Detection of Iron and Manganese Concentrations in Human Biological Fluid with Flame Atomic Absorption Spectroscopy (FAAS)

Syed Fahad Akbar Ali, Syed Umair Mehdi, Muhammad Asif, Syed Najam Ul Hassan and Eraj Humayun Mirza

***Abstract*—**The idea behind this research was to detect the concentrations of iron and manganese in human biological fluid such as blood, by using flame atomic absorption spectroscopy (FAAS) within 60 volunteers who were divided into 4 categories as, 15 welders, 15 flood victims, 15 fishermen and 15 dyers. Moreover, many surveys on metals analysis reported that the iron, zinc, sodium, potassium calcium, magnesium and manganese are most abundant elements for human biological system and they are greatly required to human body in sufficient amount for better growth and development of different organs. The amount of these metals can be varying in human body through intake of diet and different environmental factors. Even though, many metals are essential for human body but Iron and manganese, are most essential trace metals that are needed by human, for keeping their good physiology and different structures to grow. There might be a chance of iron and manganese deficiency and toxicity as their concentrations in human body increased from certain normal levels like 0.4 - 1.2 mg / l and 0.9 - 1.1 mg / l for iron and manganese respectively. These deficiencies and toxicities of iron and manganese can cause some serious risks, related to human health and diseases as well [1]. Iron is needed for hemoglobin, the protein in red blood cells that carries oxygen and it is also needed for normal function of muscles and organs [7] while manganese ensure the healthy bone structure, bone metabolism and helping in essential enzymes for bones growth [11]. The results of iron and manganese determination in human blood, shown remarkable variation within 60 volunteers as per their related categories. This research is not only focused to measure the concentrations of iron and manganese in human blood, but also increasing the awareness among the people, working with no precautions in an unhealthy environment.

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I. Introduction

IRON by far, is one of the most important elements required by human for maintaining their normal physiological functions. Hemoglobin, which is a protein in red blood cells that carries the 70% of iron found in human body to supply oxygen to the tissue and organs. The remaining 30% of iron either stores directly in human organs and muscles or in the form of proteins in various body tissues [11]. Iron is important for oxygenation of tissues as it is incorporated in the structure of hemoglobin [3]. About 400 mg is devoted to cellular proteins that use iron for important cellular processes like storing oxygen (myoglobin) [2]. Whereas, manganese is a very common element that can be found everywhere on earth. Manganese is a mineral form, found in human body in very minimal amount [11]. It is one of the metals that play a very essential role in human physiology. It can be toxic at certain level, which means it is not only necessary for human to survive, but it is also toxic when it reached to high concentration level within the human body [10].

A. Effects of Iron and Manganese on Human Health

Iron deficiency anemia is the most common form of disease related with iron metal, which can affect cognitive performance, behavior, physical growth, immune status of human body and morbidity from infections of all age group. Iron deficient humans have impaired gastrointestinal functions and altered patterns of hormone production and metabolism. Iron is then also related with those neurotransmitters and thyroidal hormones which are associated with neurological, muscular, and temperature regulatory alterations that limit the capacity of individuals exposed to the cold to maintain their body temperature [8]. Moreover, manganese is essential element in human body to ensure healthy skeletal structure and growth. It is also important for bone metabolism and regulates the essential enzymes for bones growth. Besides that, it dynamically involve in fats and carbohydrates metabolism, regulating the calcium and blood sugar level concentration, and proper function and formation of various tissues and glands. It is also very powerful antioxidant, so its removes the free radicals from human body and neutralize the damaging particle that may cause potential danger.

Manganese is also very important to perform normal functions of brain and nerve areas of human body [11]. It is important to note that, the manganese metabolism is similar to iron and both absorb in small intestine.

II. Flame Atomic Absorption Spectroscopy

The technique used to detect iron and manganese concentrations in human blood, was flame atomic absorption spectroscopy (FAAS). This technique has gained worldwide acceptance in detecting the alkaline and heavy metals concentrations in human blood with precision and all sensitivity measures [9]. The principle of flame atomic absorption spectroscopy as shown in figure 1, is based on the phenomena that the ground state atoms of the metals absorb light, at specific wavelengths when they converted to the atomic state by means of a flame and the amount of light absorbed is then measured by detectors which give the direct value of element concentration as result. This technique requires liquid sample to be aspirated, aerosolized, and mixed with combustible gases, such as acetylene and air or acetylene and nitrous oxide [5].

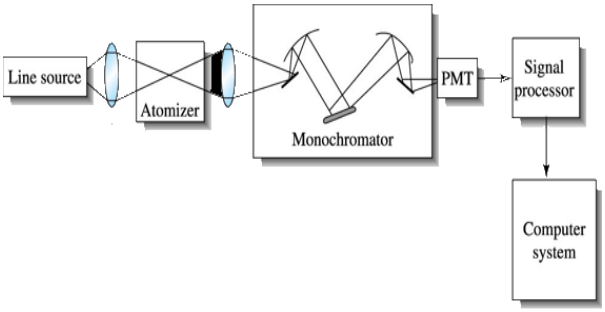

Figure 1. Schematic of Flame Atomic Absorption Spectroscopy [6].

III. Design Methodology of Research

Complete design methodology of our research work illustrated in figure 2. We started our research with reading of different research papers, articles and journals based on metal concentration detection in human biological system. After literature study we were able to prepare stock solutions of elements of interest, i.e. iron and manganese. After preparation of iron and manganese stock solutions, we prepared series of standard solutions to achieved standard calibration curves of iron and manganese metals. Furthermore by acquiring theses calibration curves successfully, we visited different sites for sample collection. Our interest was to approach those people who are working without any protection and safety rules in an unhealthy environment which affecting their health badly. We found 60 volunteers who participated in our research work and categorized them as welders, flood victims, fishermen and dyers (15 each) and collected their blood samples. After collecting the blood samples, we gone through testing procedures and obtained the results through flame atomic absorption spectroscopy (FAAS).

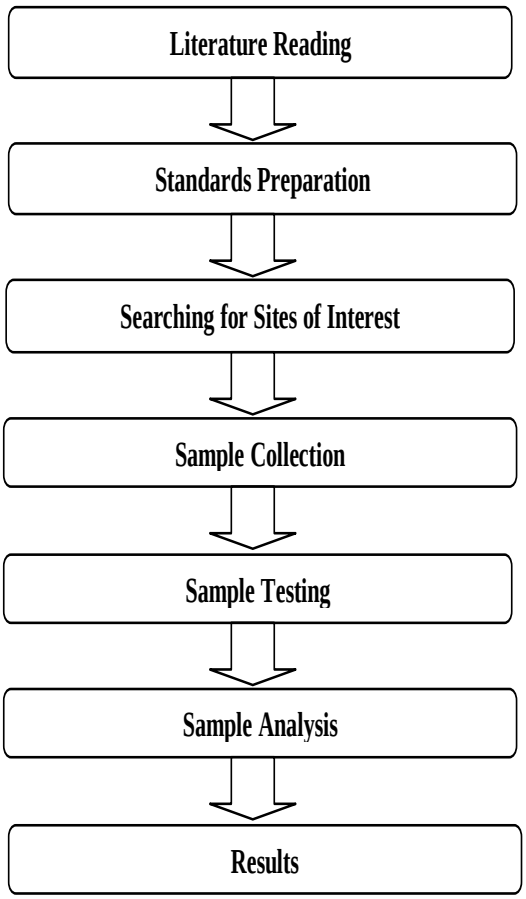

Figure 2. Design Methodology of Research Work

IV. Experimental Implementation

A. Apparatus Used

- Volumetric flasks
- Cylinders
- Beakers
- Micro pipettes
- Justers
- Test tubes
- Epindroffs
- BD tubes
- Syringes

B. Reagents / Chemicals Used

- Iron metal strips
- Manganese metal wire
- Hydrochloric Acid (HCl)
- Nitric Acid (HNO_3)
- Deionized water

C. Iron and Manganese Stock Solution Preparation

For preparation of iron stock solution, 1.00 gm of iron metal strips were dissolved in a minimum volume of 1:1 HCl

and diluted to 1 liter of deionized water, which gave 1000 ppm (part per million) or mg / l iron stock solution. While manganese stock solution was prepared as, 1.00 gm of manganese metal wire was dissolved in a minimum volume of 1:1 HNO3 and diluted to 1 liter of deionized water , which gave 1000 ppm (part per million) or mg / l manganese stock solution.

D.Standard Calibration Curves of Iron and Manganese

We prepared standard calibration curve of iron as shown in figure 3, by running a series of standard solutions ranging from 0 ppm, 0.4 ppm, 0.8 ppm, 1.2 ppm and 1.6 ppm (as per sensitivity limits recommended for iron) made from iron stock solution. Whereas, manganese standard calibration curved shown in figure 4, established by running a series of standard solutions ranging from 0 ppm, 0.5 ppm, 1.0 ppm, 1.25 ppm and 1.5 ppm (as per sensitivity limits recommended for manganese) made from manganese stock solution.

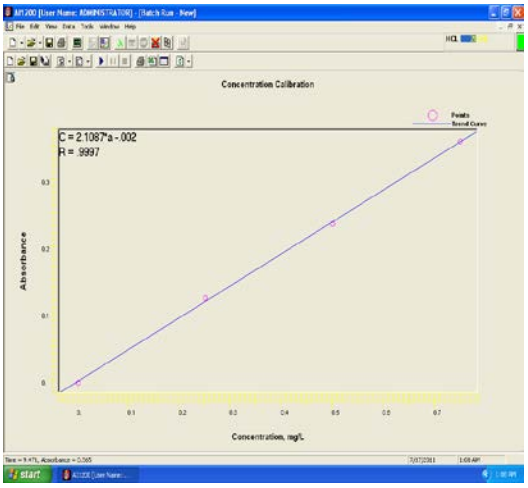

Fig 3. Standard Calibration Curve of Iron Metal

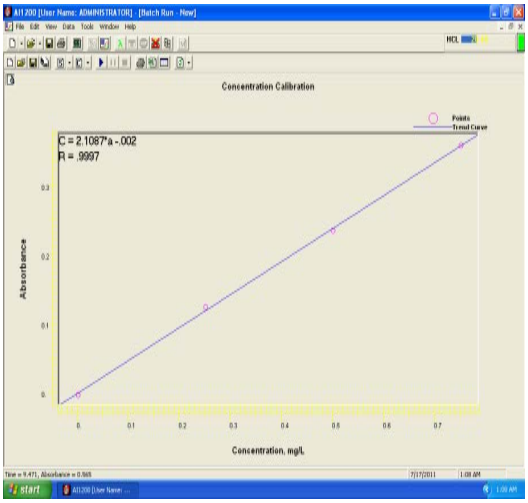

Fig 4. Standard Calibration Curve of Manganese Metal

E. Blood Sample Preparation for Iron and Manganese

The detection of iron and manganese concentrations were automatically performed by taking 1 ml of each blood serum sample (after being centrifuged), diluted to 1:5 or 1:10 ratio with deionized water [4].

V.RESULTS

Table I, shows the results of iron concentration determination within the group of 60 volunteers categorized as welders, flood victims, fishermen and dyers. Whereas, Table II represents the results of manganese concentration detection among the same categories of 60 volunteers as used for iron metal detection, done by flame atomic absorption spectroscopy (FAAS).

VI. DISCUSSION

The aim of this research work was to detect the iron and manganese concentrations in human biological fluid such as

TABLE I. IRON CONCENTRATION OF WELDERS, FLOOD VICTIMS, FISHERMEN AND DYERS IN MG / L.

S. No.	Iron in Welders	Iron in Flood Victims	Iron in Fishermen	Iron in Dyers
1	0.88	0.23	0.42	0.67
2	1.16	0.31	0.51	0.44
3	0.47	0.38	0.53	0.61
4	0.59	0.34	0.97	0.47
5	1.10	0.26	0.92	0.42
6	0.31	0.45	0.98	0.41
7	0.39	0.42	0.90	0.42
8	0.83	0.25	0.58	0.48
9	0.99	0.30	0.87	0.42
10	0.91	0.26	0.54	0.90
11	0.92	0.38	0.78	0.65
12	0.70	0.36	1.08	0.98
13	0.68	0.33	0.69	1.18
14	0.85	0.34	0.58	0.72
15	0.91	0.38	0.92	0.59

TABLE II . MANGANESE CONCENTRATION OF WELDERS, FLOOD VICTIMS, FISHERMEN AND DYERS IN MG / L.

S. No.	Manganese in Welders	Manganese in Flood Victims	Manganese in Fishermen	Manganese in Dyers
1	0.50	0.90	0.27	1.16
2	0.69	1.10	1.35	1.23
3	0.62	1.20	0.85	1.80
4	0.44	1.10	0.92	0.22
5	0.89	1.13	0.98	1.50
6	1.00	1.21	1.05	1.13
7	0.46	0.75	1.02	1.02
8	0.65	1.51	0.79	1.43
9	0.44	1.10	0.94	1.70
10	1.02	1.36	1.01	1.16
11	1.20	1.04	0.74	1.25
12	1.33	1.01	0.99	0.98
13	0.90	0.84	1.00	1.52
14	1.20	1.24	0.69	1.39
15	1.33	1.41	0.85	1.00

blood, by using flame atomic absorption spectroscopy within the 60 volunteers categorized as 15 welders, 15 flood victims, 15 fishermen and 15 dyers respectively. The detection in variations of iron and manganese concentrations in human blood serum was the objective of our research work. The blood samples taken from the different sites, replied with a greater deficiencies and efficiencies problems in iron and manganese concentrations due different environmental factors as well as the intake of foods. From table I, the obtained results of iron concentration in blood samples of welders, fishermen and dyers are positive and show no deficiency in iron concentration as it compared with the normal range, whereas all flood victims are being reported as slightly iron deficient. Apart from iron concentration of blood in welders, fishermen and dyers, the iron deficiency detected in blood samples among flood victims could be because of their medical history and no proper food and other health care facilities available during the period when they were suffering from disasters of flood, which might be the key elements in decreasing of iron concentration in blood. While from table II, the obtained results in blood samples of flood victims, was reported no deficiency and toxicity of manganese concentration i.e. within the normal range. While there are some variations in manganese concentration has been detected in blood samples of other volunteer. The deficiency and toxicity of manganese concentration found in blood samples among welders and fishermen, whereas detection in blood samples of dyers, shown toxicity of manganese concentration. These observed deficiencies and toxicities of manganese concentration within the blood samples of welders, fishermen and dyers (except flood victims), could be due to different environmental factors, food they intake and their respective work places.

VII. Conclusion

The main objective of this research work was the determination of iron and manganese concentrations in blood samples of 60 volunteers classified as welders, flood victims, fishermen and dyers done by flame atomic absorption spectroscopy (FAAS). The results of our research work suggested that the amount of iron in blood samples of welders, fishermen and dyers are very much positive and has no signs of deficiencies, while the flood victims are the high profile people having great deficiency of iron in their blood samples because of the water they drunk and the food they eaten, were not good for their health and the arrangements of water and food supply by different domestic and international NGO's were also not up to their needs. On the other hand, absolute variations in manganese concentration have been detected among welders, fishermen and dyers (except flood victims). The manganese deficiency and toxicity found in welders (who were already suffering from kidney problems, abdominal pain and other lung diseases) and in fishermen because the way fish is transport store, no proper arrangements were done for healthcare of these people resulting in diseases. Moreover, the dyers were suffering from manganese toxicity which could cause neurological and mental problems. Finally this research work was not only focused to measure the concentrations of iron and manganese in human blood, but also increasing the awareness among the people, working with no precautions in an unhealthy environment.

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