

## DETERMINATION OF HEAVY METALS CONCENTRATION OF LOCAL AND IMPORTED WHEAT GRAINS STORAGE AND WHEAT FLOUR IN SOME SILOS OF BAGHDAD CITY

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### ABSTRACT

The aim of this study was to estimate the levels of some toxic heavy metals such as (Cd, Pb, Cr, Ni, Zn, Cu, Fe, Co, As) by using the X-Ray fluorescence. In a total of forty-one samples of wheat grains which were (local, American, Australian, Canadian and mixing mills) samples collected randomly and seasonally from three silos in Baghdad, also wheat flour collected from mills related to the manufactured of grains of each silo. The results showed that the levels of (Cadmium, Lead and Chromium) were surpassed the permissible safe limits according to FAO/WHO (2001). It was found that the highest concentration of cadmium detected in wheat flour in AL Dora silo for summer and spring seasons were 12.6 mg/kg, as well as the high level of lead 1.021 mg/kg detected in AL Dora silo in local wheat for winter and summer seasons and wheat flour for spring season, also in Australian wheat for spring season in Taji silo. Finally, the high value of chromium content was in wheat flour in Taji silo for spring season (4.686) mg/kg. Generally, analysis of these data shows significant effects ( $P \leq 0.05$ ) of most samples analyzed for  $Cd > Pb > Fe > Zn > Cu > Ni > Cr > Co$  while AS show no significant difference in all samples.

**Keyword:** X-Ray fluorescence, toxic, chromium, mixing mills, Arsenic

مهدي وعمران

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تقدير تركيز بعض المعادن الثقيلة في حبوب الحنطة المحلية والمستورده ودقيق القمح في مخازن بعض الصوامع في مدينة بغداد.

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الباحث

### المستخلص

تهدف الدراسة الحالية الى تحديد مستويات بعض المعادن الثقيلة السامة مثل (الكاديوم، الرصاص، الكروم، النيكل، الزنك، النحاس، الحديد، الكوبلت، الزرنيخ) في احدى واربعين عينة من حبوب القمح التي كانت (محليه، امريكيه، استراليه، كنديه وخلطة المطاحن) باستخدام مضان الاشعه السينيه، تم جمع النماذج عشوائيا وموسميا من ثلاث صوامع في بغداد، كذلك دقيق القمح الذي تم جمعه من المطاحن المتعلقة بتصنيع الحبوب في كل صومعه. اوضحت النتائج ان مستويات (الكاديوم، الرصاص والكروم) قد تجاوزت الحدود الامنه المسموح بها وفقا لمنظمة الاغذيه والزراعه ومنظمه الصحه العالميه (2001)، ووجدت ان اعلى تركيز للكاديوم تم اكتشافه في دقيق القمح في صومعه الدوره لموسم الصيف والربيع كان 12,6 ملغ/كغم، وكان المستوى المرتفع للرصاص 1,021 ملغ/كغم في صومعه الدوره في القمح المحلي لموسم الشتاء والصيف ودقيق القمح لموسم الربيع، وكذلك في القمح الاسترالي لموسم الربيع في صومعه التاجي. واخيرا، كانت القيمه العاليه لمحتوى الكروم في دقيق القمح في صومعه التاجي لموسم الربيع 4,686 ملغ/كغم. بشكل عام، يظهر تحليل هذه البيانات تاثيرات كبيره ومعنويه لمعظم العينات التي تم تحليلها ل (كاديوم < رصاص < حديد < زنك < نحاس < نيكل < كروم < كوبلت) بينما لا يظهر الزرنيخ اي فرق معنوي في جميع العينات.

الكلمات المفتاحيه: مضان الاشعه السينيه، السموم، الكروم، خلطه مطاحن، الزرنيخ.

## INTRODUCTION

Wheat is one of the most common staple food crops for more than one-third of the world's population, it provides on average one-fifth of the total calorific input of the world's population (4). Compare with other grains, Wheat contain a high proportion of protein, fat and fiber, also it is abundant in potassium, phosphorus, manganese, zinc, vitamin B6, folate, thiamine, riboflavin and niacin(7). The consumption of Food was identified as the main exposure pathway to Arsenic (As), cadmium (Cd) and lead (Pb), than other pathways of exposure, as inhalation and dermal contact (28). Moreover, these above elements can cause adverse effects on humans even at very small concentrations while exposure occurs over a long time period (19). The health risk associated with the ingestion of toxic metals can be valued via carcinogenic and non-carcinogenic ways. The Hazard Quotient (HQ) is a non-cancer risk valuation which is calculated thru using the ratio between the estimated of pollutant dose and the dose below level for which there will not be any risk noticeable (23). Majority of heavy metals accumulate in wheat organs reserved in glume, stem, and leaf after roots, and followed by grains, indicating that heavy metal was accrued from atmospheric dust more than to another sources (20). The stress of Cadmium, lead, Arsenic, mercury, and Chromium on wheat crops and components in the farmland and Wheat Consuming is regarded to be one of the main sources of heavy metals intake for individuals, whose can affect human health (21). The aim of this study is to determine the concentration of heavy metals (pb ,Zn,Hg,Fe,Cr,Co,Cd,Sn,Cu,As,Ni) in a local and imported wheat grains storage and wheat flour that may be found in some Silos of Baghdad.

## MATERIALS AND METHODS

### Description of the state of wheat grain stores and collection of samples

The wheat grain stores of (Al Dora silo and Taji Silo) were a warehouse with cyclone dust and scattered grain residues on the ground of store, as well as the present of animal waste residues from birds and rodents, the aeration of the stores in silos were poor. On the other hand the silo of AIRusafa where the warehouse with

average cleanliness and aeration also. As for the mills belonging to the General Company for the manufacture of grain, the stores were fairly clean and the flour material was supplying after grinding immediately. For each sampling one kg. of wheat grain and flour were put into sterile polyethylene bags and seal properly, amount from each sample discrete and divided into two parts which preserved in a sterile plastic containers, to estimate the chemical properties (heavy metals). Samples were transported to the laboratory at 25°C until analysis were performed.

### X-ray fluorescence

XRF is emerging as an appropriate method for speedy quantification owing to, the non-destructive nature of analysis heavy metals in vegetables and other foodstuff, as contemporary study revealed that lead and other heavy metals are absorbed and transported from the soil into consumable vegetable tissues (12). The principle of XRF is simple: when an X-ray emission from a radioactive source strikes a sample, the X-ray can be either absorbed by atoms or scattered through the material. The atoms after absorption becomes "excited" and release a characteristic X-ray which energy level is matchless to the element impacted by the incident X-ray, this characteristic X-ray emission is invited X-ray fluorescence, or XRF. The separate energy measurement of the X-ray emitted is used to determine the types of minerals present, and the measurement of the number of X-ray emitted supplies a quantitative indication of the concentration of the metal present in sample. That confirmed that each of the atomic elements it is found in a sample that produces a unique set of distinctive X-rays that are a fingerprint of the specified element (5).

### Preparation and sample analysis

Wheat grain samples were collected from silos, 10g of each of them were oven dried at around 70°C, and left to cool at room temperature 25 °C. The dried mass of each sample was grounded to fine powder using grain miller (BraBenDer company, Germany origin), preserved in a sterile plastic container with identification mark label until analysis. Three grams prepared of the powder samples

were weighed and pressed into pellets, the pellets were used for the determination of heavy metals such as (Hg, Pb, Co, Cr, Fe, Cd, Ni, Ar, Ag, Sn, Cu) levels were carried out using X-ray fluorescence spectrometry (Ametek company, Germany 2010 in origin) according to methods described previously (2).

### Statistical analysis

Statistical analysis (25) program was used to reveal the effect of differences agents on study parameters. LSD test (Least significant difference) was used for a significant difference for comparison between means. Correlation coefficient between traits was calculated.

## RESULTS AND DISCUSSION

### Cadmium (Cd)

From the results obtained in this study, shown in Figure 1, the concentration value of cadmium in all samples analyzed of wheat grains and wheat flour ranged from (0.4–12.6) mg/kg = ppm. The highest concentration values detected in wheat flour and Australian wheat grain samples in Al Dora silo for summer and spring seasons which were 12.6 mg/kg and 12.1 mg/kg respectively. While, the lowest concentration of Cd was detected in wheat flour samples and local wheat in Al Dora silo and Al Rusafa silo for spring season and summer season respectively, the values were 0.4 mg/kg and 0.5 mg/kg respectively. These values of Cd in all samples analyzed were found to be above the permissible limits of 0.2 mg/kg by FAO/WHO 2001 Codex Alimentarius Commission (11). Statistical analysis revealed (Table 11) that the means differed significantly at probability ( $P \leq 0.05$ ) in the levels of Cd content in all samples analyzed of wheat grains and wheat flour in three silos for three seasons, high significant difference was observed in Al Dora silo for spring season which was (3.52\*) and within the same sample of wheat flour LSD value was (2.87\*). Cd is highly toxic non-essential element and it does not have a role in the biological process in living organisms, even lower concentration of Cd in the food chain could be harmful to living organisms (15). Furthermore, these results were agreed with study conducted by Chandra *et al.*, 2009 found Cd content was 1.06 mg/kg in wheat

grains with soil irrigated with industrial wastewater (6). In previous studies found that application of sewage sludge to fields can be an alternative to manure addition which leads to accumulation of Cd in cereals. Moreover, Cadmium content of wheat grain or flour is influenced by several factors such as annual variation, cultivar differences, genetically and regional variations. Regional differences found in cadmium level are mainly affected by cadmium deposition via the atmosphere, soil fertilization and soil properties such as soil type, pH, origin and soil cadmium content. Also soil salinity enhances Cd uptake of many crops (9).

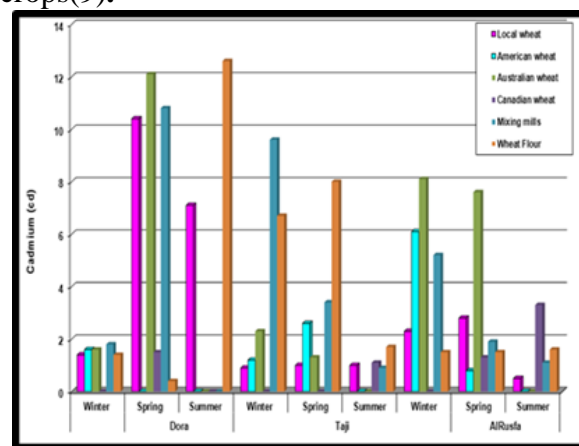


Figure 1. The effect of location, season and type of wheat on cadmium concentration

**Lead (Pb)** the concentrations of lead in various samples of the wheat analyzed were ranged (0.092–1.021) mg/kg, shown in Figure 2. The maximum concentration of Pb was detected in Al Dora silo in local wheat for winter and summer seasons and wheat flour for spring season which value was 1.021 mg/kg, furthermore the same value was detected in local wheat for winter season, in Australian wheat for spring season in Taji silo and mixing mills in Al Rusafa silo for summer season. While, the minimum level concentration of Pb was detected in the local wheat sample in Taji silo for spring season which value was 0.092 mg/kg. These values of Pb in most samples analyzed were found to be above the permissible limits of 0.2 mg/kg by (FAO/WHO) Codex Alimentarius Commission (11), except in Taji silo was detected in wheat flour sample for winter season 0.185 mg/kg, local wheat 0.092 mg/kg for spring season, mixing Mills for summer season 0.185 mg/kg, also in Al Rusafa silo

sample of wheat flour 0.186 mg/kg for winter season, finally in local wheat 0.185 mg/kg for summer season. That ingestion of lead is harmful at both high and low levels especially for the most sensitive populations (fetuses and young children). Chronic exposure to lead may cause birth defects, mental retardation, psychosis, hyperactivity, shaky hands, muscular weakness, paralysis (beginning in the forearms) and even death (26). Statistical analysis revealed (appendix2) that the means differed significantly at probability ( $P \leq 0.05$ ) in the level of pb content in most samples of wheat grains and wheat flour analyzed, highest significant differences were detected in Al Dora silo for winter season (0.883\*) and within the same samples of mixing mills were (0.723\*). While, that the means didn't differ significantly in the levels of pb contents were observed in Taji silo for summer season, and AlRusafa silo for both winter and spring seasons. These results agreed with previous study was conducted in A (Table 2) dis Ababa which reported that pb level content in wheat grains was 1.02 mg/kg, while high value of pb content was detected in barley which was 2.23 mg/kg (13). These results were in disagreement with the study conducted by Shobha and Kalshetty, 2017 in India (27), which pb content ranged from (0.08-0.163) mg/kg. The main factor that affects the high content of lead in grain is absorption through air pollution as a result of the pollution from the highway traffics which can affect the irrigation water or farm soil of the plants, and related to the milling plates in both dry and wet conditions (8).

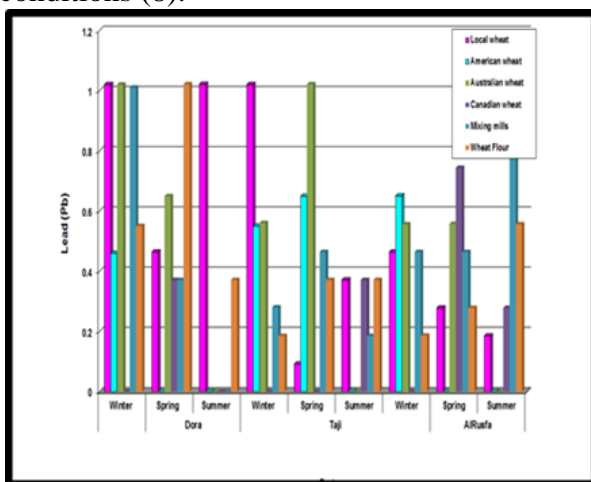
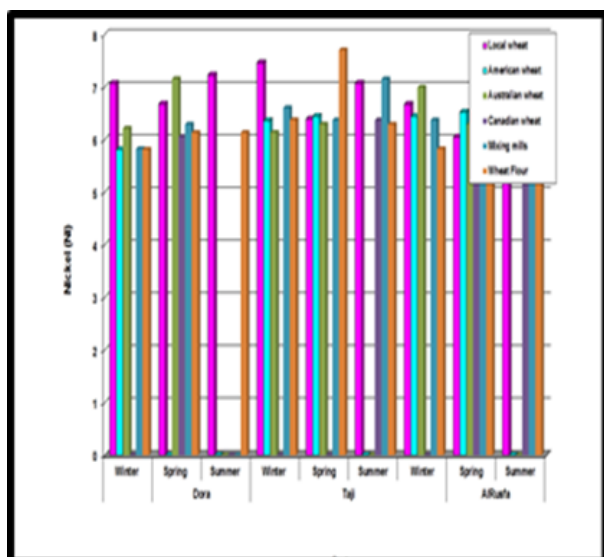


Figure 2. The effect of location, season and type of wheat on lead conc

### Nickel (Ni)

The concentrations of Ni ranged from (5.655 - 7.698) mg/kg. The highest concentration of Ni was detected in wheat flour samples in Taji silo for spring season which value was 7.698 mg/kg, and local wheat sample in Taji silo for winter season 7.46 mg/kg. While, the lowest concentration of Ni was detected in the samples of local wheat and mixing mills in Al Rusafa silo for summer season which values were 5.655 mg/kg. And the highest level in AlDora silo for summer season was detected in local wheat 7.22mg/kg, and the lowest value was 5.81mg/kg in American wheat sample. In general, the concentration of Ni in all samples were below the maximum permissible level 67.90 mg/kg according to the FAO/WHO 2001 (11). This result shows in Figure 3. Statistical analysis revealed (appendix3) that was significant difference at probability ( $P \leq 0.05$ ) among means in the Ni content across most samples of wheat grains and wheat flour analyzed, high significant difference was detected in Taji silo for spring season (2.381\*), and within the same samples of mixing mills which was (2.804\*). Moreover, the differences didn't significant in the level of Ni occurrence in AlRusafa silo for spring season. Ni play some role in body activities including enzyme function in very trace amounts, it could be beneficial to activate some systems, but its toxic at higher level however, Ni toxicity in human is not a very common occurrence because its absorption by the body is very low, also Ni enhances the absorption of Zn. (22) these results complies with (17) which reported that wheat grain and flour values up to 6.2 mg/kg (Table 3).

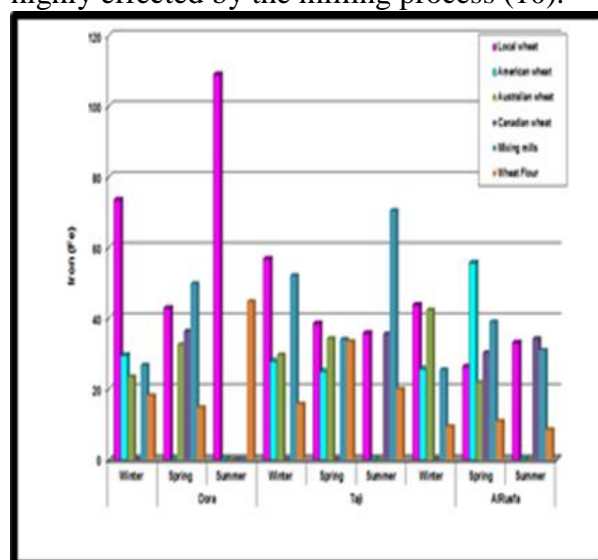


**Figure 3: the effect of location, season and type of wheat on Nickel conc.**

### Iron (Fe)

From the results obtain as can reveal in Figure 4 the concentration of Fe in wheat grains and wheat flour samples ranged from (8.429-108.95)mg/kg (Table 4) The maximum concentration of Fe was found in the samples of local wheat in Al Dora silo for summer and winter season which values were 108.95 mg/kg and 73.45 mg/kg respectively .while, the minimum concentrations of Iron was detected in the samples of wheat flour in AlRusafa silo for summer season and winter season for the same silo, the values were 8.429 mg/kg and 9.302 mg/kg respectively. The current data exhibited that the levels of Fe was found to be below the permissible limits in all the samples analyzed according to the FAO/WHO 2001 (11) which was detected maximum limits for Fe Concentration 425 mg/kg. Statistical analysis revealed (appendix4) significant differences at probability ( $P \leq 0.05$ ) in the level of Iron content in all samples of wheat grains and wheat flour analyzed. Highest significant mean detected in Al Dora silo for summer season (13.66\*), while within the same samples of local wheat in all silos and for all season which was (13.47\*). Iron is an essential element in man and plays a vital role in the formation of hemoglobin, oxygen and electron transport in human body, various diseases of the digestive tract (chronic gastritis, enteritis) can also contribute to development of iron deficiency. Excess of iron in the organism is

also harmful, it can cause siderosis of lungs and eyes, a disease that arises due to deposition of excess iron compounds in the tissues of those organs (16). These results were agreed with study conducted by Shobha and Kalshetty, 2017 which recorded the concentration of Fe in wheat was 39.9mg/kg(27), another local study in Iraq recorded a high level of Fe in local wheat which was (56.323+/-9.213) mg/kg (18). The variation in Fe concentration can be traced back to the application of several types of fertilization and that mineral nutrition greatly affected the concentration of Fe in the grains, also the bioavailability of Fe in flours are highly effected by the milling process (10).



**Figure 4: the effect of location, season and type of wheat on Iron conc.**

**Zinc (Zn)** From the Figure 5 shows the concentration of Zn in wheat grains and wheat flour samples ranged from (56.51-15.66) mg/kg, the highest concentration of Zn was detected in samples of local wheat and Canadian wheat in Al Dora silo for spring season which values were 56.51 mg/kg and 55.836 mg/kg respectively (Table 5). While, the lowest concentration of Zn was detected in sample of wheat flour in AlRusafa silo for winter season 15.66 mg/kg. The content of Zn found in these study was generally lower than the permissible levels set by FAO/WHO 2001 (11), the maximum limits of Zn in wheat grain was 99.4 mg/kg. Statistical analysis revealed (appendix5) among means significant differences at probability ( $P \leq 0.05$ ) in levels of

Zn content in all samples of wheat grains and wheat flour analyzed. The highest significant was detected in Al Dora silo for spring season (8.55\*), while within the same samples of mixing mills (8.61\*). Zn is essential to all organisms and has an important role in metabolism, cellular growth and development. Zn is known to be a co-factor of many enzymes involved in metabolic pathway in the body. Zn deficiency lead to Coronary heart diseases and various metabolic disorders (24). The obtained result has Consistent and close agreement with the earlier reported by Gezahegn *et al.*, 2017 which Zn content in wheat was (32.3 ± 2.7) mg/kg (13).

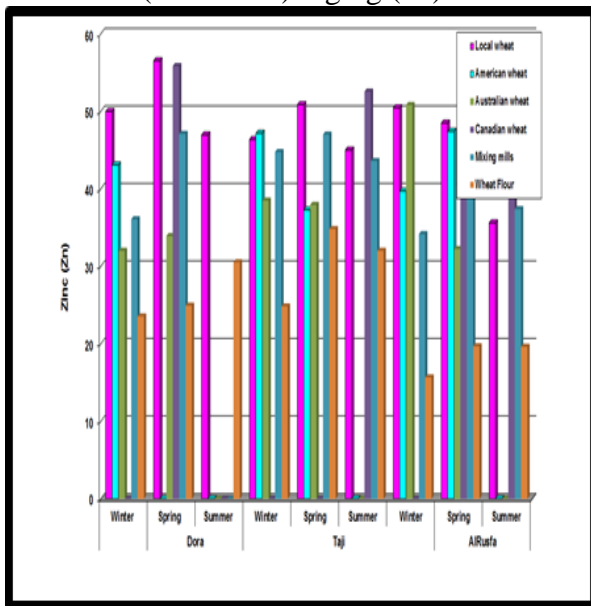


Figure 5. The effect of location, season and type of wheat on Zinc conc

**Copper (Cu)** the results show in Figure 6, concentration of Cu ranged from (3.675-11.104) mg/kg (Table 6) The highest concentration of Cu was detected in local wheat samples in Taji silo for summer season and Al Dora silo for winter season which values were 11.104 mg/kg and 10.22 mg/kg respectively. While, the lowest concentration of Cu was detected in sample of wheat flour in Al Rusafa silo for spring season which value was 3.675 mg/kg. The level of Cu in all samples were observed to be lower than the permissible limit in wheat grains 73.30 mg/kg according to FAO/WHO 2001 (11). Statistical analysis revealed (appendi6) a significant differences at probability (P≤0.05) in levels of Cu content in all samples analyzed. Highest significant was detected in Al Dora silo for winter season (3.59\*). moreover, within the

same samples of local wheat was (3.29\*). Copper is an essential trace element in plants and animals in the gut Copper is absorbed that facilitates iron uptake. RBC formation, its shortage can produced anemia-such symptoms, bone abnormalities, cholesterol metabolism, increased incidence of infections, abnormalities in glucose and neutropenia. However, excessive consumption may result in serious health problems like kidney and liver damage (14). The results of Cu are in agreement with Jamali *et al.*, 2009 (17), and the level of copper in wheat was found to be a close agreement with Gezahegn *et al.*, 2017 between (3.7 ± 0.5 mg/kg) to (5.5 ± 0.4 mg/kg)(13).

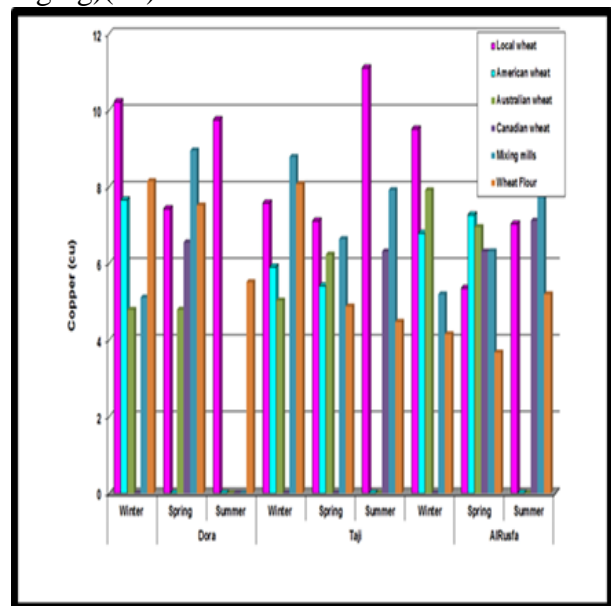
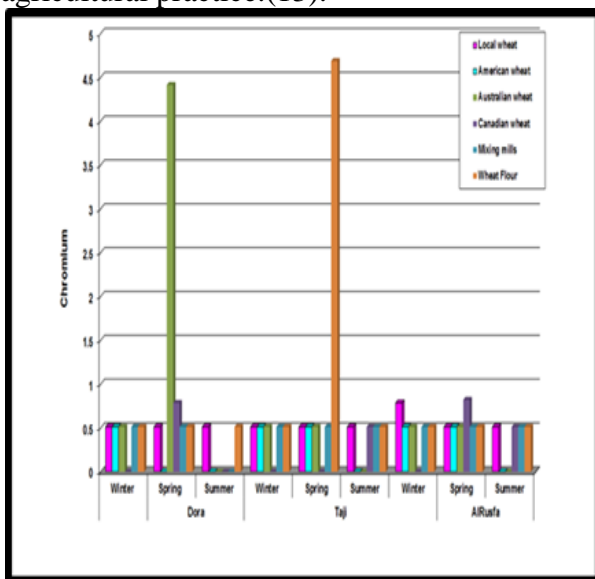


Figure 6. The effect of location, season and type of wheat on Copper conc

**Chromium (Cr)**

The results in Figure 7 show the different concentrations of Cr ranged from (4.686-0.513) mg/kg.(Table 7) The maximum concentration Cr was detected in the samples of wheat flour In Taji silo for spring season and in Australian wheat in Al Dora silo for spring season which values were 4.686 mg/kg and 4.413 mg/kg respectively, these values were above the permissible limits as 2.3 mg/kg set by FAO/WHO 2001 (11), while the lowest concentration of Cr was detected in most samples analyzed which valued 0.513 mg/kg. Statistical analysis revealed (Table 7) significant differences at probability (P≤0.05) in level of Cr content in Al Dora silo for spring season which value was (1.382\*), in Taji silo for spring season LSD was (1.437\*), in

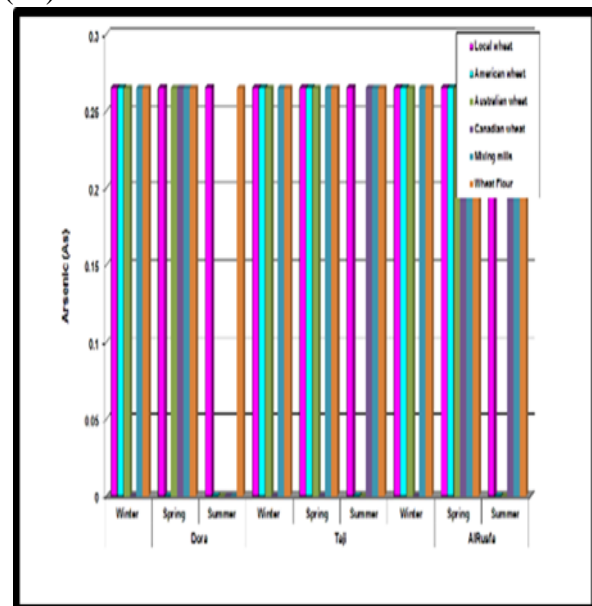
AlRusafa silo for winter season was (0.544\*). Moreover, within the same samples of wheat flour, Canadian wheat and Australian wheat were (1.226\*, 0.639\*.and 1.662\*), respectively. While, in level of Cr occurrence in Al Dora silo for winter and summer seasons, Taji silo for winter and summer seasons and AlRusafa silo for spring and summer seasons, also within the same samples of local wheat, American wheat and mixing mills LSD value had no significant differences. These results obtained was a close agreement with study with study conducted by Gezahegn *et al.*, 2017 in Addis Ababa reported Cr content in wheat grains as (2.5±0.2) mg/kg(13). Cr is important for effective insulin activity and DNA transcription (15). However, chronic exposure to Cr may have an effect on the liver (29). The observed variations in the concentration of Cr may be due to change of cereals variety, growing area, type of soil, climate, used fertilizer, water and agricultural practice.(13).



**Figure 7. The effect of location, season and type of wheat on Chromium conc**

**Arsenic (As)**  
 From Figure 8 we can observe the different concentrations of As in all samples of wheat grains and wheat flour were the same concentration which was 0.265 mg /kg. In general, the As content in samples analyzed was below the maximum permissible safe limits in cereals 0.43 mg/kg according FAO/WHO 2001 (11). Statistical analysis revealed (Table 8) didn't significant differences among means in levels of As content in all samples analyzed. As is

extremely toxic and is thought to be carcinogenic for human. Long term exposure results in health effects like cardiovascular diseases and diabetes (1). The main source of AS to the environment is agrochemicals (pesticides) or volcanic eruption. Study conducted for distribution of As in wheat plant that the maximum level was found in Mardan 0.363 mg/kg, while the lowest level was observed in the Shergarh area 0.049 mg/kg (3). Another study AS content was found in a very low level and almost same in all studied cereals and wheat grain which was 0.2 mg/kg (13).



**Figure 8. The effect of location, season and type of wheat on Arsenic conc**

**Cobalt (Co)**  
 From the results obtained in this study, as can be show from the Figure 9, the content of (Co) in all samples analyzed were the same concentration which was 3.067 mg/kg. The concentration of (Co) in all samples analyzed were below the maximum permissible safe limits in cereals 50 mg/kg according to the codex alimentarius commission ( Table 9) (11). Statistical analysis revealed (appendix9) significant differences in level of (Co) content in all samples analyzed except in Al Rusafa silo for spring season, within the same samples of wheat flour and local wheat which was no significant differences. Moreover, high significant differences was detected within the same samples of American wheat was (1.58\*) and in Al Dora silo for spring season was (1.57\*). A similar study for survey heavy metals in wheat grains conducted in India the

maximum concentration of Cobalt found in wheat 0.49 ppm and minimum value of Cobalt found 0.13 ppm in the same location. (27). Co is an important component of the vitamin B-12 molecule. It's required in the manufacture of RBC and in preventing anemia. Additionally, Vitamin B-12 prevents nerve damage by contributing to the formulation of the protective sheath that insulates nerve cells. An excess intake of cobalt may cause the overproduction of red blood cells (16).

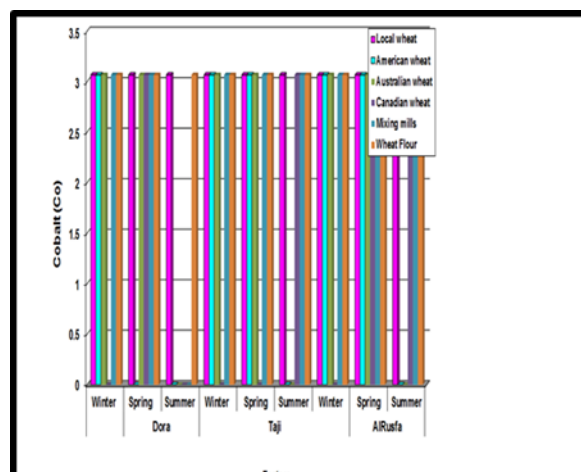


Figure 9. The effect of location, season and type of wheat on cobalt conc

Table 1. Effect of Location, Season and Type of wheat sample on Cadmium concentration

Location	Season	Type of wheat sample						LSD value
		Local Wheat	American Wheat	Australian Wheat	Canadian Wheat	Mixing Mills	Wheat Flour	
Al Dora Silo	Winter eceember 2018/12/19	1.4	1.6	1.6	0	1.8	1.4	1.39 *
Al Dora Silo	Spring March 2019 /3/27	10.4	0	12.1	1.5	10.8	0.4	3.52 *
Al Dora Silo	Summer May 2019 /5/19	7.1	0	0	0	0	12.6	3.07 *
Taji Silo	Winter December 2018/120/2	0.9	1.2	2.3	0	9.6	6.7	2.15 *
Taji Silo	Spring April 2019/4/3	1	2.6	1.3	0	3.4	8	2.33 *
Taji Silo	Summer June 2019/6/17	1	0	0	1.1	0.9	1.7	1.18 *
AlRusfa Silo	Winter January 2019/1/17	2.3	6.1	8.1	0	5.2	1.5	1.79 *
AlRusfa Silo	Spring March 2019/3/26	2.8	0.8	7.6	1.3	1.9	1.5	2.05 *
AlRusfa Silo	Summer May 2019/5/7	0.5	0	0	3.3	1.1	1.6	1.72 *
LSD value		2.48 *	1.93 *	2.82 *	1.55 *	2.68 *	2.87 *	---

\* (P≤0.05).

Table 2. Effect of Location, Season and Type of heat sample on Lead concentration

Al Dora Silo	Winter December 2018/12/19	1.02	0.46	1.02	0	1.01	0.55	0.883 *
Al Dora Silo	Spring March 2019 /3/27	0.464	0	0.649	0.371	0.371	1.021	0.672 *
Al Dora Silo	Summer May 2019 /5/19	1.021	0	0	0	0	0.371	0.684 *
Taji Silo	Winter December 2018/120/2	1.02	0.55	0.56	0	0.28	0.185	0.592 *
Taji Silo	Spring April 2019/4/3	0.092	0.649	1.021	0	0.464	0.371	0.633 *
Taji Silo	Summer June 2019/6/17	0.371	0	0	0.371	0.185	0.371	NS
AlRusfa Silo	Winter January 2019/1/17	0.464	0.65	0.556	0	0.464	0.186	NS
AlRusfa Silo	Spring March 2019/3/26	0.278	0.278	0.557	0.743	0.464	0.278	NS
AlRusfa Silo	Summer May 2019/5/7	0.185	0	0	0.278	1.021	0.556	0.623 *
LSD value		0.602 *	0.482 *	0.643 *	0.405 *	0.723 *	0.655 *	---

\* (P≤0.05).

Table 3. Effect of Location, Season and Type of wheat sample on Nickel concentration.

Location	Season	Type of wheat sample						LSD value
		Local Wheat	American wheat	Australian Wheat	Canadian wheat	Mixing Mills	heat Flour	
Al Dora Silo	Winter December 2018/12/19	7.07	5.81	6.21	0	5.82	5.81	1.778 *
Al Dora Silo	Spring March 2019 /3/27	6.677	0	7.151	6.051	6.286	6.127	1.805 *
Al Dora Silo	Summer May 2019 /5/19	7.227	0	0	0	0	6.129	1.796 *
Taji Silo	Winter December 2018/120/2	7.46	6.36	6.13	0	6.60	6.37	2.065 *
Taji Silo	Spring April 2019/4/3	6.390	6.441	6.286	0	6.365	7.698	2.381 *
Taji Silo	Summer June 2019/6/17	7.072	0	0	6.365	7.148	6.284	1.952 *
AlRusfa Silo	Winter January 2019/1/17	6.67	6.44	6.99	0	6.365	5.82	1.886 *
AlRusfa Silo	Spring March 2019/3/26	6.048	6.522	6.286	6.365	6.834	5.736	NS
AlRusfa Silo	Summer May 2019/5/7	5.655	0	0	6.834	5.655	6.362	2.305 *
LSD value		1.671 *	2.563 *	2.392 *	2.552 *	2.804 *	1.744 *	---

\* (P≤0.05).



**Table 4. Effect of Location, Season and Type of wheat sample on Iron concentration**

Location	Season	Type of wheat sample						LSD value
		Local Wheat	American wheat	Australian wheat	Canadian wheat	Mixing Mills	Wheat Flour	
Al Dora Silo	Winter December 2018/12/19	49.97	43.061	31.99	0	36.072	23.53	7.61 *
Al Dora Silo	Spring March 2019 /3/27	56.51	0	33.903	55.836	47.079	24.919	8.55 *
Al Dora Silo	Summer May 2019 /5/19	46.945	0	0	0	0	30.529	7.29 *
Taji Silo	Winter December 2018/120/2	46.35	47.15	38.48	0	44.74	24.82	7.05 *
Taji Silo	Spring April 2019/4/3	50.855	37.277	37.920	0	46.99	34.807	8.10 *
Taji Silo	Summer June 2019/6/17	44.990	0	0	52.542	43.569	31.993	6.59 *
AlRusfa Silo	Winter January 2019/1/17	50.45	39.71	50.803	0	34.144	15.66	7.04 *
AlRusfa Silo	Spring March 2019/3/26	48.473	47.401	32.217	44.589	48.044	19.683	7.35 *
AlRusfa Silo	Summer May 2019/5/7	35.610	0	0	45.96	37.379	19.614	6.92 *
LSD value		8.22 *	8.35 *	7.82 *	8.07 *	8.61 *	6.94 *	---

\* (P&lt;0.05).

**Table 5. Effect of Location, Season and Type of wheat sample on Zinc concentration.**

Location	Season	Type of wheat sample						LSD value
		Local Wheat	American wheat	Australian Wheat	Canadian wheat	Mixing Mills	Wheat Flour	
Al Dora Silo	Winter December 2018/12/19	73.45	29.52	23.36	0	26.72	18.01	8.39 *
Al Dora Silo	Spring March 2019 /3/27	42.81	0	32.45	36.30	49.73	14.69	10.62 *
Al Dora Silo	Summer May 2019 /5/19	108.95	0	0	0	0	44.659	13.66 *
Taji Silo	Winter December 2018/120/2	56.76	27.94	29.58	0	52.01	15.66	8.96 *
Taji Silo	Spring April 2019/4/3	38.50	25.008	34.20	0	33.96	33.36	8.33 *
Taji Silo	Summer June 2019/6/17	35.741	0	0	35.531	70.409	19.902	9.02 *
AlRusfa Silo	Winter January 019/1/17	43.75	25.70	42.29	0	25.393	9.302	8.57 *
AlRusfa Silo	Spring March 2019/3/26	26.302	55.640	21.75	30.215	38.929	10.806	8.91 *
AlRusfa Silo	Summer May 2019/5/7	33.053	0	0	34.172	30.849	8.429	8.37 *
LSD value		13.47*	11.20 *	8.66 *	8.07 *	9.72 *	11.28 *	---

\* (P&lt;0.05).

**Table 6. Effect of location, Season and Type of wheat sample on Copper concentration.**

Location	Season	Type of wheat sample						LSD value
		Local Wheat	American wheat	Australian Wheat	Canadian wheat	Mixing Mills	Wheat Flour	
Al Dora Silo	Winter December 2018/12/19	10.22	7.66	4.79	0	5.11	8.148	3.59 *
Al Dora Silo	Spring March 2019 /3/27	7.429	0	4.793	6.550	8.947	7.513	2.74 *
Al Dora Silo	Summer May 2019 /5/19	9.752	0	0	0	0	5.513	2.61 *
Taji Silo	Winter December 2018/120/2	7.58	5.91	5.032	0	8.78	8.068	2.66 *
Taji Silo	Spring April 2019/4/3	7.109	5.417	6.231	0	6.635	4.876	2.71 *
Taji Silo	Summer June 2019/6/17	11.104	0	0	6.311	7.913	4.476	2.86 *
AlRusfa Silo	Winter January 2019/1/17	9.51	6.79	7.91	0	5.192	4.154	2.30 *
AlRusfa Silo	Spring March 2019/3/26	5.355	7.269	6.950	6.311	6.315	3.675	2.44 *
AlRusfa Silo	Summer May 2019/5/7	7.034	0	0	7.114	8.713	5.195	2.82 *
LSD value		3.29 *	2.66 *	2.07 *	2.18 *	3.08 *	2.61 *	---

\* (P&lt;0.05).

**Table 7. Effect of Location, Season and Type of wheat sample on Chromium concentration.**

Location	Season	Type of wheat sample						LSD value
		Local Wheat	American wheat	Australian Wheat	Canadian wheat	Mixing Mills	Wheat Flour	
Al Dora Silo	Winter December 2018/12/19	0.513	0.513	0.513	0	0.513	0.513	NS
Al Dora Silo	Spring March 2019 /3/27	0.513	0	4.413	0.786	0.513	0.513	1.382 *
Al Dora Silo	Summer May 2019 /5/19	0.513	0	0	0	0	0.513	NS
Taji Silo	Winter December 2018/120/2	0.513	0.513	0.513	0	0.513	0.513	NS
Taji Silo	Spring April 2019/4/3	0.513	0.513	0.513	0	0.513	4.686	1.437 *
Taji Silo	Summer June 2019/6/17	0.513	0	0	0.513	0.513	0.513	NS
AlRusfa Silo	Winter January 2019/1/17	0.786	0.513	0.513	0	0.513	0.513	0.544 *
AlRusfa Silo	Spring March 2019/3/26	0.513	0.513	0.513	0.821	0.513	0.513	NS
AlRusfa Silo	Summer May 2019/5/7	0.513	0	0	0.513	0.513	0.513	NS
LSD value		NS	NS	1.662 *	0.639 *	NS	1.226 *	---

\* (P&lt;0.05).

**Table 8. Effect of Location, Season and Type of wheat sample on Arsenic concentration.**

Location	Season	Type of wheat sample					LSD value	
		Local Wheat	American wheat	Australian Wheat	Canadian wheat	Mixing Mills		Wheat Flour
Al Dora Silo	Winter December 2018/12/19	0.265	0.265	0.265	0	0.265	0.265	NS
Al Dora Silo	Spring March 2019 /3/27	0.265	0	0.265	0.265	0.265	0.265	NS
Al Dora Silo	Summer May 2019 /5/19	0.265	0	0	0	0	0.265	NS
Taji Silo	Winter December 2018/12/02	0.265	0.265	0.265	0	0.265	0.265	NS
Taji Silo	Spring April 2019/4/3	0.265	0.265	0.265	0	0.265	0.265	NS
Taji Silo	Summer June 2019/6/17	0.265	0	0	0.265	0.265	0.265	NS
AlRusfa Silo	Winter January 2019/1/17	0.265	0.265	0.265	0	0.265	0.265	NS
AlRusfa Silo	Spring March 2019/3/26	0.265	0.265	0.265	0.265	0.265	0.265	NS
AlRusfa Silo	Summer May 2019/5/7	0.265	0	0	0.265	0.265	0.265	NS
LSD value		NS	NS	NS	NS	NS	NS	---

NS: Non-Significant.

**Table 9. Effect of Location, Season and Type of wheat sample on Cobalt concentration.**

Location	Season	Type of wheat sample					LSD value	
		Local Wheat	American wheat	Australian Wheat	Canadian wheat	Mixing Mills		Wheat Flour
Al Dora Silo	Winter December 2018/12/19	3.067	3.067	3.067	0	3.067	3.067	1.35 *
Al Dora Silo	Spring March 2019 /3/27	3.067	0	3.067	3.067	3.067	3.067	1.57 *
Al Dora Silo	Summer May 2019 /5/19	3.067	0	0	0	0	3.067	1.18 *
Taji Silo	Winter December 2018/12/02	3.067	3.067	3.067	0	3.067	3.067	1.35 *
Taji Silo	Spring April 2019/4/3	3.067	3.067	3.067	0	3.067	3.067	1.35 *
Taji Silo	Summer June 2019/6/17	3.067	0	0	3.067	3.067	3.067	1.44 *
AlRusfa Silo	Winter January 2019/1/17	3.067	3.067	3.067	0	3.067	3.067	1.35 *
AlRusfa Silo	Spring March 2019/3/26	3.067	3.067	3.067	3.067	3.067	3.067	NS
AlRusfa Silo	Summer May 2019/5/7	3.067	0	0	3.067	3.067	3.067	1.44 *
LSD value		NS	1.58 *	1.44 *	1.49 *	1.37 *	NS	---

\* (P≤0.05)

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