

Detection of Heavy Metals in Wheat (*Triticum aestivum* L.) of various regions of Baluchistan

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Abstract

Wheat provides us minerals, proteins, dietary fibers and B-group vitamins. It is considered to be an outstanding health-building food. Beside its nutritional importance it also has many medicinal virtues. The whole wheat, which consists of wheat germ and bran, provides defense against diseases such as heart disease, constipation, diverticulum, obesity and appendicitis etc. The purpose of conducting current study is to determine the concentration of various heavy metals in wheat taken from various regions of Baluchistan. The Analysis was carried out for six heavy metals i.e. Fe, Pb, Co, Mn, Cd and Cu analysis was performed through atomic absorption spectrophotometer. Pb, Fe, Cd, Co, Mn, Cu are the metals that were detected in the current study. The different heavy metals that were detected in the present study were within the permissible limit of World Health Organization. Hence the current study reveals that the various varieties of wheat used in different regions of Baluchistan are not contaminated with heavy metals and are safe to be used.

Keywords: Heavy Metals, Wheat, Atomic Absorption Spectrometer, Balochistan

INTRODUCTION:

Wheat is the main staple food that provides more protein and calories to the world diet as compared to any other cereal crops. It is used as a staple food by more than one third of the population. It can not only be stored and transported easily but can also be processed into different types of food. Wheat flour can be used for making many products such as wheat gluten, noodles, bread, biscuits and confectionary products. It is also used as a raw material for synthesizing cosmetic products [1]. Out of the three most important staple crops, wheat is considered to be main source of protein used by 2.5 billion people in 89 developing countries worldwide [7]. According to agricultural research council of Pakistan, per capita the use of wheat for the country is 120 kg per year-among the highest in the world.[4]Some heavy metals are important for the nutrition of plants, however if the plants are grown in polluted environment so they can accumulate these trace metals at high concentration thus causing harm to human health.[12]

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Heavy metals are the set of metalloids or metals having atomic density greater than water or greater than 4 g/cm^3 , or 5 times [9]. These are the substances which occur naturally and are frequently present in the environment in small amount. They can be dangerous if present in large amount. The exposure of human to these metals is generally due to inhalation, ingestion or working near the places where these metals are utilized [10]. The pollution caused by heavy metals has been the rising subject of attention throughout the world. Several heavy metals like nickel, chromium and lead are not required by human and plants for proper growth despite they may cause serious problems in both animals and plants if taken in excess. However, some heavy metals like zinc, manganese and copper are important for plant growth and are termed as micro nutrients [2]. Cadmium, Zinc, Cu, Pb and Ni can lower food quality or decrease plant production if present in excess amount in soil [8].

Heavy metals are naturally stable so, they can accumulate in the agricultural products and soil. Hence it becomes necessary to understand the relationship between their accumulation in wheat and concentration of these metals in soil. [13]. After entering the plant tissues from the soil, these metals induce major reduction in both grain production and growth of wheat plant. They can be risky for antioxidant enzymes, photosynthetic activity and chlorophyll synthesis. Plants interact with each heavy metal in a particular way which mainly depends on various factors such as growth condition, soil type and presence of other ions. [3]. A possible way of applying nutrients to plants along with reducing need for less desirable and more expensive disposal strategies is applying sewage sludge to winter wheat. [14]. The accumulation of heavy metals in plants may cause change in human and animal psychological function via food chain, therefore the research on the uptake of heavy metals by plants from contaminated soil has become more importance [5]. The major sources of soil heavy metals pollution are waste water irrigation, solid waste disposal and industrial application and an enlarged uptake of these metals by food crops growing on such polluted soils is common [4]. The sewage sludge which is used as fertilizer is a major source of heavy metals. The use of such fertilizers may cause problems to crop and hence affecting human health. This is because many heavy metals are immobile in nature and remain in soil for long period of time [6]. This research aims to assess the presence and concentration of heavy metals in wheat samples obtained from various regions in Baluchistan, considering their potential impact on food safety.

Experimental:

Study Area:

The current study was conducted in Quetta (Balochistan). Balochistan is the largest province by area of Pakistan situated in southwest region. In this study, four important regions were in wheat production including Pishin, Panjgor, Kharan and Mastung were chosen as sampling points.

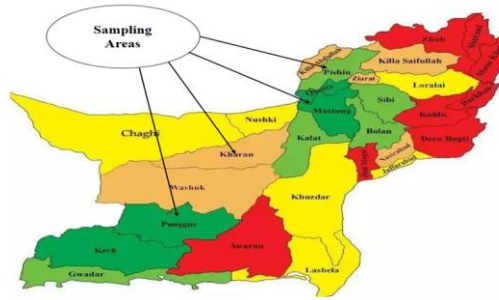


Figure 1: Map of Balochistan Districts

Sample preparation:

The samples were collected in labeled polyethylene bags from the sampling points and transported to the lab. Heavy metals were analyzed by atomic absorption spectroscopy. In the lab these samples were washed with distilled water to remove any attached particles and oven dried at 100 OC until a constant weight was obtained. The dried samples were crushed well by using ceramic pestle and mortar. The samples were digested by using mixture of 2 ml of 30% H2O2 and 5 ml of 70% HNO3. All the reagents were of supra- pure quality. The sealed beakers were placed in a sand bath at 60 OC for one complete night. The samples were evaporated completely and cooled. After cooling the samples were diluted up to 10 ml by using distilled water. By using what man filter paper 41, the solutions were finally filtered and kept for further study.

Instrumentation:

The heavy metals analysis was performed using Atomic absorption spectrophotometer. Air was used as oxidant while acetylene was used as fuel. AAS is an analytical technique used for the quantitative analysis of elements. It involves absorption of various wavelengths from a light source.

RESULT AND DISCUSSION:

Pb, Cu, Mn, Co, Fe and Cd are the metals that were detected in the current study. Different concentration of each element was observed in different samples except for Cd whose concentration was same in both Zardana and T-D one Pishin wheat.

Table 1: Concentration of heavy metals with standard deviations in wheat samples of different regions of Balochistan (mg/L).

Metals	Zardana Punjab	Super Gandum	Kharan Gandum	T-D one Pishin
Fe	0.999 ± 0.001	1.079 ± 0.002	1.108 ± 0.001	1.251 ± 0.003
Cd	0.018 ± 0.001	0.017 ± 0.002	0.016 ± 0.001	0.018 ± 0.001
Cu	0.213 ± 0.001	0.189 ± 0.001	0.187 ± 0.001	0.299 ± 0.002
Mn	0.289 ± 0.001	0.217 ± 0.003	0.244 ± 0.002	0.219 ± 0.005
Pb	0.213 ± 0.002	0.273 ± 0.01	0.169 ± 0.001	0.308 ± 0.001
Co	0.013 ± 0.003	0.019 ± 0.002	0.018 ± 0.001	0.007 ± 0.002

Iron (Fe):

Iron is considered to be an important element for plants as it plays very important role in various biological processes such as chlorophyll biosynthesis, photosynthesis and chloroplast development. In earth crust it is second most abundant element. The development of iron toxicity in plants is mainly due to the uptake of Fe+2 ions by roots and its transfer to leaves through transpiration system [9]. In human iron is the main component of several enzymes, hemoglobin and myoglobin. [15]. Fe is not only involved in the transportation of gases in and out of body but also in metabolism. The Recommended dietary allowance of Fe for females is 18mg/day while for male it is 8mg/day. The present study reveals its highest concentration in T-D one Pishin and lowest amount in zardana.

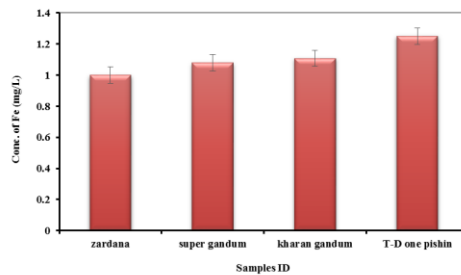


Figure 2: Concentration of Iron in Wheat samples

Cadmium (Cd):

Cadmium is well known for its high toxicity. Breathing high level of Cd may cause damage to lungs. If inhaled in high amount, it may cause irritation to stomach by causing diarrhea and vomiting [10]. Cadmium treatments are responsible for the reduction in the ATPase action of the plasma membrane of sunflower and wheat roots [9]. Its adverse effects on human health includes high BP which damages liver and kidney. According to WHO the permissible limit of Cd for wheat plant is 0.1-1mg/kg. [15]. In the current study same amount of Cd was observed for all the analyzed samples with no significant difference.

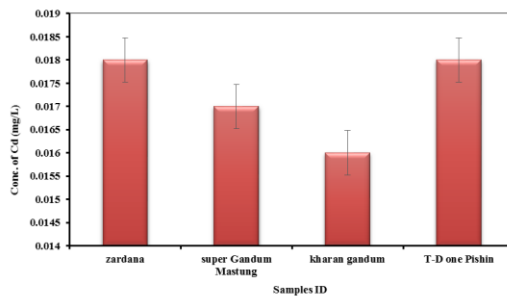


Figure 3: Concentration of Cd in Wheat samples

Lead (Pb):

Plants have the tendency to take up lead from the soil and preserve most of this in their roots. By applying Ca and phosphorous to the soil, the uptake of lead by roots may greatly be reduced. It badly affects not only the growth and morphology but also the

photosynthetic process of plants [9]. Due to its ability of interfering with electron transport chain, it is well known for the inhibition of respiration and photosynthesis in plants [10]. The present study showed the highest amount of Pb in T-D one Pishin and lowest amount in Kharan Gandum among all the analyzed samples.

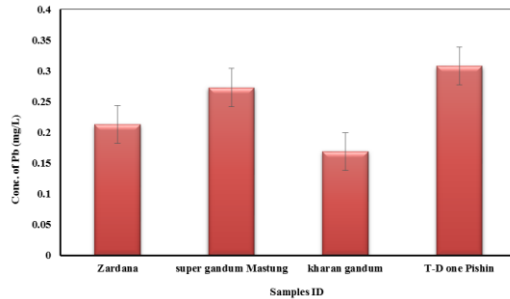


Figure 4: Concentration of Pb in Wheat samples

Manganese (Mn):

Manganese (Mn) plays a significant role in many physiological processes of plants like photosynthesis and hence is considered an important nutrient for plants. Mn toxicity results in brown spotting on stems, petioles and leaves which initially originate on lower leaves and then moves to upper leaves [9]. The highest concentration of Mn along with the other heavy metals is found in geological plant materials. For women its RDA is 1.8 mg/day while for men it is 2.3 mg/day [11]. The current study finds its highest amount in Zardana and least in Super gandum. However, the concentration of Mn was within the permissible limit of WHO.

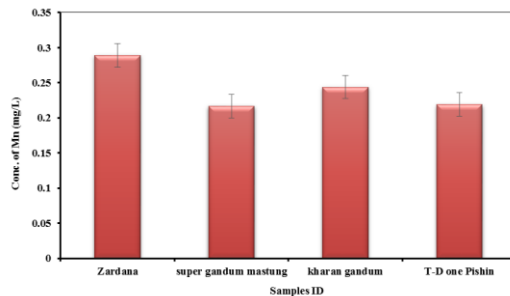


Figure 5: Concentration of Mn in Wheat samples

Cobalt (Co):

Cobalt is an important transition element present in various co-enzymes and enzymes. In cauliflower, the transfer of S, P, Cu and Zn from roots to top is affected by Co [9]. Vitamin B12 which is involved in the production of RBCs contains Co as one of its constituent. It is naturally occurring metal in earth's crust and is an essential trace element. If taken in excess, it may cause heart diseases. In the present study, the least concentration of Co was observed in T-D one Pishin. While in all the remaining analyzed samples its concentration was same with no significant difference

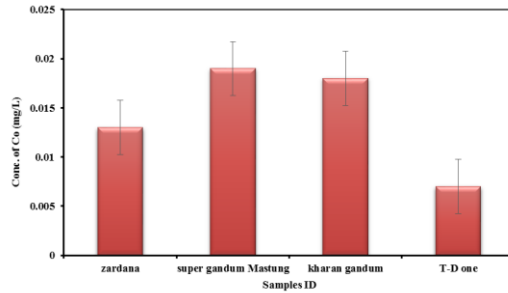


Figure 6: Concentration of Co in Wheat samples

Copper (Cu):

The third most abundant element found in human body is copper which is about 150 mg. For copper, the recommended daily allowance is 2-5 mg/day. Beside its high toxicity, copper is considered to be an important micronutrient for the development and appropriate growth of plants. It plays an essential role in ATP synthesis and CO₂ assimilation. However, its high concentration in soil can cause injury and induced stress to plants. The present study reveals that Kharan Gandum contains least amount of copper while its highest concentration was detected in T-D one Pishin.

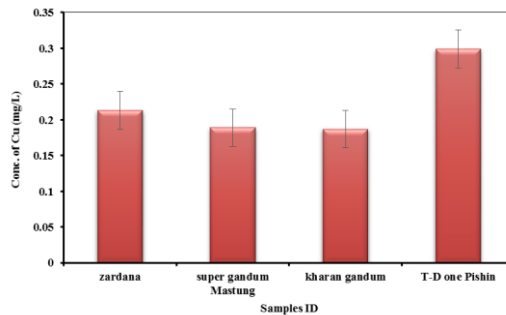


Figure 7: Concentration of Cu in Wheat samples

CONCLUSIONS:

The current findings show that wheat contains considerable amount of iron, Cd, Cu, Mn and Pb etc. Wheat is used for making various food products, cosmetics and paper products etc. The present data shows that the concentration of Fe was highest of all while least concentration was observed for Co. However, the concentration of all detected metals was within the range of standards given by World Health Organization. Hence concluded that the various varieties of wheat available to the natives of Balochistan are not contaminated with heavy metals and have no toxic effect on human health. Hence are safe to be used.

Acknowledgement:

The authors are thankful to Chemistry Department of university of Baluchistan for providing laboratory and all other facilities.

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