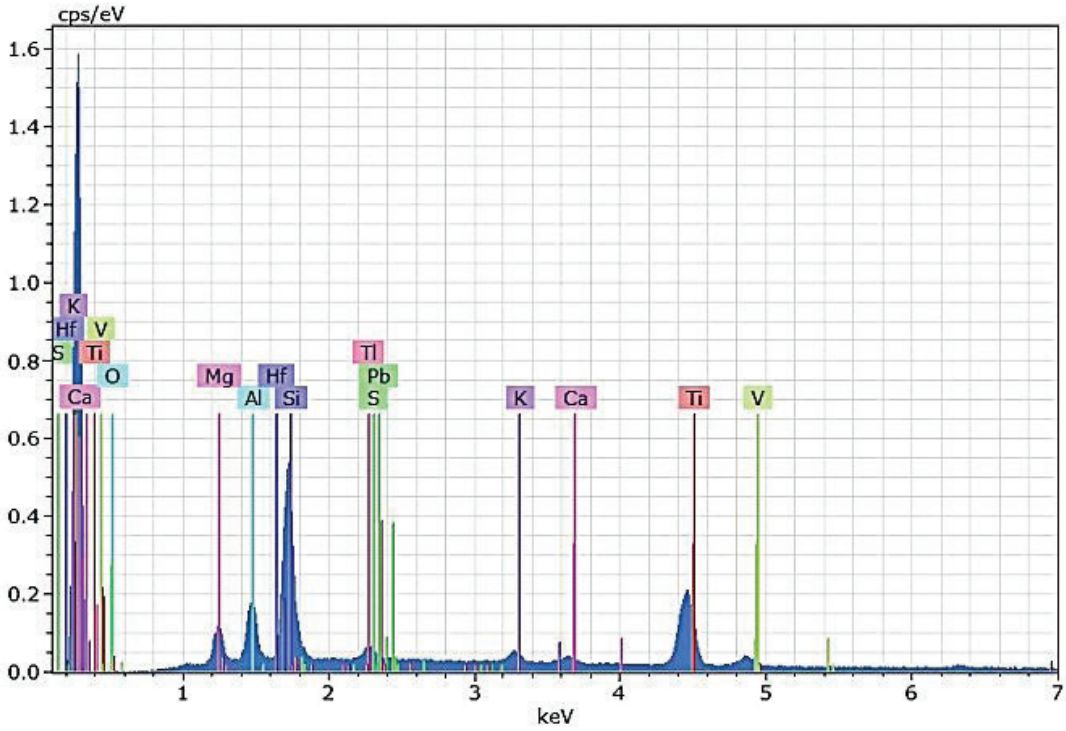

Figure 2: EDX for Lipstick-03

Samples withdrawn from crime scene as criminal evidence: Criminal evidence inspectors are keen to select samples that may be of benefit from the crime scene. Contaminants with personal belongings, such as lipstick, will certainly be of interest to the relationship of someone to the crime scene. The prepared samples which explained in sec. 2.3 were examined for elemental composition using EDX instrument. Results for the five samples stated in figures: 3 and 4.

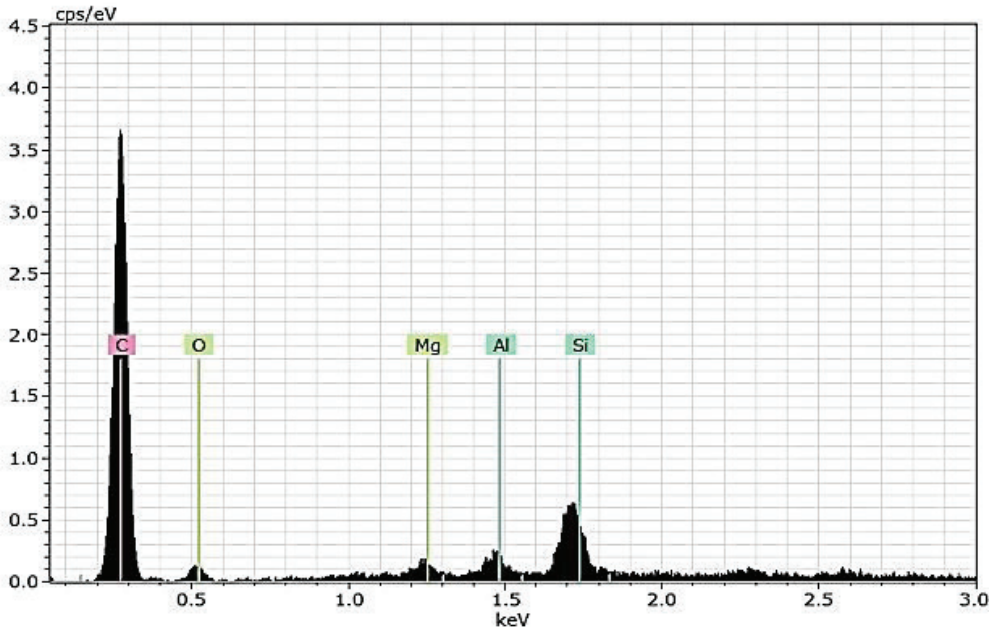

Figure 3: Plastic bottle contaminated with Lipstick-51

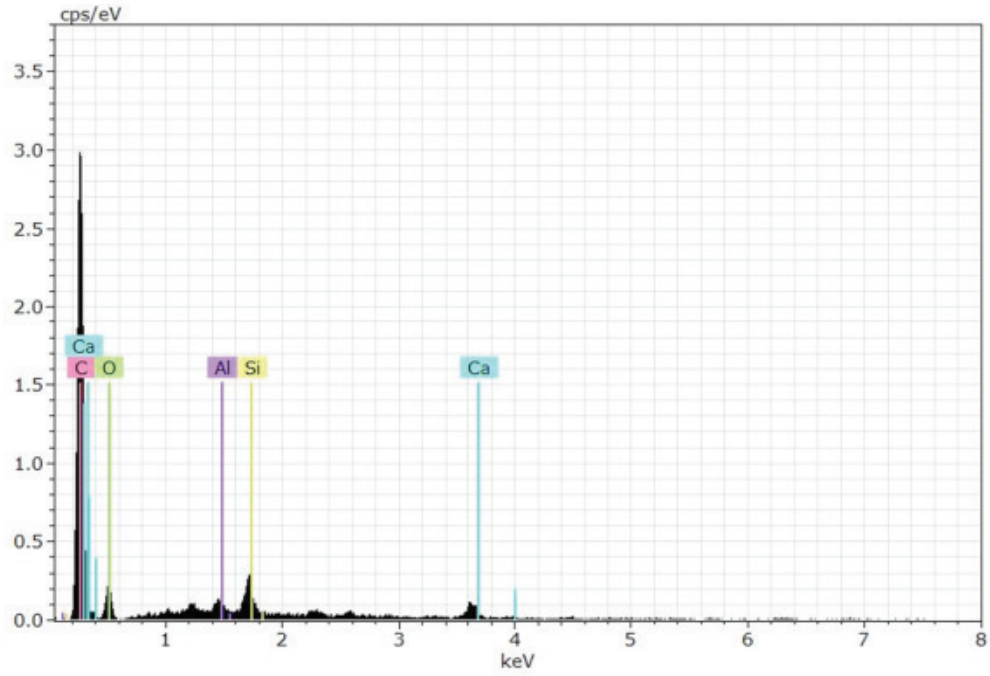

Figure 4: Cigarette filter contaminated with Lipstick-51

In order to identify the elements in the samples taken from the crime site that belong to the contaminant (Lipstick-51), these samples must be examined using the same instrument (EDX), but without contaminants. Therefore, the elements of the contaminant will be known. Table 1 shows the elemental analysis for the contaminant and uncontaminated samples.

Table 1: The elemental analysis for the contaminant and uncontaminated samples

Sample	Elements
(**Lipstick-51**) (contaminant)	C, Ba, Mg, Se, Al, Si, Hg, Ru, K, Ba, Ca
Plastic bottle withcontaminant	C, O, **Mg, Al, Si**
Plastic bottle without contaminant	C, O
Plastic cup with contaminant	C, O, Al, **Fe, Si**
Plastic cup without contaminant	C, O, Al
Glass bottle with contaminant	C, O, Al, Si, **Fe**
Glass bottle without contaminant	C, O, Al, Si
Cigarette filter with contaminant	C, O, Al, **Ca, Si**
Cigarette filter without contaminant	C, O, Al
Tissue paper with contaminant	C, O, **Al, Si, Mg**
Tissue paper without contaminant	C, O

From table 1 it was found that the elements belongs to the lipstick-51 in the plastic bottle (**Mg, Al, Si),** Plastic cup (**Fe, Si**), Glass bottle (**Fe**), Cigarette filter (**Ca, Si**) and for Tissue paper (**Al, Si, Mg**). These elements are part of the elements in the lipstick-51(C, Ba, Mg, Se, Al, Si, Hg, Ru, K, Ba, Ca).On the basis of these results, it takes two things to focus on:

1. Accuracy in taking the sample from the crime scene so that it contains the most contaminated material.
2. The EDX operator must examine and select the most concentrated places of the contaminated sample, as well as a precise focus of the radiation(X-ray) on the site of the contamination, making the results more accurate.

Conclusion

The crime scene contains many elements and observations through which forensic inspectors can access the facts and analyze the components of the crime. The use of EDX technology could be a guide to identify the nature of existing elements as contaminants for samples taken from the crime scene. It was recommended to be more accurate in identifying the contaminated material and select the most concentrated positions when taking samples from the crime scene and conducting tests.

Ethical Clearance: The Research Ethical Committee at scientific research by ethical approval of both MOH and MOHSER in Iraq.

Conflict of Interest: Non

Funding: Self-funding

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