Determined the Concentration Elements to Human Nail Using X-Ray Fluorescence Technique

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Abstract

Cancer constitutes a serious disease and a major health problem in worldwide, a lot of people were infected with this dangerous disease, Therefore, there must be attention to this disease through diagnosis and prevention there. In this study, we determined the relationship between the Cancer and the concentration of trace elements by comparing the concentration trace elements for infected and non-infected people. The trace elements concentrations to nails are one of the diagnostic criteria that easily to detect and dated this disease without any harm to the patient. Eight nails samples were collected from cancer-infected and eight samples from non-infected of the relatives of first-degree. All samples were measured by the concentration’s elements using X-ray fluorescence. The accuracy and precision were verified using standard samples. The results showed that the average concentrations of elements (Magnesium, silicon, potassium, calcium, ironand selenium,) were lower for cancer patients than their non-infected relatives and the trace elements (zinc, copper, cadmium, lead, chromium, manganese) were higher for cancer patients than their non-infected relatives. In conclusion, we need further studies to confirm the relationship between trace elements and cancer disease and attention the effect of diet and environmental risk of cancer.

Key word: X-Ray Fluorescence, Trace elements, Cancer, Nails.
1. Introduction

Identifying the concentration elements for biological tissues, such as nails, where used in several purposes such as the level of environmental pollution [1]. The impact of work areas to the healthy workers, and the diagnosis of many diseases such as diabetes [2]. Heart disease and cancer [3]. And indication of many characteristics such as heavy metal exposure related to a geographical location, drinking water, type of food [4]. Soil, smoking [5]. And some diseases [6].

In recent years, the researchers have attention to the measurement of trace elements in human tissues because these elements and effect of the biochemical and physiological processes [7]. Trace element concentrations in the nails were used to monitor exposure to toxic elements or to assess the association between increased or decreased concentrations of elements with cancer [8].

Cancer is a complex disease, several factors cause it like food system, environmental factors, genetic and smoking [9]. The probability of cancer incidence is due to environmental factors 65-70%, 30-40% dietary habits and only 2% genetic predisposition [10]. Blood and other Body fluids give transient concentrations, while the nail growth is a continuous process of longevity. Therefore, the presence of minerals is long. Moreover, nails are a continuous record of concentration of elements. Also, we have features such as ease of collection and storage because they do not require any complicated conditions for analysis. All these features make it a more attractive screening and diagnostic tool in developing countries [11]. Several studies have focused on the relationship between heavy metals and human’s cancer [12, 13].

There are many techniques that can be used to determine the concentrations of elements for nails, such as Atomic Absorption Spectrometry (AAS) [14]. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) [15]. Neutron Activated Analysis (NAA) [16]. X-ray fluorescence (XRF) technique [17]. It was chosen in this study because the preparation of sample easily, accurate results and the analyzing of many samples at the same time was possible. The incidence of cancer has increased in recent decades; the number of cases reported annually was expected to raise from 10 million cases in 2000 to 15 million cases in 2030 according to the World Health Organization (WHO) [18]. Therefore, it needs many researches on screening methods, disease symptoms and cancer indicator in the initial stages. The aim of this study is to identify the concentrations of trace elements in nails of patients with cancer and compared with their relative non-infected, and identified a possible relationship between the concentrations of elements and cancer. This study attempted to develop the possibility of monitoring cancer incidence and to identify the effect of concentrations elements to cancer incidence.

2. Materials and Method

2.1. Sample Collection and Preparation

Eight samples were collected from the people with cancer and eight samples from their relatively non-infected that were in hospital. A special form has been filled for each person, including the person's age, place of residence, gender, occupation, and diseases clinical stage as shown in Table 1. The people washed their hands with soap and water and then dried it with paper tissue, after that the nails was trimmed. The samples were immersed in a 70% ethanol
solution for 10 minutes to reduce the risk of microbiological pollutants such as fungi and bacteria, then we washed the samples from ethanol.

Table 1. The history of human with cancer.

| Sample code | Sex | Edge | Side | History of the disease / month | Treatment time / month |
|-------------|-----|------|------|--------------------------------|------------------------|
| S1          | Male| 74   | Karkh| 5                              | 2                      |
| S2          | Male| 52   | Karkh| 11                             | 10                     |
| S3          | Male| 74   | Karkh| 8                              | 6                      |
| S4          | Female| 70 | Diyal| 12                             | 5                      |
| S5          | Female| 67 | Rusafa| 7                              | 6                      |
| S6          | Female| 70 | Karkh| 18                             | 14                     |
| S7          | Male| 10   | Karkh| 12                             | 8                      |
| S8          | Male| 68   | Karkh| 24                             | 16                     |

2.2. Preparation of samples

The samples were crushed with an electric grinder to a diameter range between (60µm - 125µm) that makes the powder a homogenous particle size. This process ensured the minimizing of the matrix effect error. The crushed samples were dried at 200°C for 30min with the oven and then pressed in a hydraulic press into 100 mg/cm² pellet with a diameter of 32 mm. The weight of each samples was (3-4) gm.

2.3. Procedure for sample analysis

The samples were analyzed using the SPECTRO XEPOS XRF unit with silicon drift lithium detector. The resolution of this system is 45eV at 5.9KeV to the iron isotope ^{55}\text{Fe}. This detector did not need liquid nitrogen for cooling; it was cooled using Peltier effect. The X-ray unit has formed tube with beryllium window; the thickness was approximately 0.076 mm. This system uses targets that covered a wide range of X-ray energies. These targets were highly oriented pyrolytic graphite (HOPG), alumina (Al₂O₃) and Molybdenum.

3. Results and Discussion

X-ray spectroscopy technique is an acceptable accuracy for such research as shown in Table 2, 3. The tables show the concentrations elements (Magnesium, Silicon, Potassium, Calcium, Iron and selenium) of the infected person’s nails and compared with their healthy relatives. The results showed decrease in the concentration of elements in above for cancer patients. The results showed a decrease in the concentration of calcium and magnesium, as some studies had shown. Patients with brain, lymph and leukemia usually have low calcium and magnesium concentrations [19]. Table 4. Showed the increase the concentration elements (Arsenal, chromium, Zinc, Copper, cadmium and, lead) in the cancer patient’s nails compared with their first-degree relatives. Our study had showed a decrease in the concentration of selenium, in cancer patients relative to healthy relatives. This is consistent with many studies and this has been proven by clinical trials [20]. Other researchers have also observed that selenium supplements were effective in suppressing cancers of the gastrointestinal [21]. Clinical trials have also shown that low selenium concentration is an important factor in cancer, especially gastrointestinal, prostate and breast cancer [22]. The manganese component ranged from the increase and decrease among cancer patients and their relatives.Arsenic and Cadmium are very
toxic elements; these elements are a carcinogen even at very low levels and have no beneficial functions for humans [11]. Chromium is an essential element in low concentration but it is toxic and known human carcinogens [11]. Lead is a deadly poison and the increase the concentration causes many diseases, including cancer, where it enters the human body through air, water and food.

**Table 2.** Shows the comparison of results between experimental data and the results published in certificate data to [PCC-1].

| No | A. N. | E.S | Con* | Con** | Error % | No. | A. N. | E.S | Con* | Con** | Error % |
|----|-------|-----|------|-------|---------|-----|-------|-----|------|-------|---------|
| 1  | 11    | Na  | 0.35 | 0.36  | 2.78    | 10  | 25    | Mn  | 0.52 | 0.50  | 4.00    |
| 2  | 12    | Mg  | 28.34| 26.19 | 8.21    | 11  | 26    | Fe  | 1.41 | 1.25  | 12.80   |
| 3  | 13    | Al  | 0.33 | 0.35  | 5.71    | 12  | 27    | Co  | 0.006| 0.0062| 3.22    |
| 4  | 14    | Si  | 20.61| 19.48 | 5.80    | 13  | 28    | Ni  | 0.34 | 0.37  | 8.11    |
| 5  | 15    | P   | 0.37 | 0.40  | 7.50    | 14  | 29    | Cu  | 0.0001| 0.0001| 0       |
| 5  | 16    | S   | 0.26 | 0.24  | 6.56    | 15  | 30    | Zn  | 1.71 | 1.87  | 8.56    |
| 6  | 17    | Cl  | 0.75 | 0.87  | 13.79   | 16  | 34    | Se  | 0.002| 0.003 | 33.33   |
| 7  | 19    | K   | 9.11 | 10.00 | 8.9     | 17  | 42    | Mo  | 0.004| 0.003 | 33.33   |
| 8  | 20    | Ca  | 0.24 | 0.27  | 11.11   | 18  | 80    | Hg  | 0.001| 0.001 | 0       |
| 9  | 24    | Cr  | 0.032| 0.031 | 3.22    | 19  | 82    | Pb  | 0.0001| 0.0001| 0       |

A.N.: atomic number, E.S.: element symbol, Con*: The experimental concentration (%), Con**: The certificate concentration (%).

**Table 3.** The concentrations of main elements of nails the cancer patients and compared with their relatives Healthy.

|        | Active |      |      | Nonactive |      |      |
|--------|--------|------|------|-----------|------|------|
|        | Mg     | Si   | K    | Ca        | Fe   | Mg   | Si   | K    | Ca        | Fe   |
| S1     | 420    | 67   | 789  | 1546      | 268  | 450  | 89   | 890  | 1897      | 320  |
| S2     | 340    | 90   | 966  | 1352      | 311  | 380  | 121  | 1583 | 2032      | 423  |
| S3     | 310    | 45   | 785  | 1276      | 322  | 342  | 52   | 983  | 1534      | 420  |
| S4     | 390    | 62   | 734  | 1032      | 210  | 420  | 81   | 896  | 1342      | 334  |
| S5     | 350    | 41   | 617  | 1321      | 423  | 390  | 53   | 722  | 1255      | 320  |
| S6     | 430    | 37   | 623  | 1122      | 173  | 450  | 112  | 1201 | 1902      | 461  |
| S7     | 410    | 32   | 590  | 1011      | 182  | 430  | 37   | 623  | 1122      | 257  |
| S8     | 420    | 34   | 100  | 348       | 175  | 440  | 38   | 120  | 1123      | 232  |

**Table 4.** The concentrations of trace elements of nails the cancer patients and compared with their relatives healthy.

|        | Active |      |      | Nonactive |      |      |
|--------|--------|------|------|-----------|------|------|
|        | Ni     | Mn   | Hg   | As        | Cr   | Ni   | Mn   | Hg   | As        | Cr   |
| S1     | 58     | 39   | 8.7  | 2.2       | 37   | 34   | 28   | 3.4  | 1.5       | 21   |
| S2     | 31     | 21.8 | 5.7  | 1.4       | 25   | 36   | 11   | 3.4  | 1.2       | 14   |
| S3     | 52     | 55.1 | 6.2  | 2.2       | 30   | 49   | 22   | 5.2  | 1.2       | 22   |
| S4     | 65     | 62   | 1.5  | 2.4       | 43   | 51   | 50   | 4.0  | 1.5       | 16   |
4. Multivariate Statistical Analysis

The statistical software SPSS (17.0 version) was used to identify the relationship among the element’s variables. The basic of statistical analysis, such as standard deviation, skewness, variance, kurtosis, median, mean, min., max., were used to describe the statistical characteristics of the elements as shown in Table 5 and 6. The standard deviation of elements was less than the mean value and this indicated a high degree of irregular in their distribution. The skewness of concentrations (Si, Fe, Ni, Mn, Pb, Cr) in the two groups were positive, showing that their distributions were symmetric towards values that were more positive. While skewness of concentrations (Mg, K, S, Ca, Hg) was negative that showed their distributions which were asymmetric towards values that were more negative.

Table 5. Statistical analysis of nails concentrations elemental of cancer patients.
### Table 6. Statistical analysis of nails concentrations elemental to relatives healthy.

|     | Mean    | Median | Std. Dev | Variance | Skewness | Kurtosis | Range  | Min  | Max  |
|-----|---------|--------|----------|----------|----------|----------|--------|------|------|
| Mg  | 412.75  | 425    | 38.66    | 1494.81  | -0.896   | -0.148   | 108    | 342  | 450  |
| Si  | 72.87   | 67     | 32.75    | 1072.42  | 0.383    | -1.543   | 84     | 37   | 121  |
| K   | 877.25  | 893    | 427.08   | 182395   | -0.166   | 1.209    | 1463   | 120  | 1583 |
| Ca  | 1525.88 | 1438   | 371.87   | 138291   | 0.284    | -1.958   | 910    | 1122 | 2032 |
| Fe  | 345.87  | 327    | 81.98    | 6720.4   | 0.061    | -1.312   | 229    | 232  | 461  |
| Ni  | 59.5    | 57.5   | 21.69    | 470.57   | 0.588    | -0.352   | 63     | 34   | 97   |
| Mn  | 37.95   | 28     | 37.33    | 1393.93  | 2.241    | 5.445    | 115.2  | 9.8  | 125  |
| Hg  | 4.11    | 3.7    | 1.55     | 2.39     | 0.262    | -1.229   | 4.4    | 2    | 6.4  |
| As  | 3.35    | 1.4    | 5.52     | 30.5     | 2.814    | 7.937    | 15.9   | 1.1  | 17   |
| Cr  | 19.5    | 18     | 6.279    | 39.43    | 1.586    | 2.905    | 19     | 14   | 33   |
| Zn  | 58.64   | 76.75  | 35.15    | 1235.5   | -0.768   | -1.475   | 82.1   | 8.4  | 90.5 |
| Cu  | 16.99   | 15.5   | 14.37    | 206.43   | 1.911    | 4.392    | 44.8   | 4.6  | 49.4 |
| Cd  | 5.25    | 5      | 1.50807  | 2.274    | 1.04     | 0.246    | 4.4    | 3.6  | 8    |
| Pb  | 3.09    | 2.95   | 1.03017  | 1.061    | 2.222    | 5.755    | 3.4    | 2.1  | 5.5  |
| Se  | 1.62    | 1.75   | 0.40267  | 0.162    | -0.4     | -1.764   | 1      | 1.1  | 2.1  |
5. Conclusion

The results showed that the average concentrations of trace elements (manganese, chromium, arsenal zinc, copper, cadmium, lead, selenium) were higher for cancer patients than their non-infected relatives. This result showed that the cancer patient had the high concentration of these elements. Furthermore, we need studies to confirm the relationship between trace elements and cancer, with attention to the effect of diet and environmental risk of cancer.

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