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Elemental analysis for human identification assisted by machine learning techniques

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Abstract---Background: Biometrics Authentication is the process of measuring the biological, physical and behavioural characteristics to identify and to verify the individual. Most of the characteristics are inherited and cannot be guessed or stolen. Objectives and Aims: The present research aims to investigate a novel method in Biometric authentication to overcome the difficulties that exist in present Biometric Authentication. The research is to study the trace elements present in the biological nail tissue and measuring their concentration and to prove that this is the best method to identify individuals .It uses Biological features to authenticate the person. Study Data and Participant Sampling: This study collected data from open dataset www.pubmed,com. The datasets are free to use. The capabilities of laser ablation double focusing sector field inductively coupled plasma mass spectrometry is used for the determination of 55 trace elements in nails and the elemental composition were studied and analysed. In this study, the first set of data of Fingernail samples of the human body were collected from two healthy individuals (male of 36 years of age, female of 28 years of age) and they were monitored over an 8-month period of duration (at 3-4 weeks once) - (from July– to February). Also samples of 18 healthy people were analysed for various population. Results/Findings: In this study it shows that the trace element present in the human nail is different for each person and the trace element concentration is stable for a particular period of time. In Nail it is stable for few months rather than the biological fluids urine, blood and serum. Conclusion: The concentration of elements in nail can be used as the ancillary information with the primary biometrics to provide a better and speedy biometrics with greater accuracy. This study has explored a novel biometric authentication method that show promise for the future, even if it

limited today due to the cost of devices needed to proceed with some analysis.

***Keywords*---**Nail, Trace-Element, concentration, Multi-modal, Soft Biometrics, Biometrics

1. Introduction

The main focus of this work performed on trace elements in Human nail was to find and analyse it for biometric authentication .Element Biometrics provide different advantages in the field of medical, information technology and so on.it is widely used for security purpose and in critical recognition of various fields ,including large organizations. Many biometric system data of individuals are misused .Many password and card can be stolen or forgetton.

The elements and trace elements in the human body tissues such as finger nail and toenail are available at various levels and measurement of various trace element's concentration is used to determine them for biometric Authentication.
Trace elements has various impact on many physiological and biological activity or process. The study of their presence and concentration levels in the human body helps to identify their excess or deficiencies, but also several diseases associated with it. We focus on to study and compare the concentrations levels of fifty five essential elements and trace elements in two healthy individual people. The identification and determination of fifty five trace elements was determined by an analytical method which is called as (ICP-MS) inductively coupled plasma mass spectrometry.

This present research shows that the usage of the above analytical method calculate the concentration of essential trace elements in human nails and also it is highly possible to differentiate each and every individual person. The Trace elements availability and their levels of concentration in human nail is unique to each and every individual. So this is used to determine Biometric Authentication and this information also can be considered as a soft biometrics which provide ancillary information to the primary biometrics such as face, retina and fingerprint. The human nail either toe nail or finger nails are not dependent on the homeostasis of the human body and the human nail is considered to be a perfect choice for the identification of diseases and trace element deficiencies in human body when compared with the other biological fluids like serum, blood ,saliva and urine. All the finding will be stored in knowledgebase.

2. Background

Trace Elements or elements are transferred to the human body in different ways. They enter into the human body in the form of air, foods, liquids, and drugs through the human body organs such as respiratory tract, skin and GI traces. They are accumulated in various parts of the human body and transferred throughout the human body and distributed by the blood i.e., muscle, kidney and liver [1]. From intake of air, foods and liquids to final utilization of the human

body and also during the transport transformation and various interactions occurs and results metabolism and its regulation [2]. Finally it is excreted from the human body in the form of urine, sweat and faeces.

The biological materials such as nail are not dependant of homeostasis and they are highly useful in identifying diseases and deficiencies or excess of minerals in human body. The Nail found to be more precise and accurate in calculation of concentration of trace elements than the biological body fluids such as plasma, serum, urine, and blood. The human body fluids such as serum, blood and urine depicts the present status of the human body whereas the biological tissue samples such as nails depicts long time exposure of trace elements. The biological tissue nail has various advantages and uses such as painless removal from the skin and it has higher elemental concentration than other human body fluids such as serum ,Whole blood and urine and other body tissues such as hair and they are applied in various scientific research areas such as environmental ,medicine, biochemistry, toxicology, health physics, public health, food science and computer science[3]. The alternative materials human nails are independent of homeostasis and thus seems to be more useful within the detection of diseases and mineral deficiencies in human in comparison with the opposite biological fluids like serum and blood [4]. The physical body fluids like serum, Blood and Urine shows current status of the physical body where as nails have different uses and advantages like painless removal and comparatively higher elemental concentration than other body fluids and tissues.

3. Elements for multimodal and soft biometrics

Soft biometrics is the sub area of biometric identification field which use physical or behavioural traits which can be naturally used to describe or recognize or identify humans. Soft biometrics identification uses the descriptions such as height, weight, Scars, Tattoos, and eye colour to identify a person with the primary biometric information such as fingerprint or face recognition. We can also use the elements or trace elements present in the teeth of the human being for soft biometrics as the composition and concentration varies to everyone of human being and for multimodal Biometrics. In this paper, a novel identification system for biometrics, a multimodal biometric identification system is proposed based on combining the results obtained from the various elements from permanent teeth for soft biometrics as well as Multimodal Biometrics and Biometric Authentication.

4. Trace Elements in Nail

Soft biometrics is the physical or behavioural traits of the human. It includes gender, height, weight, hair colour, skin colour etc. and these characteristics are not unique but are useful for verification and identification of an individual human. Soft Biometrics traits are ancillary information that can be combined with primary biometric system such as palm, retina, Fingerprint, Face and iris in order to increase the accuracy and speed of a primary biometric system. It can also be used to speed up the databases searches of biometric system. Soft Biometric traits or ancillary information such as height. Weight, cloth colour, Tattoos or accessories of a human can be used to identify a person at distance. In

this work we determined that the Trace element present in the human finger Nail and Toe nail can be considered for Soft Biometrics as well as It can be taken for Biometric Authentication.

Elements are very important for the biological process of the human body and the deficiencies of the trace elements can affect the metabolic process in the human body and leads to various health problem. The elements in the human body is categorized into abundant elements and trace elements. The important trace element s that are available in the human body are Molybdenum (Mo), copper (Cu), Cobalt (Co), Chromium (Cr), Selenium (Se) and Zinc(Zn). The Trace elements that are present in the human body is only 0.02% of the whole human body. These are present at small amounts and their absence in the human body is difficult to identify.

The advantages of the analysis of trace elements in nail over other biological materials or samples are the concentration of trace elements are not fluctuated in rapid. They maintains a long-span of stability in nutritional status. Further the identification and analysis of various elements and trace elements and heavy metals in human hair and human nail needs a simple laboratory test which is used to monitor the status of the human body and how they are reacted to foods, diets, liquids, air and water and also the environment.

The mineral components of nails mainly derive from the blood circulating pool and should reflect the long-term patterns of mineral metabolism reflecting a long-term period of months [10]. The nail's mineral content of people varies between populations, and not all minerals are deposited on the nails at an equivalent speed [10].The various elements present in nails have different metabolic roles within the body, and consequently, they might be used as indicators of their nutritional status. Moreover, the trace metal content in nails following physiological processes is practically unknown also as their role within the mineral metabolism. Evaluating chemical element concentrations in nails might be a best approach and non-invasive method to study the nutritional status individuals. Also, toenail are useful because they're environmentally sheltered in populations that wear shoes; they're less susceptible to superficial contamination than hair; and that they are easily collected, transported, stored and cleaned [10]. Then, the aim of the present study is to assess the chemical element contents within the nails of healthy human and its association with regular physical activity.

5. Previous and Related Works

5.1 Previous Work

In my previous work the body Fluids such as serum, Blood and urine was analysed for Transient Biometrics. The Elements and trace elements or minerals exposure in Human Whole blood, Human urine, Human Serum was studied. The important factor in studying the concentration of various elements, trace element or metals in the human body fluids or tissues is that they are constant for a particular period of time and after that it changes. The blood Concentration is stable for certain period (Several days). The Concentration in urine for several Weeks [4]. So they are Determined for Transient biometrics. The element exposure

in the body tissues such as Toe nail and finger nail have shown longer exposure (several months) than the Human body Fluids such as Blood, Serum, and urine. Compared to other body fluids Human nail can be collected easily and nail samples can be obtained Non-Invasive way.

5.2 Present work

The human biological fluids like Whole blood, Urine, serum provides us the recent and present body status when compared with other kinds of body tissues like nail and hair. The human tissue nail has various advantages and uses than body fluids like saliva, sweat, serum blood and Urine or other biological tissues like hair. The Main advantages or Characteristics of nail is painless removal, Easy to handle, Easy to collect, easy to transport, high stability over room temperature. The human Nail has relatively higher elemental concentration than other body fluids such as serum, Whole blood and urine and tissues like nail and hair. The examination and analysis of the human Whole blood and urine does not provide the actual concentration of elements and trace elements in the human body. The human body mechanisms provides homeostasis that avoid disturbances in the administration of trace elements. Hair and nail provides excellent biological sample or material which are partially not reflect the metabolic process and regulatory mechanism in the human body [4]. The human Nail tissue also provide long exposure than other biological samples [5].

Determination of elements within the various body fluids/tissues indicates susceptibility to certain diseases, support therapeutic interventions and explain disturbances associated with many pathological conditions [10]. However, the selection of the appropriate specimen depends on several factors, such as toxic-kinetics, the convenience or invasiveness of the sample collection procedure and therefore the potential for specimen contamination [10]. The blood, hair and nails are most ordinarily used materials which, as compared to other body tissues, demonstrate many advantages [10]. Blood analysis provides reliable information about what the body has recently absorbed and the concentrations are largely independent of tissue deposition as a stable matrix, of low cost, and collection and transportation are far simpler, painless and fewer hazardous to handle [10]. Additionally, they're partially independent of the influence of metabolic processes and homeostatic mechanisms [11]. Many epidemiological studies in humans have demonstrated the carcinogenic effects of chemical element exposure including prostatic adenocarcinoma [11], concerning the trace elemental concentrations within the prostate cancer patients. Thus, there's a need to study the interrelationship of trace elements, which could have clinical and diagnostic significance.

6. Analysing Diseases Using Nail Elements

Since past, the nails growth is employed as an indicator of health and physiological imbalances of human[14] . The fingernails and toenails are used as indication of aging, additionally of varied properties, like thickening, thinning, discoloration, splitting, grooves concave and convexity in order that flatness are often used as indicate disease within the body, nutrient deficiencies, drug reaction and poisoning or nail injury[14]. The nails thickness change or loosened

and infected with bacteria are illness signed of certain disease [1]. The human nail is permeable than skin and therefore the composition consists of seven - 12% of water, in order that it's a solid part in body. Mechanical pressure on nails can cause harmful pain; also the nails are affected with stretched, tight and cosmetics. Nails after growth is [14]remain isolated from other metabolic activities within the physical body , which is taken into account as an honest reflection of long-term exposure [14]. the benefits of nails in elements evaluation are preferable biologic medium due to simple collection, storage convenience, simple handling and reproducibility of later analysis results. The nails from various fingers in feet and hands are growth in several weeks of your time between formation and clipping which indicates exposure to elevated concentration contamination integrated over a 2 - 12 month period.The trace elements levels in nails are subject of interest within the biomedical and environmental sciences since recent years. Nails measurement remains the topic of interest as indices for assessing nutritional status, diagnosing diseases, identifying systemic intoxication and environmental exposures. The determination of elements contents within the nails are often considered as an indicator of level in other tissues which reflect mineral metabolism within the body [12].

The measurement of elements in nails is employed as biomarker for exposure, in order that the acceptable selection of these elements is of critical importance for health care management purposes, public health deciding, and primary prevention activities [14]. Significant result may cause develop a far better and straightforward diagnostic measure about metal toxicity particularly as serving program for data recording. Thus, nails are often considered as an excretory product, the chemical element contents of which reflect mineral metabolism within the body and results in contentious data record for several people resulting in many valuable properties [14].

In these work elements concentration investigation in nails population has possible risk factors exposure to topsoil, beverage, sorts of food and other environmental sources [14]. The aim of this study was to find out a bottom line information concerning levels of elements exposure within the nails in our population, since previously no reported data are available during this regard in our area [14].

Assessments of elements concentration in nails and standards samples are largely based on instrumental Atomic Absorption Spectroscopy elements identification technique in hands and feet nails used [14]. The results were obtained clearly indicate that nails concentration of heavy metals can be used as an indication of many properties such as heavy metal exposure related to a geographical location and soil, drinking water, type of food and may be some certain diseases.

7. Research Methods and Data

7.1 Dataset Creation

- The dataset has been obtained from Pubmed open dataset available in https://pubmed.ncbi.nlm.nih.gov/12670755/, DOI:10.1016/S0048-697(02)00463-1
- PMID: 12670755

Application of double focusing sector field ICP-MS for multi elemental characterization of human hair and nails. Part III. Direct analysis by laser ablation - PubMed (nih.gov)

7.2 Methods

There are so many analytical methods are available at present for the determinations of elements or trace element and its concentrations in nails .They are i). Inductively coupled plasma mass spectrometry and ii). Atomic absorption spectrometry. The most common and widespread techniques for measuring the trace elements concentration in biological tissue samples are: 1. Liquid chromatography-ICP-MS. 2. High resolution (HR)-ICP-MS.3. (FAS)-Flame atomic absorption spectroscopy and/or electro thermal atomic absorption spectrometry.4.(ICP-OES) ICP optical emission spectroscopy 5.(ICP-AES) Inductively coupled plasma (ICP)-atomic emission spectroscopy. 6. (ICP-MS) ICP mass spectrometry.

The Analytical methods present nowadays must determine the trace elements with minimum samples .It should also provide high precision, and high accuracy and should operate in low detection limits. Considering all these factors and requirements, ICP is a good choice in determination of Trace element it provide perfect solution also. It also provide identification and determination of multi elements at rapid and precise in a single solution. It also provides wide dynamic range of elements and trace elements, operate in low detection limit and with high accuracy.

It is well known that after formation of the nail the chemical composition present in the nail is stable and will not be affected by chemical exposure, blood chemistry [13]. Apart from this the biological tissue nail nails are easily collected and stored at normal room temperature before the analysis and small amounts of samples (about 10 mg) only needed for chemical analysis. The chemical compositions of nails can be related to nutritional status, gender specification, occupation, age, disease and season.

7.2.1 Intra-individual variation

The precision of LA-ICP-SMS in nail analysis is difficult to evaluate due to possible spatial inhomogeneity of the sample matrix. Variations in elemental concentrations from one nail to another nail for the same individual are also important to be aware of when using nail analysis for diagnostic purposes [10]
In spite of claims that ‘simultaneous measurement of several elements is likely to produce falsely positive results’ and cost-effective multi elemental analyses are now capable of producing the data necessary for studying antagonistic and synergistic effects as well as for explanation of co-occurrence of elements based on inter-element correlation. The moderate sensitivity of ICP-AES for certain elements is the main obstacle for wide coverage of trace and ultra-trace elements in biological samples.

The element content of nails tends to vary from one geographical region to another, depending on the natural background conditions [12]. The time window of exposure reflected by the nail clipping is dependent on the distance of the clipping and the rate of nail growth. Several known biological factors such as age, gender, and other individual-level characteristics can influence nail growth [12]. Although growth rates vary among individuals, fingernails grow at an average of 0.1 mm/day while a normal fingernail takes about 6 months to grow out completely [12]. Since concentration of metals in nails reflects their mean level in human body during a period of 12–18 months [12], its use is far from being the universal tool for monitoring long exposures to environmental pollutants [12].

7.2.2 Instrumentation
7.2.3

Modern instruments are capable of finding and determining the trace elements in a very short duration of time and it operate at parts per billion concentrations (ng g-1). The analytical method (ICP-MS) takes only a small quantity of biological samples. This method seems to be very helpful in the analysis of trace elements. ICP-MS is more outstanding and powerful technique when compared with other methods of elemental analysis. The techniques provide good precision, excellent linearity range, multi-elemental analysis, extensive analytical range, extremely low limits of detection (LODs), and accuracy and high throughput of biological samples. The most important advantage of the Inductively Coupled Mass Spectrometry (ICP-MS) analytical technique is the capability to perform determination and analysis of multiple elements at a single solution. It also produces vast number of results.

The Analytical method which is called as synchrotron radiation is extensively used from the past decades to measure the spatial distribution of elements and trace elements in the human body tissue and chemical affinity of elements found in trace concentrations in animals and also in human tissues. The number of elements or trace elements examined and monitored in this study are fifty five elements from seventy seven elements and by exclusion of some elements in platinum groups such as (Ph, pb, Ru and Ir). The exclusion includes the rare earth elements other than Ce and La.

6.2 Samples and Sampling Methods

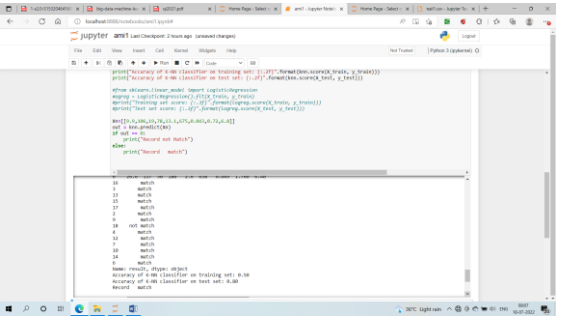
Table 1: Structure of the participants

Gender	Age range	Number	Characteristics/Comment
male	28 years	1	Healthy
Male	36 years	2	Healthy

Table 2: Nail sample

Source (female or male)	Sample size	Characteristics/Description
Person A	1	Healthy male
Person B	1	Healthy Male

Fingernail samples for the analysis of biometrics were collected using nail clippers from two healthy individuals (28 year male and 36 year male of age) and observed over an 8-month period (July– February) at 3–4 week intervals, providing nail clippings ranging in width from 2mm to 3.5 mm. Note that the purpose of this work is to evaluate the capabilities of LA-ICP-SMS for providing spatially resolved, multielemental, quantitative information. Therefore, samples from two individuals are sufficient to assess whether the technique can adequately show the differences that the concentration of elements in nail is different to person A and Person B with careful study.

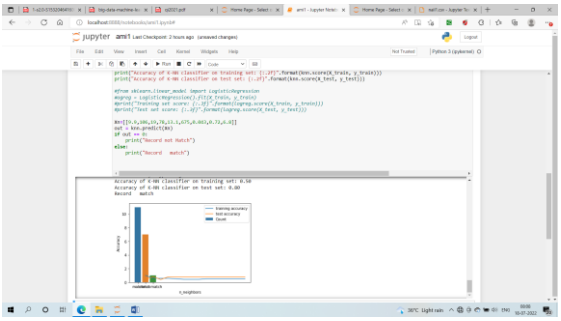


7. Data Analysis for Soft Biometrics and Multimodal Biometrics system

The capabilities of laser ablation double focusing sector field inductively coupled plasma mass spectrometry for the determination of 55 elements in nails were studied.. The novelty of this research is to show how an individual can be identified from a data obtained from individuals nail element concentration. These findings can be transferred to a knowledgebase and to train automatically to identify an individual based on the knowledge base created. The data obtained are entered in the Microsoft Excel tool and analysed for finding Mean STD, Minimum, Maximum, and Median.

8. Machine Learning for elements in human Nail

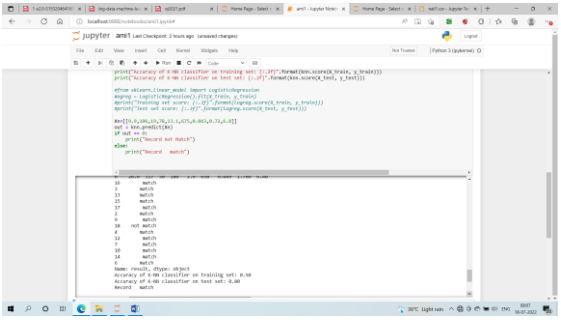
machine learning techniques are used here to identify human. The concentrations of Elements in the nail are stored in the separate (.csv file) and developed the Algorithm using the Support vector machine ,K-Nearest Neighbours Algorithm. Searching algorithm were also used to search the particular human in identifying human. Data analysis are powerful tools to conduct human identification using elements in human nail.
The elements Na,Mg, Al, Cl, K, Ca, V, Mn, Cu and their concentrations in nail were taken for machine learning.



The concentrations of mineral elements (Na, K, Mg, Ca, B, Ti, Al, Mn, Fe, Co, Cu, Zn, As, Se, Rb, Li, Be, V, Cr, Ni, Mo, Ag, Cd, Sr, Sn, Sb, Ba, La, Ce, Pb, U, Tl, and Bi) were determined by ICP-MS .

9. Results

The first set of Data of 55 elements in fingernail samples of PERSON A and PERSON B is compiled in Table 3. The second set of data is determined using ICP-MS and INAA method are compiled in Table 5 and 6. Analysis of the nail samples using INAA and ICP-MS .The results obtained by INAA are presented in Table 4. Magnesium, Cl and Ca were found as minor elements (100-10000 mg g−1), while Na, Al, K, V, Mn, Cu as trace elements (less than 100 mg g−1). Instrumental neutron activation analysis has the advantage over ICP-MS in the determination of light elements and halogen such as Na, Mg, Al and Cl.



The human finger nail concentration shows that the various trace elements present at various levels .The trace element concentration of Person A is different from concentration of Person B .So the concentration of trace element in human nail provides the recognition of a person A or B. So this provide additional information to the primary biometrics also.

Biological tissues the nails have been used as bioindicator or biomonitor for the analysis of the environmental pollution level through the studies of trace element composition. The people or individuals exposed to environmental pollution could be diagnosed through the evaluation of the abnormality of trace element concentrations in nail samples. The reason for using fingernails as diagnostic material is that trace elements accumulated in the nails can reflect the long term

exposure to environmental pollution The chemical compositions of nails may be related to gender, nutrition, occupation, age, disease and season. Dietary intake of chemical elements plays an essential role in human nutrition and health. In recent years, collaborative studies joined by many countries have been conducted to determine the reference values for daily dietary intake of chemical elements. The elemental concentrations in nail samples are compared with elemental dietary intakes and elemental compositions of reference man. In this figure, mean values from this work and literatures for nail samples were plotted by arranging the elements in increasing atomic numbers. All values plotted are assumed for healthy individuals representing individual countries. Based on their contents, elements determined can be divided into two groups: Na, Mg, Al, S, Cl, K, Ca, Fe and Zn vs. V, Mn, Co, Cu, As, Se, Ag, Sb and Hg. Our data showed lower values for elements Na, Al, K, V, Sb and Hg than the literature values Dietary intake of chemical elements plays an essential role in human nutrition and health. In recent years, collaborative studies joined by many countries have been conducted to determine the reference values for daily dietary intake of chemical elements. In Figure 1, elemental concentrations in nail samples are compared with elemental dietary intakes and elemental compositions of reference man. In this figure, mean values from this work and literatures for nail samples were plotted by arranging the elements in increasing atomic numbers. All values plotted are assumed for healthy individuals representing individual countries. Based on their contents, elements determined can be divided into two groups: Na, Mg, Al, S, Cl, K, Ca, Fe and Zn vs. V, Mn, Co, Cu, As, Se, Ag, Sb and Hg. Our data showed lower values for elements Na, Al, K, V, Sb and Hg than the literature values.

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10. Discussion

In this study it shows that the trace element present in the human nail is different for each person and the trace element concentration is stable for a particular period of time. In Nail it is stable for few months rather than the biological fluids urine, blood and serum.

Table 3 Mean and median concentrations (mgg) of two healthy persons using surface and interior layers (RESULTS FROM I. Rodushkin, M.D. Axelsson /2003)

Concentration of elements in Human Nail				
	PERSON A		PERSON B	
Element	Surface Ablation	Interior Ablation	Surface Ablation	Interior ablation
	Mean (median)	Mean (median)	Mean (median)	Mean (median)
As	0.194 (0.207)	0.034 (0.033)	0.049 (0.048)	0.041 (0.041)
Ag	0.209 (0.186)	0.0057 (0.0020)	0.074 (0.047)	0.0014 (0.0012)
Au	0.040 (0.036)	0.0008 (0.0006)	0.045 (0.029)	0.0010 (0.0004)
Al	41 (35)	0.620 (0.270)	15 (14)	0.340 (0.165)
Be	0.0022 (0.0022)	0.0007 (0.0007)	0.0006 (0.0006)	0.0004 (0.0005)
Bi	0.0092 (0.0073)	0.00024 (0.00018)	0.0069 (0.0021)	0.00015 (0.00009)
B	0.210 (0.200)	0.095 (0.092)	0.110 (0.105)	0.085 (0.084)
Br	9.7 (9.5)	9.8 (7.9)	11.9 (11.7)	9.6 (9.3)
Ba	0.480 (0.490)	0.029 (0.027)	0.230 (0.135)	0.014 (0.010)
Cd	0.040 (0.040)	0.0024 (0.0022)	0.013 (0.009)	0.0018 (0.0015)
Ca	580 (560)	75 (72)	220 (180)	86 (83)
Cr	0.660 (0.580)	0.046 (0.043)	0.180 (0.170)	0.019 (0.015)
Cs	0.0027 (0.0025)	0.00019 (0.00016)	0.00039 (0.00035)	0.00019 (0.00018)
La	0.290 (0.320)	0.0047 (0.0024)	0.014 (0.011)	0.00031 (0.00013)
Cu	8.4 (8.6)	1.9 (1.8)	4.5 (4.2)	1.5 (1.3)
Cl	3900 (3800)	3700 (3800)	3600 (3600)	3700 (3800)
Co	0.029 (0.028)	0.0024 (0.0021)	0.0052 (0.0048)	0.0020 (0.0015)
Ce	0.460 (0.490)	0.0067 (0.0028)	0.015 (0.011)	0.0003 (0.0002)
Fe	110 (110)	3.1 (2.6)	6.4 (6.1)	0.82 (0.77)
Hg	0.083 (0.084)	0.071 (0.071)	0.097 (0.096)	0.087 (0.084)

K 32 (33) 31 (29)	21 (22)	31 (28)	
Hf 0.0042 (0.0033) 0.00015 (0.0009)	0.00016 (0.00016)	0.0041 (0.0039)	
Ga 0.011 (0.011) 0.00028 (0.00024)	0.00042 (0.00035)	0.0035 (0.0027)	
I 0.084 (0.088) 0.027 (0.027)	0.032 (0.031)	0.044 (0.036)	
Na 62 (66) 50 (47)	52 (53)	49 (46)	
Mn 1.2 (1.3) 0.013 (0.012)	0.095 (0.083)	0.069 (0.057)	
Pt 0.00015 (0.00014) -0.00001	-0.00001	0.00009 (0.00009)	
Mo 0.024 (0.025) (0.0022)	0.0023 (0.0024)	0.0070 (0.0066)	0.0023
Li 0.051 (0.046) (0.0041)	0.0080 (0.0081)	0.0087 (0.0084)	0.0041
Ni 0.28 (0.28) 0.061 (0.062)	0.11 (0.12)	0.12 (0.12)	
Pb 1.0 (1.1) 0.029 (0.015)	0.025 (0.018)	0.54 (0.44)	
Mg 51 (55) 12.6 (12.2)	12.7 (12.7)	12.4	
Sc 0.010 (0.010) 0.00007	0.00010 (0.00009)	-0.00007	-
Nb 0.015 (0.015) (0.00008)	0.00030 (0.00019)	0.0019 (0.0011)	0.00010
Sb 0.023 (0.023) (0.00079)	0.00057 (0.00053)	0.011 (0.010)	0.00090
P 130 (130) 58 (56)	79 (77)	110 (95)	
Rb 0.084 (0.079) 0.026 (0.025)	0.028 (0.026)	0.029 (0.027)	
Si 61 (54) 0.7 (0.6)	1.8 (1.6)	6.4 (5.8)	
Sn 26.3 (29.8) 0.0066 (0.0035)	0.20 (0.22)	0.17 (0.13)	
Re 0.00005 (0.00004) -0.000008	-0.000008	0.00004 (0.00003)	
Ta 0.00099 (0.00089) 0.00005 (0.00004)	0.00004 (0.00004)	0.00014 (0.00011)	
V 0.12 (0.13) 0.0041 (0.0035)	0.0036 (0.0023)	0.018 (0.016)	
Se 0.61 (0.61) 0.64 (0.64)	0.60 (0.61)	0.66 (0.65)	
Ti 2.3 (2.4) 0.036 (0.013)	0.059 (0.024)	1.3 (1.1)	
U 0.010 (0.010) 0.00019 (0.00007)	0.00022 (0.00014)	0.0052 (0.0044)	

W	0.012 (0.010)	0.00027 (0.00020)	0.0025 (0.0021)	0.00019 (0.00014)
Y	0.093 (0.099)	0.0013 (0.0007)	0.0096 (0.0060)	0.00039 (0.00028)
Tl	0.00043 (0.00043)	0.00005 (0.00005)	0.00008 (0.00007)	0.00005 (0.00004)
Zr	0.071 (0.078)	0.0021 (0.0018)	0.12 (0.091)	0.0021 (0.0017)
Te	0.00010 (0.00009)	0.00007 (0.00006)	0.00010 (0.00009)	0.00005 (0.00003)
Zn	99 (99)	82 (82)	91 (88)	96 (95)
Th	0.031 (0.031)	0.00056 (0.00053)	0.0011 (0.0009)	-0.00001
Sr	0.29 (0.27)	0.061 (0.054)	0.15 (0.12)	0.051 (0.049)

Table 4 Analytical results of nail samples by INAA.

Sample **Concentration (mg g−1)**

Sample	Na	Mg	Al	Cl	K	Ca	V	Mn	Cu
S1	15.8	71	21	54	13.3	781	0.024	1.62	4.0
S2	8.1	92	14	33	2.5	495	0.019	1.05	7.3
S3	21.8	80	2	100	11.0	8 71	0.005	0.46	4.4
S4	8.2	65	12	30	5.8	971	0.011	0.89	5.2
S5	25.3	112	1	57	22.7	116	0.009	0.50	3.8
S6	12.1	46	20	60	17.3	413	0.082	0.84	6.9
S7	26.6	117	50	180	2.6	638	0.049	1.76	6.4
S8	58.1	65	13	409	54.4	188	0.026	0.62	6.0
S9	26.2	114	4	228	16.8	1037	0.029	0.38	10.4
S10	84.6	64	12	138	82.6	639	0.022	0.79	5.3
S11	12.8	69	9	118	13.5	496	0.018	0.12	4.3
S12	23.7	124	4	98	25.5	864	0.011	0.22	4.8
S13	9.9	106	19	78	13.1	675	0.043	0.72	6.8
S14	11.7	28	9	127	9.9	447	0.003	0.18	4.9

S15	110.0		174	9	37	66.5	134	0.028
0.63	4.6							
S16	30.9		64	4	502	29.4	315	0.005
	0.23	4.0						
S17	2.0		45	5	75	11.2	428	0.010
	0.23	5.3						
S18	20.5		85	20	125	28.5	336	0.040
	0.18	3.0						

Results from Masaaki Kasamatsu1, Yasuhiro Suzuki1, Shinichi Suzuki1, Wee Boon Siong2, Yasuji Oura3 and Mitsuru Ebihara3

Table 5 Analytical results of nail samples of 18 (N1-N18) healthy people ICP-MS method

SAMPLES	Cu	Zn	Sr	Ag	Pb
N1	4.1±0.0 0	102±1	.37±0.01	.0200±0.003	0.50±0.01
N2	5.3±0.0	83±3	0.12±0.00	2.913±0.071	4.89±0.07
N3	4.3±0.0	99±1	0.08±0.01	0.030±0.004	2.01±0.01
N4	4.7±0.0	158±1	0.60±0.01	0.161±0.002	0.31±0.01
N5	4.7±0.0	122±2	0.53±0.01	0.076±0.004	1.18±0.02
N6	7.2±0.0	116±1	0.09±0.05	0.111±0.009	0.59±0.03
N7	6.8±0.1	95±1	0.34±0.01	0.187±0.005	3.33±0.05
N8	4.5±0.1	97±1	—c)	0.026±0.001	0.74±0.01
N9	6.8±0.1	143±1	0.24±0.01	0.159±0.003	4.03±0.04
N10	8.0±0.1	106±1	0.24±0.01	0.471±0.010	2.63±0.03
N11	4.6±0.0	105±3	N0.09±0.01b)	0.210±0.054	0.54±0.16
N12	3.9±0.0	97±1	0.60±0.01	0.057±0.004	0.14±0.00
N13	4.9±0.0	115±1	.68±0.01	00.016±0.001	0.28±0.01
N14	4.9±0.0	92±1	0.15±0.01	0.849±0.008	0.36±0.01
N15	4.6±0.0	94±1	0.37±0.01	0.057±0.003	0.64±0.01
N16	4.7±0.0	—c)	99±1	0.011±0.002	0.16±0.01
N17	3.8±0.0	145±1	0.14±0.01	0.106±0.004	0.41±0.01
N18	3.3±0.0	87±1	0.27±0.01	0.081±0.003	1.37±0.02

a) Mean±SD (n=5). b) Mean±SD (n=4). c) Under detection limit

Conclusion

The analysis or examination of trace elements in the human body tissues - nail for the biometric authentication is a novel approach and interesting research topic also in the field of biometrics and biotechnology research. The elements in the human nail is completely different to each and every person or individual and it is highly helpful in identifying or recognising people and the concentration of each trace element in the human nail of an each individual varies.so this research shows that the concentration of trace elements in the human body tissue - nail is

considered for biometrics. The human tissue-nail can be considered as the bio-indicators of certain toxic or elements over a long span (may be months or years) than the other human body fluids such as Whole blood, serum and urine. The rapid development of Biometrics authentication techniques and methods in various domains such as banks and financial organization provided a new area of computer science that comprise biology and chemistry. Studies in this research provides ancillary information to the primary biometrics to improves the primary biometrics such as finger print, face recognition and iris biometrics also increase the speed and accuracy of biometrics. From this paper it is clear that the concentration of elements in nail can be used as the ancillary information with the primary biometrics to provide a better and speedy biometrics with greater accuracy.

Limitations of the Study

This study is Analysed with the NAIL samples collected from healthy human .There is no instrument to calculate the concentration of NAIL at present to identify elements in nail directly from the persons. This work will be useful and identify human if any devices found in future to calculate the element concentration directly with persons nail.

Future Work

The deficiency of a particular essential chemical element or elemental overload could also be life threatening or debilitating to the human beings [5]. So, it is essential to check the concentration of the elements in human often. So, this work could be stored in knowledge base and database and also to be trained using artificial intelligence techniques so that diseases can be identified earlier, and the system will give alert to the people with nutritional status also.

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Ethical Statement
This manuscript does not contain samples that were obtained from clinical studies and no personally identifiable patient data is included.

Conflict of Interest
The authors declare that they have no conflict of interest.

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