Determination of Toxic Elements in Beauty Creams by X-ray Spectrometric Techniques (2001 – 2002)

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ABSTRACT

This paper is carried out to examine the contents of toxic heavy metals in various kinds of beauty creams by using Energy Dispersive X–ray Fluorescence Technique (EDXRF). By applying EDXRF system, it is found that most of the beauty cream contained titanium and zinc, and some of the beauty cream contained lead, bismuth, iron and mercury. Among heavy toxic metals, mercury is more harmful to human's health.

1. INTRODUCTION

Energy Dispersive X-ray (EDXRF) spectrometry is an established technique for qualitative and quantitative element analysis. EDXRF analysis plays a considerable role in elemental analysis, since it usually enable the simultaneous detection of several elements, present in a wide concentration range (several percent down to a few parts per million) at relatively high speed and low cost per result. It has a number of applications in geology, material sciences, medicine, biology, environmental sciences and nuclear industry.

The aim of the study is to develop EDXRF technique for toxic elements analysis especially for beauty cream (cosmetics). The toxic elements levels are not constant in different batches of same products sampled at different periods. The results have for reaching implications on the quality control process during the manufacture and it is possible that some of the products in the market could be having higher levels of toxic elements than those sampled during this experiments.

EDXRF analysis of beauty creams showed that there was mercury present in significant amounts 0.19% in cosmetic brands being sold in Myanmar. The World Health Organization (WHO) limit of mercury in human blood is 5. The effect of mercury in the skin lightener creams used to improve facial appearances is that kidneys damage.

In the present work, compositions of toxic elements in various kinds of beauty creams are determined by XRF technique applying Emission –Transmission technique. The performance and results are presented in this paper.

2. EXPERIMENTAL

Samples of beauty creams are bought randomly from various shops in Myanmar. To compare the cosmetics made in foreign and local, various kinds of beauty creams made in foreign and local are used. The sample preparation for the XRF analysis is very

simple and fast mainly in homogenization is necessary, but it is a critical step. This step gives the main source of error and need to be careful for contamination. Each sample is put into a clean beaker and then heated on a water bath at 40 – 50 C until melting is complete. The melt of beauty cream is then poured onto a 2.5 cm diameter Mylar (Spectra film grade) supported on aluminium ring so as to acquire the configuration of a homogenous pellet (0.3g) when cooled. No other physical and chemical treatments are applied to the sample.

The number of detector output pulses is number of particles striking the detector multiplied by the efficiency of the detector. The counting rate is obtained directly by a determination, through an electronic means, of the rate of arrival of the pulse. The output from a detector is a small change pulse. It is necessary to precondition this pulse so that it can be utilized in a linear amplifier system which provides the necessary pulse shaping and amplification. The output of the detector appears as a pulse of current at the input of the pre-amplifier.

The output of the preamplifier is connected to pulse-shaping main amplifier. The pulses are amplified by amplifier of Canberra model 2020. The output of amplifier is connected to analog-to-digital converter (ADC) to Multi-channel analyzer (MCA) Canberra series 35 plus. The analog-to digital converter (ADC) is a key element in determining the performance characteristics of the analyzer. The series 35 plus consists of a master controller and five sections: memory, display, signal, processing, Operator/MCA interface and data input/output.

By using 'spectrum transfer program', the spectrum is transferred from MCA is compatible microcomputer of IBM/AT. This program simultaneous by with moving the spectral data from MCA to the computer, perform the reformatting so the spectrum stored in the file in the selected directory can be directly use as the input is the QXAS (quantitative X-ray analysis system). The X-ray spectra are fitting by program of analysis of X-ray spectra by Iterative Least Squares fitting (AXIL) which is a well known non-linear fitting program which performs complex and accurate determination of peak area under individual peak in the spectrum and Analysis Results (ASR) files are created.

The energy dispersive X-ray fluorescence analysis system setup and experimental procedure is shown in Fig- 1.

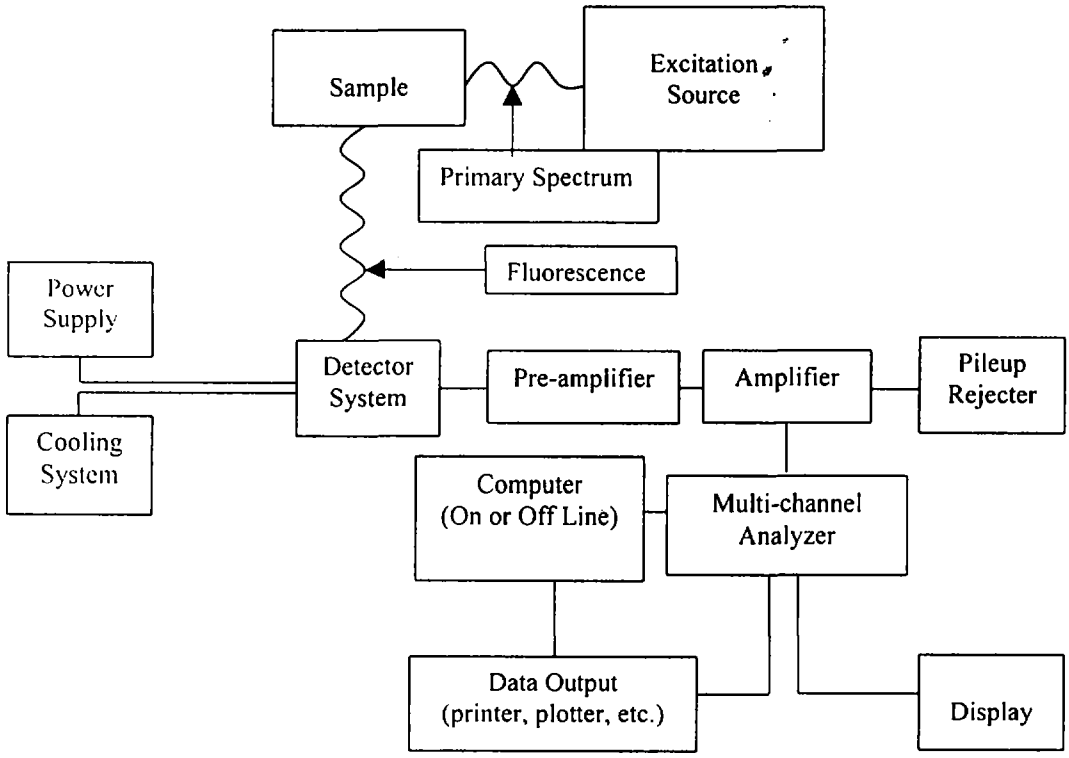

Fig. 1.Basis Components for EDXRF System

3. Calibration and Sensitivity Calibration

Energy calibration is carried out by measurement of pure standard metal sheets namely titanium (Ti) and molybdenum (Mo). The energy calibration spectrum of Ti and Mo is measured and the collected spectrum of Ti and Mo at MCA is calibrated with the channel number and known energies of Ti and Mo.

For any spectrum in which there is a sufficient number of single peaks with known energies, the determination of the X- ray energies is straightforward. The primary question is the consideration of the precision and accuracy to carry out such a measurement, and the corresponding care that must be taken.

Sensitivity calibration of EDXRF system is carried out by measurement of pure standard ZnO cellulose pellets. Firstly, pure zinc oxide 100% is measured. Secondly, pure zinc oxide 50% is mixed with cellulose 50% and then is measured side by side. Finally pure zinc oxide 25% is mixed with cellulose 75% and then is measured side by side. The energy calibration spectrum of zinc oxide cellulose (ZnO cellulose) is measured the collected spectrum of ZnO cellulose at MCA is calibrated with the channel number and known energies Zn (zinc).

Sensitivity calibration of XRF system is carried out on measuring the coherent and incoherent scattering of fluorescence X-ray generated by excitation of pure standard ZnO cellulose. The spectra of each pure standard ZnO cellulose are collected and the coherent and incoherent scatter peaks of each standard ZnO cellulose are measured with

MCA software. System calibration is done by the concentration with AXIL software program.

ZnO cellulose pellets are excited by Cd-109 source and the spectra are collected at Multi Channel Analyzer (MCA). The data of ZnO cellulose standard pellets are presented in Table (1).

Table. 1. The Calibration Data using ZnO Cellulose Pellets

	Zn%	ZnO%	ZnK_α	Incoherent	Coherent	$\frac{ZnK_\alpha}{Inc+Coh}$
BLANK	0	0	0	0	0	0.000
ZNO 25	20.085	25	362717	170425	52202	1.629
ZNO252	20.085	25	367189	167871	52181	1.669
ZNOCELL	40.17	50	454290	84827	42570	3.566
ZNOCELL2	40.17	50	440446	87642	43578	3.357
ZNO	80.34	100	533741	38766	36802	7.063

The calibration curve can be obtained by the calibration data using standard ZnO cellulose pellets. From the calibration curve, they can be obtained.

$y = 0.0885x - 0.0818$ ---------- (1)

According to straight line Equation $y = mx + c$

$ZnK_\alpha / (Inc + Coh) = a_0 + a_1 * concentration$ --------- (2)

$a_0 = -0.0818$

$a_1 = 0.0885$

The calibration curve obtained from ZnO cellulose pellets can be shown in Fig.(2).

The calibration spectrum of ZnO cellulose pellets can be seen in Fig. (3).

4. Beauty Cream Samples Measurement

The samples of analyzed creams are excited by Cd-109 source and the spectra are collected at MCA. By using "Spectrum transfer program, "the spectra are transferred from MCA to computer. After reformatting in the computer, the spectra stored in the files in the selected directory can be directly used as the input to the QXAS. These X-ray spectra are fitted by program of Analysis of X-ray spectra by Iterative Least-squares fitting (AXIL). The analysis of result files of concentration of individual peak such as zinc, lead, bismuth, mercury, titanium are created.

The experiment is carried out by measuring the brands of local cosmetics such as SHE, Sander, Unine, Playboy, Maungth Mahaythi. The brands of foreign cosmetics such as Arche, Dream, Mena, Panstick, Renow-D, Promina are examined.

X-ray spectra of Mena made in foreign is excited by Cd-109 source and is shown in Fig.(4).

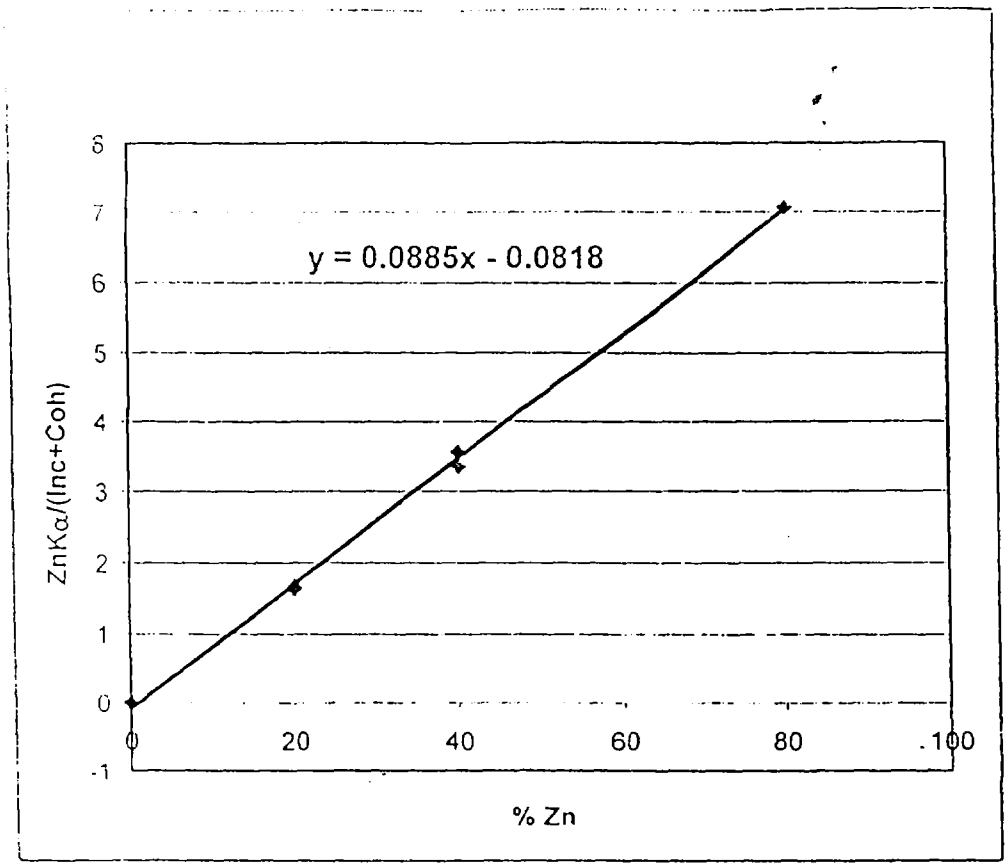

Fig. 2 ZnO Calibration Curve

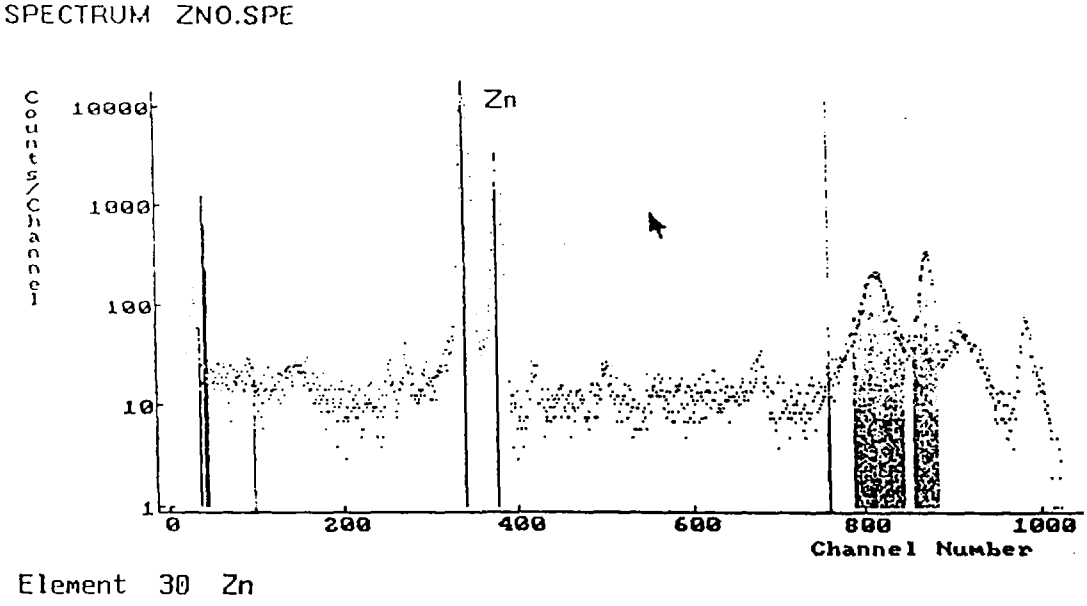

Fig. 3 The Calibration Spectrum of ZnO Cellulose.

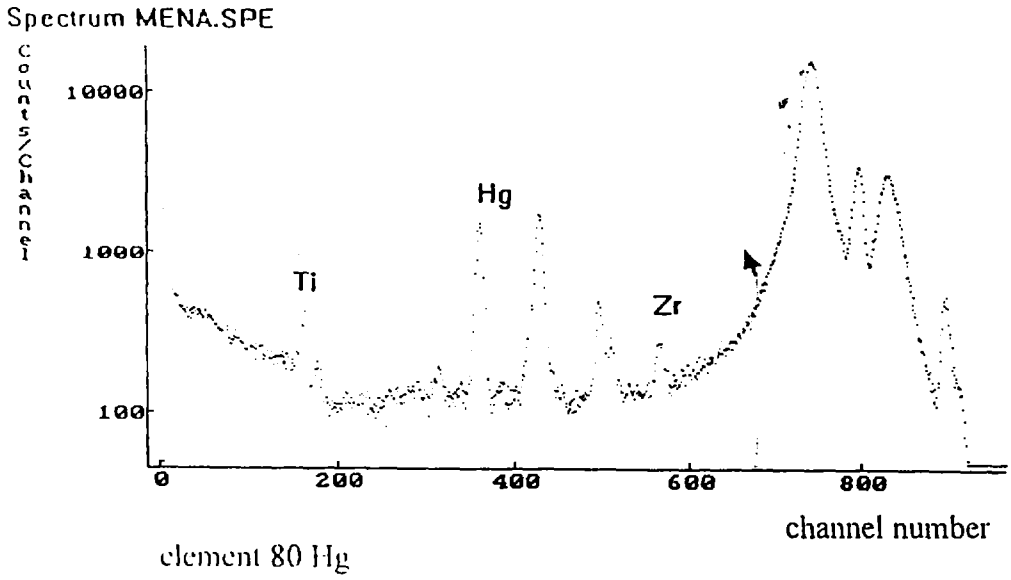

Fig. 4 : X-ray Spectrum of Mena Cream Sample (Computer Printout)

5. Calculation of Zn Concentration of Beauty Creams.

From Equation (2), the concentration of Zn can be calculated.

$$\text{Zn Concentration} = \frac{1}{a_1} \left[\frac{ZnK_\alpha}{Inc+Coh} - a_0 \right] \quad \text{---------- (3)}$$

The Zn concentration for beauty creams can be calculated by using data from calibration curve Fig. (2). From this calibration curve, a_0 and a_1 are used for calibration of Zn concentration for beauty creams. The detail calculation of Zn concentration for beauty creams are presented in Appendix.

Table (2) shows the analysis of beauty cream samples by using of calibration data of Zn cellulose pellets.

Table. 2. Analysis of Beauty Cream Samples.

No.	Brands	ZnK_α	Incoherent	Coherent	$\frac{ZnK_\alpha}{Inc+Coh}$	Concentration Zn%
1	ARCHE	86532	248890	56120	0.2837	4.1
2	SHE	572981	84012	40944	4.5854	52.7
3	SANDAR	87701	198833	50321	0.3519	4.9
4	UNINE	548676	91673	42191	4.0987	47.2
5	PLAYBOY	272616	71895	43760	2.3571	27.9
6	DREAM	2998	288232	61095	0.0085	1.0
7	MENA	96	344922	57554	0.0002	0.9
8	PANSTICK	141	166904	53550	0.0006	0.9
9	MAHAYTHI	552410	89367	41786	4.2119	48.5
10	RENOW-D	474595	136238	44944	2.6194	30.5
11	PROMINA	91087	153876	35741	0.4803	6.4

6. RESULTS AND DISCUSSIONS

The beauty cream samples are measured by radio-isotopes X-ray fluorescence technique.

On measuring ZnO cellulose pellets, the calibration curve is obtained as shown in Fig. 2.System calibration is done by these concentration with AXIL software program. By using window AXIL program and quantitative analysis of fundamental parameter method. the elemental concentration of each element obtained in different brands of beauty creams can be obtained as result file. The summaries of analysis beauty cream results are obtained in Table(3).

From the results, the toxic heavy metals such as mercury, iron and lead are present in some of the samples. Some of cosmetics that in brand namely, Promina, Arche, Renow-D, Dream and Maungth Mahaythi contain bismuth. In the brand such as Mena, there is mercury (0.19%) above the WHO limits. A small amount of lead are present in the brands such as Renow-D, Sandar, Promina, Arche,Mena and Panstick. There are a large amount of lead in brands such as SHE, Unine, Maungth Mahaythi and Playboy.

One of the beauty creams, Panstick, which has the patent mentions that contain the necessary ingredients in cosmetic rules.

Nowadays, many ladies in everywhere are widely used the beauty creams according to their living status. Anyhow from the point of view of health hazard, it is better to avoid the use of beauty creams which contain toxic elements. In beauty creams, toxic elements such as lead, mercury and iron are found.

7. CONCLUSIONS

According to research and examination, the following brand of beauty cream contained mercury and the user should not use these products. It is Mena; Mercury metal is protoplasmic poisons that can be fatal to humans, and plants. Mercury may enter the body through the skin, gastrointestinal tract, and respiratory tract. Cosmetic use of

mercury was prohibited except in special cases, was dumping waste containing more than trace amounts of mercury.

SHE, Unine, Maungth, Mahaythi, and Playboy contain a large amount of lead. The renal or neurologic impairment has occurred. After poisoning by ingestion, induce emesis and then catharsis. Renow-D, Sandar, Promina, Arche, Panstick contain a small amount of lead. They, except Arche and Promina, should be used than the above mentioned brands that contained more lead percentage.

Some of beauty creams that in brands namely, Promina, Arche, Renow-D, Dream and Maungth Mahaythi contain bismuth. This bismuth is readily taken up by red blood cells then deposited in the liver, kidney, muscle, bone, skin and hair. The use should avoid these brands of beauty creams.

Finally, beauty creams should be produced in such a way to protect the product from microbial and other contamination. The quantity of a product depends on the starting materials, production and quality control process, building, equipment and personal involved.

As the conclusion, a quality control system should be developed, established and implemented as a means by which stated policies and objectives will be achieved. In the manufacture of beauty cream products, overall control and monitoring is essential to ensure that the users receive products of specified quality.

Acknowledgment

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Table (3) Summary of Analysis Beauty Cream Results

No.	Brands	Concentration							
		Ti	Fe	Zn	Zr(ppm)	Np(ppm)	Hg	Pb	Bi
1	ARCHE	2.00%	-	4.10%	180	LDL	-	350ppm	2.60%
2	SHE	1.90%	-	52.70%	290	340	-	0.60%	-
3	SANDAR	3.40%	0.98%	4.90%	LDL	840	-	LDL	-
4	UNINE	2.10%	-	47.24%	170	380	-	0.46%	-
5	PLAYBOY	2.20%	-	27.60%	100	1400	-	3.10%	-
6	DREAM	0.70%	-	1.04%	LDL	110	-	-	5.65%
7	MENA	1.22%	0.57%	0.96%	LDL	LDL	-	LDL	-
8	PANSTICK	3.40%	-	0.96%	LDL	LDL	0.19%	LDL	-
9	MAHAYTHI	2.60%	-	48.52%	100	1200	-	0.62%	LDL
10	RENOW-D	1.60%	-	30.53%	180	LDL	-	500ppm	2.40%
11	PROMINA	3.00%	-	6.35%	90	LDL	-	500PPM	3.40%

LDL = Low Detection Limit
LDL for Bi = 0.04%
LDL for Zr = 67 ppm
LDL for Pb = 50 ppm
LDL for Nb = 51 ppm