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Determination of Metals Concentration in drinking water of Jaffarabad, Balochistan

ABDUL QAYYUM
Higher and Technical Education Department, Government of Balochistan, Quetta
Department of Chemistry University of Balochistan Quetta
ATTIQ-UR-REHMAN KAKAR
Department of Chemistry University of Balochistan Quetta
ABDUL HAKEEM
Secondary Education Department, Government of Balochistan, Quetta
Department of Chemistry University of Balochistan Quetta
NAQEEBULLAH
Department of Chemistry University of Balochistan Quetta
MUHAMMAD IBRAHIM
Agriculture Research Department Government of Balochistan, Quetta

Abstract:

Water is an essential component for human beings and its quality has a significant impact on public health. In this study, the concentrations of eight heavy metals (Iron, Cadmium, Lead, Manganese, Copper, Cobalt, Nickel, and Sodium) in ground and surface water samples from rural and urban areas of district Jaffarabad were analyzed using an Atomic Absorption Spectrometer. Four samples each were collected from rural and urban areas. The results revealed that Manganese was not detected in samples A, B, D, G, and H, while Cadmium was not detected in samples A, B, C, D, and H. The concentrations of Fe, Cu, Mn, and Ni were within acceptable limits in samples C, D, E, F, and G, and Cd was not detected in samples A, B, C, D, and H. However, the sodium concentrations exceeded the permissible limit in all samples. In urban areas, Pb exceeded acceptable limits in samples B, F, G, and H, while Cd exceeded the permissible limit of the World Health Organization in samples E and F. Co concentration exceeded the limit in samples C, D, and E. Overall, the excessive concentrations of heavy metals make the water unsafe for drinking and remedial measures should be taken to ensure the safety and usability of water.

Keywords: Metals, Drinking Water, Atomic Absorption spectrometer, Jaffarabad

INTRODUCTION:

Water quality refers to the biological, physical, and chemical characteristics of water that determine its suitability for a specific purpose, such as drinking, swimming, fish farming, or agriculture. Human activities often contaminate water quality, which depends on factors such as sediments, minerals, disposal systems, sewerage, and seepage routes [1]. Additionally, water can be contaminated by organic and inorganic pollutants resulting from natural disasters, residues of pesticides and fertilizers, domestic and industrial wastes. The presence of hazardous contaminants in water can lead to health problems, particularly for infants, pregnant women, elderly individuals, and those with weak immune systems [2]. Floods are a common cause of water contamination, especially in areas affected by climate change, such as Pakistan. Recent

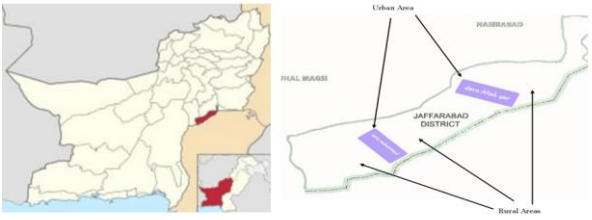
studies have shown that flood-hit areas have higher incidences of waterborne diseases, including malaria, diarrhea, cholera, typhoid fever, pathogenic bacteria, gastroenteritis, and food poisoning.

Several health and environmental issues arise from the presence of heavy metals in water. The United States Environmental Protection Agency (US EPA) warns that the consumption of heavy metals such as arsenic (As), nickel (Ni), chromium (Cr), lead (Pb), and mercury (Hg) through drinking water can increase the risk of both carcinogenic and non-carcinogenic effects on human health. Arsenic, for example, can cause cancer and skin lesions as well as cardiovascular disease, diabetes, cognitive development issues, and increased mortality in young adults according to the World Health Organization (WHO). Cadmium (Cd) exposure through drinking water can negatively impact the reproductive system, cause lung cancer, osteoporosis, and gastrointestinal illness. Cd is also considered a carcinogen that can cause bone fragility and kidney diseases. Although lead (Pb) is still used in many industrial countries for manufacturing purposes, it has harmful effects on human health and has been banned in many countries worldwide according to the United Nations Environment Programme. Pb exposure can cause neurological and physiological problems [3]. Nickel (Ni) is one of the most frequently found metals on earth's core and crust, and high concentrations of it can have carcinogenic impacts on human health such as lung, throat, and nose cancer [4].

Considering the significance of heavy metal intake, this research study aims to assess the heavy metal concentrations in the drinking water of both rural and urban areas of Jaffarabad district.

Experimental:

Study Area: Jaffarabad is one of the agrarian district of Baluchistan .it is lies in the south east of the Baluchistan province of Pakistan .it is located at $12^{0}41'23.7"$ N and $78^{0}36'36.29"$ E.



Sampling Areas of District Jaffarabad

Water sampling:

Samples were collected from various sites of district jaffarabad rural and urban in clean poly propylene bottles (600 ml) for heavy metals, and physico-chemical evaluation. The sample sites are usta Muhammad city, remote area of usta Muhammad, Balan shakh area, Mohabat Shakh area, Dera Allah yar city, and a sample was collected from Dera Murad jamali of district Naseerabad. The research study was performed at Chemistry Department of University of Balochistan. The coding IDs for collected samples are expressed in the following table.

Table 1. The samples sites with ID codes

S.NO	Sample codes	Sample sites
1	Sample A	Mohabat shakh area
2	Sample B	Khan pur near kirther canal
3	Sample C	Balan shakh area
4	Sample D	Rural area of usta Muhammad
5	Sample E	Usta Muhammad Urban
6	Sample F	Dera Allah yar Urban
7	Sample G	Dera Allah yar Urban
8	Sample H	Dera Murad jamali naseerabad

Reagents and Standards preparation:

Analytical quality grade chemicals and reagents were utilized in this research study. Stock solutions from Merck employed for each element calibrations specifically for Manganese, Nickel, and lead, Cadmium, Copper, Cobalt, and Iron. (Darmstadt, Germany). The calibration of solution was accomplished from 1000ppm stock solution (Merck). At least three standards were employed for each metal analysis, working standards solution (for Flame AAS calibration) was prepared from stock, and for standards, dilution of samples, distilled water was used**.**

Instrumentation:

Instruments employed for the evaluation of different elements includes Flame Atomic Absorption Spectrophotometer (FAAS) Thermos - Electron Corporation, S4 AA System, and S. No, GE711544, China. Deuterium background and Double beam standard hollow cathode lamps of Pb, Ni, Cu, Cd, Fe, Co, and Mn, employed at wavelengths for analysis of certain metals. Atomic absorption spectrometer adjusted at triplicate for its application, 350 PH meter.

RESULT AND DISCUSSION:

The data acquired from the results from analysis is presented in table 3. Seven metals were studied by Atomic Absorption Spectroscopy and the obtained data of different sites of district jaffarabad is correlated with the standards of WHO .further the sample with code 8 is collected from nearby district of Naseerabad Urban is compared with the seven samples of district jaffarabad. The table 2 shows standard values of WHO while table 3 shows the presence of heavy metals in the drinking of jaffarabad area of Baluchistan province .thus health risk assessment is obtained for the safety of public.

Table 2: Permissible Limits of Metals in drinking water (mg/L).

S.NO	Heavy Metals	WHO*** permissible values mg/L 2008
1	Mn	0.5
2	Fe	0.5-50
3	Pb	0.01
4	Cu	2.00
5	Cd	0.003
6	Ni	0.02
7	Co	0.05
8	Na	-

WHO* =** World Health Organization

Metal content estimation:

It is beyond doubt that the intake of heavy metals have baneful implications on human body but some metals or trace metals take part in important biochemical processes and physiological functions .If high intake results lead to hazardous impacts on Health.

Table 3: The concentration of Metals in drinking water of Jaffarabad (mg/L).

S.NO	Metals	Samples with IDs							
		A	B	C	D	E	F	G	H
1	Fe	0.3967	0.3884	0.4012	0.4052	0.4008	0.4021	0.4044	0.3761
2	Mn	ND**	ND	0.0119	ND	0.0110	0.0032	ND	ND
3	Cd	ND	ND	ND	ND	0.0080	0.010	0.001	ND
4	Cu	0.2375	0.2248	0.2435	0.2670	0.3056	0.3000	0.3044	0.3180
5	Co	0.0427	0.0487	0.0532	0.0590	0.0560	0.0187	0.0347	0.0012
6	Pb	0.0018	0.0188	0.0095	0.0038	0.0082	0.0124	0.0130	0.0151
7	Ni	0.0175	0.0198	0.0130	0.0155	0.0296	0.0255	0.0280	0.0285
8	Na	200.69	73.60	76.04	135.71	99.02	75.43	74.77	31.432

ND** = Not detected

Table 4: Atomic Absorption Spectrometer Parameters

Metals	Wavelength(nm)	Bandpass (nm)	Lamp Current%
Fe	248.3	0.2	75
Mn	279.5	0.2	75
Cd	228.8	0.5	50
Cu	324.8	0.5	75
Co	240.7	0.2	75
Pb	217.0	0.5	75
Na	589.0	0.2	75
Ni	232.0	0.2	75

Iron (Fe):

Iron is essential element for many physiological and Biological processes. The excess of iron and deficiency of iron in both the cases causes' severe health issues. Iron is also plays significant role in human blood and it is one of the essential component of hemoglobin in the circulatory of living beings [5]. There are various sources for intake of iron such as minerals, fruits, vegetable, beans but it is readily available through ground water and surface water [6]. The samples collected from different sites of district jaffarabad have detected iron. study shows that iron is detected in all collected samples and iron value is lowest in sample H that was collected urban area of Naseerabad .while the sample D from rural area of usta Muhammad tehsil of district jaffarabad has highest value of iron of all water samples . Whether the water is safe for drinking or not by comparing the acquired data with the World Health Organization permissible limits.

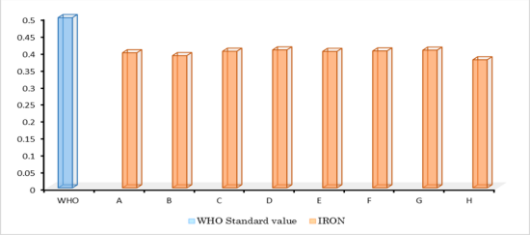


Figure 1: The concentration of Iron versus WHO standards.

Manganese (Mn):

Manganese is very important for Biochemical reaction in human body **.**In the same way like other heavy toxic metals its deficiency and its excess in the body of living beings causes several diseases [7] .Research study shows that its lowest value was present in

the sample F collected urban area of Dera Allah yar. While it was not detected in the sample A, B, D, G, and H. Its highest value was present sample C (rural area).the standard value expressed by WHO is 0.5 Result shows that samples aA,B,D,G,H were not detected and all values are less than the standard and permissible value.it means that all samples are deficient in Mn metal. No doubt it has impact on human health. These all values are expressed in the following figure 2.

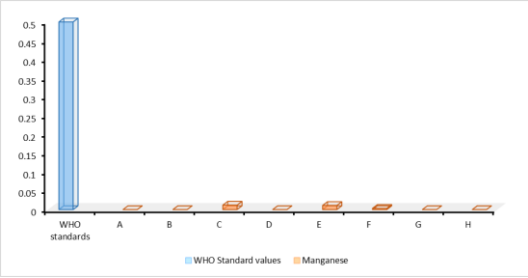


Figure 2: The concentration of Mn versus WHO standards (mg/L).

Cadmium (Cd):

It is found generally with combined state on the Earth crust .it is usually associated with the Sulphur, oxygen, and chlorine. It also occurs by eating foods if ion growned contaminated soil. And ground water seldom contaminates by sewerages, wastes in water, industrial wastes [8].it is one of the toxic metals and it has harmful impacts on body functioning if its concentration exceeds limit in the body.Cadmiun .According to WHO's permissible value is 0.003 mg/L but study shows that sample D (rural area of usta Muhammad tehsil) has highest value of Cd and the sample B (near kirthar canal) has lowest value of Cd. The results of the study has been expressed in the following figure 3.

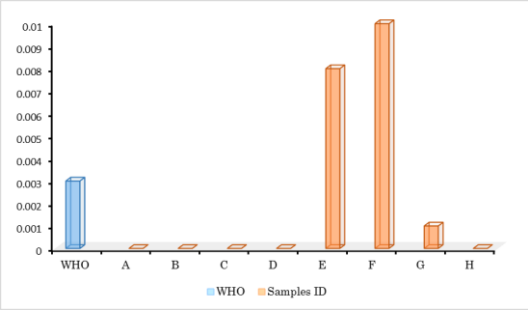


Figure 3: Concentration of Cadmium verses WHO standard (mg/L).

Copper (Cu):

Copper is one of the essential nutrients take part in biological functions, together with Fe metal ion enables human body to form RBC's. It also contributes to maintain healthy bone, immune functions, nerves, and helps in Iron absorptions. Its presence sufficiently in human diet contributes in prevention from cardiovascular diseases, osteoporosis [9]. the deficiency of Cu leads to thyroid problems [10].WHO standard concentration is 2mg/L, recommends minimum daily intake 0.47mg/L and upper level intake should not

exceed 10mg/L every day. Study shows the highest concentration of copper is present in sample E 0.3056mg/L (Urban area of district jaffarabad) and the lowest concentration in sample C 0.2435mg/L (Rural area of district jaffarabad) The Results shows that copper level in drinking water up to 2mg/L is safe for in taking of water if the concentration exceeds the limit may cause severe health issues .up to WHO standard concentration it helps to prevent any health problem.in the case of the study entire samples concentrations are not crossing the permissible line .Analyses data has shown in the following figure 4.

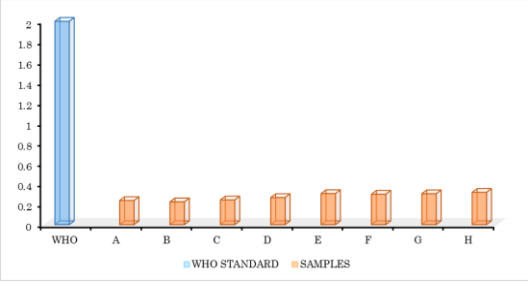


Figure 4: Concentration of Cu Versus WHO standards (mg/L).

Cobalt (Co):

Cobalt is commonly found in combined state and it is widely spread on Earth crust. Cobalt has biochemically necessary role in human body.it is required in minute quantity for its functions. Co is basic coenzymes in mitosis of cell .Co is very significant in the preparation of Amino acids and nerve cells enveloped by myline sheath [11].Its high exposure leads to poisoning of Cobalt or toxicity. It is one of the main constituents of vitamins B_{12} [12].many adverse health effects caused by high intake of cobalt such as neurological problems, visual impairment and cardiovascular diseases, Endocrine dysfunctions [13]. It is one of the cancering agent but it depends upon the duration of expose, concentration of Co [14]. the results of the study shows that the highest concentration of Co in sample D (rural area of district jaffarabad) 0.0590mg/L while lowest level in the sample H (city area of Naseerabad) 0.0012mg/L.WHO standard concentration has limit 0.05mg/L for safe usage of water for drinking .the presence of 20 mg/L in body is liable to dangerous health repercussions and hazardous to life. The results of study in comparison with WHO acceptable limit has shown in the figure 5.

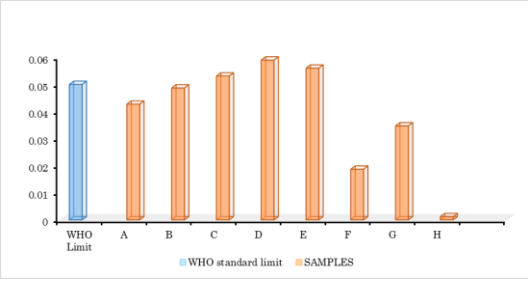


Figure 5: Concentration of Co Vs WHO acceptable limit (mg/L).

Lead (Pb):

Lead is one of the toxic metals present in atmosphere by emission of industrial wastes, motor vehicle emissions .besides this source lead exists in tap water through the pipe wastes of lead pipe. Pb dust can also come into contact with a carrier such as settles on the surface of water, on food.in this regard most probability to intake Pb when one drinks water, eats food. The high intake of Lead (Pb) leads to harmful health impacts for instance kidney problems, anemia, nervous system damages even cause death on very high concentration exposure [15]. Study reveals that the sample B collected from remote area of usta Muhammad city has highest concentration (0.0188mg/L) of lead while the sample A collected from mohabat shakh area is the lowest concentration (0.0018mg/L) of lead .Sample B (near khanpur bridge),F(dera Allah yar city),G (another site of dera Allah yar city),H (Dera Murad jamali) when compared with WHO acceptable limit ,exceed the permissible limits it may be due to the wastes that comes from populated city of usta Muhammad, Dera Allah Yar and Naseerabad. As a result sample B, F, G, H, exceed limit by 0.0088 mg/L,0.0024 mg/L,0.003 mg/L,0.0051 mg/L respectively. While sample A, C, D, E are within permissible hence safe for drinking purpose (figure 6).

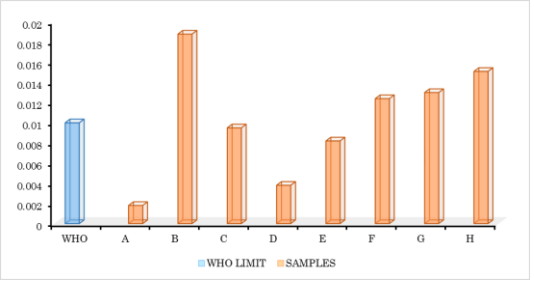


Figure 6: The concentration of Pb versus WHO standard (mg/L).

Nickel (Ni):

Nickel is found in Earth crust generally in combined state with Sulphur, oxygen .Nickel plays vital role in physiological functions, enhances hormonal activity of body [16]. Nickel is solid hard metal high exposure to it may cause skin irritation and inflammation [17]. Nickel is a significant cofactor some enzymes and pathogens. Nickel enters through body by water intake, eating food, sufficient intake of Nickel may lead to allergy, kidney diseases, cardiovascular diseases, and lung fibrosis. The data analysis of water samples of rural and urban areas of district Jaffarabad Balochistan shows that samples with ID E collected from Urban area Usta Muhammad city of District Jaffarabad has highest concentration (0.0296 mg/L) of Nickel metal while the sample with ID C accumulated from rural area of district Jaffarabad has lowest concentration (0.013 mg/L) of Nickel metal. World Health Organization has acceptable limit for drinking water 0.02 mg/L. Samples A, B, C, D are within the standard limit of WHO while Samples E, F, G, H are exceeding the prescribed limit. Sample E obtained from city area usta Muhammad crosses limit by 0.0096 mg/L. Sample F collected from city area Dera Allah Yar exceeds limit by 0.0055 mg/L, Sample G collected from Dera Allah Yar city area exceeds the limit by 0.008 mg/L. Sample H collected from Naseerabad city exceeds limit by 0.0085 mg/L (figure 7).

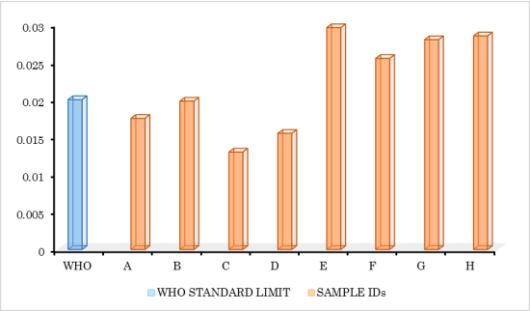


Figure 7: Concentration of Lead versus WHO permissible Limit (mg/L).

Sodium (Na):

Sodium is one of the most common element found in Earth crust.it plays vital role in physiological functions, regulates water level in the blood and in the whole body, maintains transmission of nerve signals [18]. Sodium also requires for the preservation of food.it is one of the essential components for the daily intake therefore it is needed for a cell, Muscle, and maintaining of volume and blood pressure.it means that it is necessary for a child's and adults health. High intake of sodium leads to high blood pressure, heart stroke, and causes problem in kidneys. Study shows that sample A has highest concentration of sodium while sample H has lowest concentration of sodium. Sample A is collected from urban site of district jaffarabad and sample H is collected from urban site of district Naseerabad. Whether the water is safe for drinking or not determining by comparing sodium concentration with WHO recommended permissible limit per day for child's and for adults that is 20mg/L per day .the data analysis for sodium has been expressed in the following figure 8.

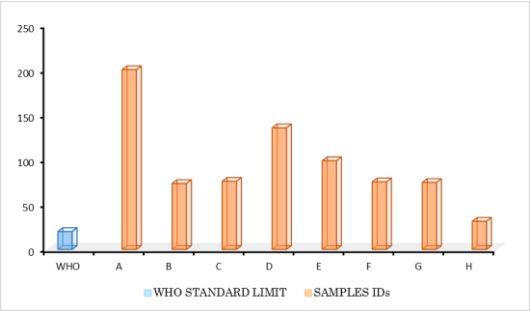


Figure 8: Concentration of Sodium versus WHO value (mg/L).

CONCLUSION:

The evaluation of heavy metal consumption in areas of District Jaffarabad, Balochistan Province, that were affected by floods revealed that there was a significant level of contamination of Cadmium (Cd), Lead (Pb), Nickel (Ni), and to some extent Cobalt (Co). The urban samples were mostly contaminated, indicating that the water was not safe for drinking purposes. Remedial measures need to be taken to ensure hygienic safety. Water samples E, F, G, and H may cause harmful impacts on human health.

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