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Determination of Selected Heavy Metals in Canal Water and its Effects on Agricultural Soil and Wheat Crop

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Abstract: This study was conducted to determine the heavy metals concentrations in canal water (Gogera Branch Canal) and their effect on agricultural soils and wheat crop at the area of Chak-65 GB in Punjab, Pakistan. Samples of water, soil, plant and grain were collected from the study area and analyzed for the subjected heavy metals and their concentration The Cadmium ranged from 0.01 to 1.9 mg/L in water samples, 0.08 to 3.08 mg/Kg in soil samples, 0.16 to 0.21 mg/Kg in plant samples and 0.57 to 0.87 mg/kg in grain samples. The concentration of Chromium is ranged from 0.03 to 1.9 mg/L in water, 55.7 to 68.3 mg/Kg in soil, 0.9 to 1.3 mg/Kg in plant and 1.06 to 3.01 mg/kg in grain samples. These values were compared with the NEQSs levels of WHO ad FAO for irrigation water, soil, plant and grains. These results show that heavy metals are accumulated in soil and then taken up by wheat.

Key words: Cadmium and Chromium · Canal water · Soil · Wheat · WHO/FAO · Pakistan

INTRODUCTION

Research samples including water, soil, wheat plant body and wheat grain were analyzed by using atomic Absorption spectroscopy. The results of water, soil, wheat plant body and wheat grain results were found 0.01-1.9 mg/l, 0.8-3.08 mg/l, 0.16-0.21 mg/kg and 0.57-0.87 mg/kg respectively. These results were compared with WHO/FAO permissible limits as shown in Table 1. It was found most of results of all samples including water, soil, plant body and wheat grain were above the permissible limit. Wheat is a grassy plant which is grown in purpose to get its seed which is a cereal grain which is used worldwide as a staple food item. Pakistan, India, Bangladesh are the prominent region in the cultivation of the wheat. Wheat have many types and species, but most common and most cultivated type of wheat is common wheat (Tritium) a large area of the world is subjected to the cultivation of the wheat approximately 224.4 million hectares which produce nearly 749 million tons of wheat this is the highest yield of any food crop around the world [1]. After the wheat, the most cultivated crop in the world is maize. The importance of wheat as a crop can be cleared from the point that it is the most demanded crop in the world, the global trade in wheat is much more than all the crops combined in 2016. Wheat is an important source of Carbohydrates and provides multiple nutrients and dietary fiber, the protein content is 13% which is relatively higher than other cereals, but its protein quality is low to provide essential Amino acids. Cadmium is the most chronic heavy metals and even its small amount in wheat grain can bring up dangerous effect on the human health. Cadmium is part of the earth crust and weathering of rocks, anthropogenic activities and other factors are responsible for the addition of cadmium in the soils. As the soil samples shows the soil of study area carrying handsome amount of the cadmium and it with water is up take by the wheat plant and it start accumulating there the cadmium is grade one carcinogen and very effective in causing cancer. Kidney disorder and high concentration of cadmium results into kidney failure sometimes.it may also cause diabetic nephropathy sometimes cadmium is also responsible for the causing cancer as it accumulates in pancreas and increase trans-differentiation and DNA synthesis which increase the risk of pancreatic cancer [2].

Chromium is also a part of the earth crust and readily present in the soil and major part of the chromium is added by the anthropogenic activities and excessive use of the fertilizers by the farmers to get high yield. If the amount shown by the result start accumulating in human body they can cause health risks like, chromium compounds are respiratory tract irritants affecting pulmonary effects like asthma chronic bronchitis, chronic irritation, chronic rhinitis, congestion and hyperemia [3].

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Pakistan is improving its agricultural techniques and introduces advance technology to its farmers to increase the per hector yield. Some of the agricultural departments work hard to make it possible such as Ayub Agricultural research institute Faisalabad, is the prominent one. Government on the other hand helps the small farmer by giving them the interest free loans so they can improve their agricultural techniques special in the case of wheat. Government also provide on field technical support in choosing best fertilizers and best techniques according to region. Therefore, the present study carried out to water quality of canal water and their impacts on agricultural soil and wheat crop.

Study Area: Our study area is a small village named Mukhanpur, it's also known as Chak No-65 gb here Gb stands for the Gogera Branch Canal. This is a famous and a historical village is near to the famous industrial city Faisalabad. It located just 25 kilometers in the south and 10 kilometers north of Faisalabad in the Tehsil Jaranwala District Faisalabad the total area of village is 2 Km^2 (0.8 sq mi) having the population of 1500 (Approx.). most of these are associated with the agricultural. This village also have a historical value and famous for its festivals, the major coordinates of the area are 31.35°N, 73.31°E this village gets its water from the Gogera Brunch Canal which is extended from the Chenab river near Jhang area. Wheat is the main agricultural product of this area. The canal system is good but few of the big framers use tube wells for the on the spot water supplies. The soil is very fertile and support good agriculture. An industrial plant is located near this village which is the main source of heavy metal pollution in water as well as in soil. As the map indicate this region lies in the center of the province Punjab and Wheat is the biggest crop of this region and because of its location near to the one of the biggest canal Gogera brunch canal it has the frequent supply of water make it good area to do agriculture.

Water Sample Collection: Water, soil, crops samples were collected from various locations points from the study area. Water samples were acid digested by using standard method.

Soil samples were collected from the same points as the wheat samples including grain and plant body were collected. Soil samples were digested in aqua regia. The Aqua Regia is the mixture of nitric acid and hydrochloric acid in the ratio of 1:3. Wheat grain and plant body were acid digested and samples were prepared by using standard procedures. After samples preparation, samples were analyzed by using Atomic Absorption Spectroscopy (AAS) in Ayub Agricultural Research Laboratories Faisalabad laboratory.

Map Showing Study Area

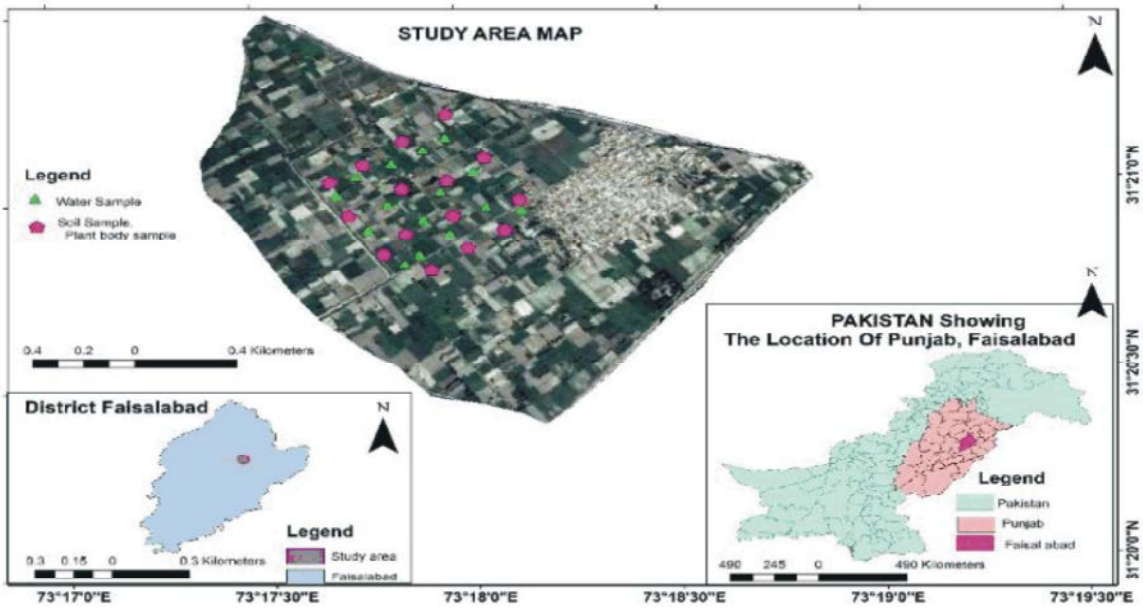

Fig. 1: Study Area Map

RESULT AND DISCUSSION

Research samples including water, soil, wheat plant body and wheat grain were analyzed by using atomic Absorption spectroscopy. The results of Cadmium (Cd) were ranged in water, soil, wheat plant body and wheat grain were 0.01-1.9 mg/l, 0.8-3.08 mg/kg, 0.16-0.21 mg/kg and 0.57-0.87 mg/kg respectively. These results were compared with WHO/FAO permissible limits as shown in table 1. It was found most of results of all samples including water, soil, plant body and wheat grain were above the permissible limit.

The results of Chromium (Cr) were ranged in water, soil, wheat plant body and wheat grain were 0.03-1.9 mg/l, 55.7-68.3 mg/kg, 0.9-1.3 mg/kg and 1.06-3.01 mg/kg respectively. These results were compared with WHO/FAO permissible limits as shown in table 2. It was found most of results of all samples including water and grains were above the permissible while soil and plant body were with in permissible limits as shown in Table 2.

The water is the main transporting agent of the heavy metals, so these samples are the most important in this study. All water samples are collected from the canals that provide water to the study area Gogera branch canal is the main water supplying body to the area and many small and big tributaries are constructed to provide water to near and far crops. These canal pass through many industrial areas that dumped their waste in them making their water contaminant with heavy metals [4]. Industrial waste is the main source of the heavy metal contamination in the water. The concentration of heavy metals varies in summers and winters. In Punjab the irrigation water is mainly supported by the Tarbela and Mangla dams located in the Azad Kashmir that's shows how long water had to flow before reaching the crops, during this journey many kinds of pollution is add to water like sewage water, industrial waste and irrigation over flows [4].Water quality is the major factor in the bioaccumulation of heavy metal in the food crop WHO is taking the initiative for improving irrigation water quality so that the process of toxic compound and heavy metals can be minimized and the quality of food can be improved. In Pakistan the Punjab food Authority in recent past taking the action all over the Punjab by destroying the standing food crops that are grown with the waste water or the sewage water this indicate the importance of the water quality for the irrigation [5]. The Pakistan have a very clear guideline for the irrigation water quality NEQS has the set base line limits for the water guidelines for the irrigation water. NEQS define limits for heavy metals, toxic compounds, phytochemicals factor and biological parameters of the irrigation water [6].

Soil is an important compartment receiving a significant amount of pollutants from various sources every year. Generally, soil not only serves as sink for the chemical pollutants but also acts as a natural buffer by controlling the transport of chemical elements and substances to the environment [7]. Heavy metals are found ubiquitously in both polluted and unpolluted soil layers of many ecological systems. These heavy metals cannot be degraded or destroyed but only are accumulated in soil, water and sediments. Heavy metals in soils may either be found naturally or generated from anthropogenic activities. However, anthropogenically origin sources related to the metal-enriched sewage sludges in agriculture, combustion, livestock manures, application of metal based pesticides, electronics (manufacture, use and disposal), volcanic eruptions, forest fires, industrial processes, municipal wastes and agricultural activities [8].

Plant samples are collected to study the heavy metals concentration in plant body of a wheat plant and to know the amount of heavy metals that makes their way inside the plant body. Wheat plant is a grassy plant in nature the plant stalk is cut in short portions and digest to perform the analysis of subjected heavy metals. The heavy metals when enter the plant body become more harmful and dangerous for the plant and cause significance impact in plant growth, grain quality and characteristics of plant in later stages. The yield of the plant and the quality of grain is affected the most the growth of plant in the contaminated soils [4].

Hms have adverse effects on physiological and biochemical function of plants, most obvious effects are the inhibition of growth rate, chlorosis, necrosis, leaf rolling, altered stomatal action, decreased water potential, efflux of cations, alterations in membrane functions, inhibition of photosynthesis, respiration, altered metabolism and activities of several key enzymes. These diseases start at the growing stages of the plant an indication of the heavy metals contamination in the soil [9].

Grain samples are the last category of samples collected from the study area and they are the most important samples because the grain of the wheat is used as the food and the concentration of the heavy metals in them are directly affect the human health. These are the part of the plant (seed) where most of the accumulation of the heavy metals are to be done in the seeds of the wheat [10].

Table 1: Cadmium concentration in water, soil, plant body and wheat grains

	Cadmium concentrations in Cd in Research samples			
S.No	Water (mg/l)	Soil (mg/kg)	Plant body (mg/kg)	Wheat grain (mg/kg)
1	0.02	1.1	0.18	0.58
2	0.01	1.9	0.2	0.6
3	0.04	0.89	0.21	0.63
4	0.6	1.97	0.18	0.68
5	0.08	1.17	0.19	0.59
6	0.09	1.99	0.21	0.57
7	0.01	1.91	0.2	0.58
8	0.01	0.8	0.18	0.69
9	0.09	1.63	0.18	0.87
10	0.9	2.16	0.17	0.58
11	1.9	1.09	0.16	0.6
12	0.9	2.18	0.18	0.66
13	1.2	1.7	0.21	0.69
14	0.04	3.08	0.18	0.59
15	1.1	1.97	0.2	0.64
Minimum	0.01	0.8	0.16	0.57
Maximum	1.9	3.08	0.21	0.87
WHO	0.01	0.8	0.02	0.5

Table 2: Chromium concentration in water, soil, plant body and wheat grains

	Chromium concentration in research samples			
S.No	Water (mg/l)	Soil (mg/kg)	Plant body (mg/kg)	Wheat grain (mg/kg)
1	0.05	60.1	1.07	1.9
2	0.03	67.1	1.3	1.9
3	0.07	59.1	0.9	1.1
4	0.03	58.4	1.1	1.7
5	0.05	60.1	0.9	1.7
6	0.04	60.7	1.09	2.1
7	0.07	68.1	1	1.9
8	1.9	60.4	1.09	2.3
9	0.07	58.4	1.3	2.7
10	1	68.3	1.07	1.9
11	1.11	60.3	1.07	3.01
12	1.44	61.3	1.03	1.06
13	0.09	60.3	1.3	1.7
14	0.04	55.7	1	1.3
15	0.05	62.3	1.02	1.07
Min	0.03	55.7	0.9	1.06
Max	1.9	68.3	1.3	3.01
WHO	0.01	100	1.3	0.5

The seeds samples are collected from the field when it is fully prepared for the harvesting so that maximum amount of the heavy metals is accumulated in the crop, the seed are gathered and digest so that the analysis for the subjected heavy metals can be performed [11]. The uptake of water carrying heavy metals and soil also contaminated with heavy metals as shown by the water samples result and soil samples result that in which condition that are contaminated with heavy metals and from where they are up taken by plant and start accumulated in the seed of the wheat. The effect on the human are made by the whole amount of wheat the person consumes in a certain time. For example, a person consumes 40 Kg in a six-month period and the amount of Cd in one Kg is 1 mg/Kg, so the effect will be read of 40 Kg Wheat of 40 mg/Kg on human health because the person intake 40 mg/Kg in the period of six month. This mention example shows that how important is the quality of grain of wheat [10]. The grain sample quality is analysis for the subjected heavy metals Cd, Cr, Ni, Cu. The Cd is

the most toxic among all and its capacity to be accumulate in the grain and the effect of the Cd is much more dangerous on human health [12]. In Pakistan wheat is a staple food crop and the being a staple food crop the consumption of wheat is much higher in Pakistan so that the quality of the wheat regarding to heavy metals is much more important because of their non-degradable in nature and long half life allow them to stay long in the human body and cause much more damage to a human health [13].

The condition in the study area is indicated that heavy metals would be accumulated in the grain and to get the picture of the level of contamination in the wheat grain samples they are compared by the limits provide the WHO/FAO (high reading record in Pakistan, mean of past 15-year data) with the reference of [14]. This give a clear picture of the situation that how many samples are above and below the limits and what will be significance of these concentration of the heavy metals in the grains and their respective effect on the human health [15]

WHO is also working on the project for improving quality of wheat grain because it is the most tread crop in the world and generate a huge forgone revenue for the countries. The wheat trade is much more then all other food crop combined. The federal department of agriculture USA. Done a lot of research on the heavy metal impact on the wheat crop and how it can be minimized and controlled.

CONCLUSION

This study was conducted in Chak-no 65 GB to determination of heavy metals (Cd and Cr) in canal water (Gogera Brunch canal) and its effect on agricultural land and wheat crops. The result obtained were compared with standards of WHO and FAO. It was found that many samples were above the allowable limits and its falls in polluted zone. This can give rise to accumulation of heavy metals in soil, plant and wheat grains. These grains when consumed can cause serious health risks because they contain handsome amount of toxic heavy metals in them. These heavy metals because of their long half-life and non-degradable in nature stays long in human body and cause serious diseases such as skin cancers, kidney cancers, lung cancers and many demagogical diseases.

These following recommendations are suggested;

- The process of accumulation is natural, so it cannot be stop but minimized by improving the water quality.
- Wheat crop is main staple food crop in Pakistan, so its quality should monitor to avoid health risk to population.
- The properties of agricultural soils must be monitored for the heavy metals concentrations.
- A further research should be carry out on this topic to find more evidence and conclusions.

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