Ibn Al Haitham Journal for Pure and Applied Science

Journal homepage:http://jih.uobaghdad.edu.iq/index.php/j/index

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

Jamal K. Al-saedi
Radioactive Waste Management and Treatment, Ministry of Science and Technology
drjamal40@hotmail.com

Nada M. Hasan
Nuclear Research and Applications, Ministry of Science and Technology, Baghdad, Iraq
nada66_altai@yahoo.com

Ali A. AbdAlhasan
Nuclear Research and Applications, Ministry of Science and Technology, Baghdad, Iraq
ali11_77ahmed@yahoo.com

Article history: Received 2October 2019, Accepted 22October 2019, Published in July 2020.

Doi: 10.30526/33.3.2470

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 relativly 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	Diyala	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 200ºC for 30min with the oven and then pressed in a hydraulic press into 100 mg/cm^2 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}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 (Al_20_3) 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

S5	98	44	9.8	2.1	50	81	30	2.7	2.0	33
S6	709	234	7.1	1.7	27	64	125	2.0	1,7	20
S7	58	30.2	6.4	1.3	31.1	64	9.8	5.8	1.1	14
S8	68	50	1.9	2.1	55	97	28.0	6.4	1.3	16
	Active					**Nonactive**				
	Zn	Cu	Cd	Pb	Se	Zn	Cu	Cd	Pb	Se
S1	91	31	6.2	4.9	0.8	82	16	4.5	2.1	1.8
S2	167.6	15.5	5.0	5.1	1.0	80.2	4.6	3.6	2.5	2.1
S3	183	20.7	7.2	5.8	1.0	90.5	8.4	3.9	2.9	2.0
S4	135	30.4	6.8	6.1	0.9	8.4	15	5.0	3	1.9
S5	101	26	11	6.1	0.9	89	17	8	3.1	1.7
S6	159.7	94.8	10	7.4	2.3	8.7	49.4	7.0	5.5	1.1
S7	72.1	8.4	12	6.3	0.4	37	4.8	5	3	1.3
S8	94.3	40.8	5.0	5.0	0.6	73.3	20.7	5.0	2.6	1.1

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 stander 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 stander 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.

	Mean	**Median**	**Std. Deviation**	**Variance**	**Skewness**	**Kurtosis**	**Range**	**Min**	**Max**
Mg	383.75	400	44.701	1998.21	-0.7	-1.2	120	310	430
Si	51	43	20.284	411.43	1.12	0.48	58	32	90
K	650.5	678.5	254.21	64624.9	-1.5	3.52	866	100	966
Ca	1126	1199	361.62	130766	-1.5	3.17	1198	348	1546
Fe	258	239	89.781	8060.57	0.83	-0.1	250	173	423
Ni	142.38	61.5	229.71	52766	2.79	7.84	678	31	709
Mn	67.013	47	68.718	4722.13	2.63	7.16	212.2	21.8	234
Pb	5.84	5.95	0.8383	0.703	0.69	0.36	2.5	4.9	7.4
Hg	5.91	6.3	2.9333	8.60	-0.5	-0.6	8.3	1.5	9.8
As	1.92	2.1	0.4062	0.16	-0.7	-1.2	1.1	1.3	2.4
Cr	37.26	34.05	11.06	122.32	0.61	-1.1	30	25	55
Zn	125.46	118	41.325	1707.72	0.19	-1.8	110.9	72.1	183

Cu	33.45	28.2	26.729	714.42	2.07	4.97	86.4	8.4	94.8
Cd	7.9	7	2.7318	7.463	0.49	-1.5	7	5	12
Se	0.99	0.9	0.5693	0.324	2.06	5.25	1.9	0.4	2.3

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.

Acknowledgments

The researchers would like to acknowledge the support of the Iraqi Ministry of Science and Technology for completing this manuscript.

References

1. Abdelrazig, M.A.; Salwa, M.I.; Ahmed, H.E. The Determination of Heavy Metals Exposure to Environmental in Fingernails of Females in Port Sudan, *International Journal of Physics and Applications*.**2014**, *6*, *1*,7-13.
2. Ensieh, N.E.; Farnoush, F.; Bagher, L.; Mohammad, R.G.; Parviz, N. Trace element analysis of hair, nail, serum and urine of diabetes mellituspatients by inductively coupled plasma atomic emission spectroscopy, *Iranian Journal of Diabetes and Lipid Disorders*. **2011**, *10*, 1- 9.
3. Ka, He. Trace Elements in Nails as Biomarkers in Clinical Research, Eur J Clin Invest. **2011**, *41*, *1*, 98–102, doi: 10.1111/j.1365-2362.2010.02373. x.
4. Fozia, B.; Shahid, I.; Kim, W.Ch.; Muhammad, I.T.; Afzal, Sh.; Muhammad, M. Concentrations of Heavy Metals in Hair and Nails of Young Pakistanis: Correlation with Dietary Elements, Environmental Forensics. **2015**, *16*, 1–6, DOI: 10.1080/15275922.2014.991434.
5. AL-Ramadi, M.A.; AL-AskarN, A.; Mostafa, G.A.E. Simultaneous determination of some heavy metals in nail samples of Saudi Arabian smokers by inductive coupled plasma mass spectrometry, Biomedical Research.**2017**, *28*, *10*, 4568-4574, 4-1.
6. Gautam, S.; Ramesh, Sh.; Tarit, R.; Dipankar, C.h. Arsenic and other elements in hair, nails, and skin-scales of arsenic victims in West Bengal, India, Science of The Total Environment.**2004**, *326*, 1–3, 33-47, DOI: 10.1016/j.scitotenv.2003.12.006.
7. Bogus, B.C.; Krzysztof, K.; Marcin, O.; Agnieszka, S.M. Screening of Trace Elements in Hair of the Female Population with Different Types of Cancers in Wielkopolska Region of Poland, *the Scientific World Journal*.**2014**, *2014*, 1-15, doi: 10.1155/2014/953181.
8. Antoni, S.; Maria, d.M.B.; Alicia, J.; Raquel, A.U.; Gonzalo, P.L.; Antoni, P.; Marcela G.G.; Josep, A.T. Trace element contents in toenails are related to regular physical activity in older adults, PLoS One.**2017**, *12*, *10*, 5-1, doi: 10.1371/journal.pone.0185318.
9. Golgis, K.; Suzana, S.h.; Nasim, H.; Roslee, R.; Abu Bakar, N.F.; Othman, M.S.H. Association between Trace Element and Heavy Metal Levels in Hair and Nail with Prostate Cancer, *Asian Pacific J Cancer Prev*. **2012**, *13*, *9*, 4249-4253, DOI: 10.7314/apjcp.2012.13.9.4249.
10. Muhammad, S.; Rabia, R.; Jamil, A.; Tariq, M. Statistical Analysis of Selected Heavy Metals Icpoes in hair and Nails of Cancer and Diabetic Patients of Pakistan , *Electronic Journal of Environmental, Agricultural and Food Chemistry*.**2012**, *11*, *3*,163-171, researchgate.net/publication/232041810.

11. Abdulrahman, F.I.; Akan, J.C.; Chellube, Z.M.; Waziri, M. Levels of Heavy Metals in Human Hair and Nail Samples from Maiduguri Metropolis, Borno State, Nigeria, World Environment.**2012**, *2*, *4*, 81-89, doi: 10.5923/j.env.20120204.05.
12. Marouf, B.H. Association between serum heavy metals level and cancer incidence in darbandikhan and Kalar Area, Kurdistan Region, Iraq.**2018**, *21*, *6*, 766-771, doi: 10.4103/njcp.njcp_384_16.
13. Nyqvist, F.; Helmfrid, I.; Augustsson, A.; Wingren, G. Increased cancer incidence in the local population around metal-contaminated glassworks sites. *J Occup Environ Med*. **2017**, *59*, *5*, 84-90, doi: 10.1097/JOM.0000000000001003.
14. Ibrahim, S.M.; Abdelrazig, M.A.; SharfEldeen, A.E. Trace Elements Assessment in Human Nails in Eastern Sudan Using Atomic Absorption Spectroscopy, *Journal of Analytical Sciences, Methods and Instrumentation*. **2014**, *4*, 1-8, DOI: 10.4236/jasmi.2014.41001.
15. Kasamatsu, M.; Suzuki, Y.; Suzuki, S.H.; Siong, W.B.; Oura, Y.; Ebihara, M. Complementary analysis of trace elements in nail samples using instrumental neutron activation analysis and inductively coupled plasma mass spectrometry.**2014**, *19*, *2*,121-127, doi.org/10.3408/jafst.19.121.
16. Wee, B.S.; Ebihara, M. Neutron Activation Analysis and Assessment of Trace Elements in Fingernail from Residents of Tokyo, Japan, Sains Malaysiana.**2017**, *46*, *4*, 605–613, doi.org/10.17576/jsm-2017-4604-13.
17. David, E.B.F.; Stephen, R.B.; Christopher, J.F. Feasibility of measuring zinc in human nails using portable x-ray fluorescence, *Journal of Trace Elements in Medicine and Biology*.**2018**, 609-614, 14-1, doi.org/10.1016/j.jtemb.2018.04.025.
18. World Health Organization (WHO), National Cancer Control Programmers. Policies and Managerial Guide lines, WHO, World Health Organization, Geneva, Switzerland, 2nd edition, **2002**.
19. Barbagallo, M.; Dominguez, L.J.; Galioto, A. Role of magnesium in insulin action, diabetes and cardio-metabolic syndrome X,"Molecular Aspects of Medicine.**2003**, *24*, 1–3, 39-52, DOI: 10.1016/S0098-2997(02)00090-0.
20. Davis, C.D.; Tsuji, P.A.; Milner, J.A. Selenoproteins and cancer prevention, Annual Review of Nutrition.**2012**, *32*, 73–95, doi: 10.1146/annurev-nutr-071811-150740.
21. Hu, Y.; McIntosh, G.H.; leLeu, R.K.; Nyskohus, L.S.; Woodman, R.J.; Young, G.P. Combination of selenium and green tea improves the efficacy of chemoprevention in a rat colorectal cancer model by modulating genetic and epigenetic biomarkers, PLoS ONE.**2013**, *8*, *5*, doi: 10.1371/journal.pone.0064362.
22. Mehdi, Y.; Hornick, J.L.; Istasse, L.; Dufrasne, I. Selenium in the environment, metabolism and involvement in bodyfunctions, Molecules.**2013**, *18*, *3*, 3292–3311, doi.org/10.3390/molecules18033292.