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Heavy Metals Content in Some Chips Products in Iraqi Markets

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Abstracts

The recent study was conducted to measure some heavy metal content in potato and corn chips in Baghdad markets. Samples were analyzed by Atomic Absorption Spectrophotometer (AAS). Four metals, Cobalt (Co), Cadmium (Cd), Copper (Cu) and Lead (Pb) were determined. Two types belonging to two manufacturer resources and two trademarks for each resource were tested in this work. Generally, the study recorded that the potato chips were containing metals less than the corn chips. According to Iraqi criteria, all tested types of potato chips were under the allowed levels. The mean of accumulation trend for both types was: Cu>Co>Pb>Cd. The mean of accumulation trend for the corn types of chips was: Baz>Pufack> Fantasia > Snack. The mean of accumulation trend for Potato chips was: Hilla>Mrsticks>Shepisco>Leez. Only Pufack (Jordan) Baz and Fantasia (Iraq) trademarks were containing levels of Cu exceeded of criteria. The aim of study is to monitor the levels of metals in chips food.

Keywords: Atomic Absorption Spectrometry, Heavy metals, chips.

محتوى المعادن الثقيلة في بعض منتجات الجبس في الاسواق العراقية

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الخلاصة

أجريت الدراسة الحالية لقياس محتوى بعض المعادن الثقيلة في رقائق البطاطس والذرة في أسواق بغداد. وتم تحليل العينات بجهاز مطياف الامتصاص الذري (AAS). وقد حددت أربع معادن هي الكوبالت (Co)، الكاديوم (Cd) والنحاس (Cu) والرصاص (Pb). تم اختبار نوعين ينتميان إلى مصدرين تصنيفيين وتم اختبار علامتان تجاريتان لكل مصدر في هذا العمل. سجلت الدراسة عموماً أن رقائق البطاطس تحتوي على معادن أقل من رقائق الذرة. وفقاً للمعايير العراقية، كانت جميع الأنواع المختبرة من رقائق البطاطس تحت المستويات المسموح بها. وكان متوسط الترتيب التراكمي لكلا النوعين كالتالي: Cu > Co > Pb > Cd. كان متوسط الترتيب التراكمي لأنواع رقائق الذرة: Snack < Fantasia < Pufack < Baz. وكان متوسط الترتيب التراكمي لرقائق البطاطس في كالتالي: Hilla < Mrsticks < Shepisco < Leez. كانت العلامات التجارية Pufack (الأردن) و Baz و Fantasia (العراق) فقط تحتوي على مستويات من Cu تجاوزت المعايير. الهدف من الدراسة هو رصد مستويات المعادن في رقائق الغذاء.

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Introduction

The potato and corn chips are considered as the main foods in the world. It is representing as a source of carbohydrate and nutritionally completes protein and source of essential nutrients [1]. A corn chip is a food made from corn in oil or baked with noodle or scoop shape. Corn chips are thick, rigid and crunchy. It has strong aroma and flavor of roasted corn, and heavily dusted with salt. Corn chips are eaten alone or with a chip dip. Heavy metals have important positive and negative roles in human life [2-5]. Common heavy metals such as mercury, lead, copper, and cadmium are cumulative able poisons, which cause environmental hazards and are reported to be toxic [6].

But, metals as copper, iron, manganese and zinc are considered as essential substances for humans, they play an important role in biological systems, but the essential heavy metals can produce toxic effects when their intake is excessively elevated [7-9].

Hence, the trace heavy metal content in potato is an important consideration. Heavy metal concentrations of plants are directly associated with their concentrations in soils, but their levels significantly differ with plant species, and even can be so affected by genotypes within the same species [10].

From this point of view, it can be concluded that potato genotypes also will differ in heavy metal concentrations. This information may be useful for designing future breeding efforts to improve potato quality management. Little information on the magnitude of variation about the heavy metal content of potato genotypes is currently available in literature and more data would benefit future nutritional studies. In the current study, the levels of lead, copper, cobalt and cadmium were determined in selected kinds of potato and corn chips. Content of Pb and Cd in food is caused a number of diseases as kidney, cardiovascular, nervous and bone diseases [11-14].

Accumulation of heavy metals in food may occur and caused long-term effects after several years of exposure. Monitoring of heavy metals levels in the food is important to preventing buildup of the metals in the food chain [15].

Heavy metal sources are wide distribution of metal products, battery production, metals melting, and vehicular emissions, Cable coating industries, diesel generators and re-suspended road dust. All these resources can be important to the contamination of food. Other sources of heavy metals are in the field as irrigation water contaminated by industrial effluent. This contamination is leading to contaminate soils and plant [16].

Therefore it needs to test the food to ensure that the levels of trace metal agreed with international criteria [17].

This study thus, provides data on the levels of Pb, Cd, Cu and Co in some kinds of potato and corn chips

Methodology

Ten samples of the potato and corn chips were collected from the markets in Baghdad, during 2016. The collected kinds and analysis were followed to two manufactured resources Iraq and Jordan.

Heavy Metals Analysis

The samples were analyzed for Co, Pb, Cu and Cd with three replicates. Flame atomic absorption spectrophotometer AAS (Shimatzo AA-700, Japan) were used to this analysis.

Grinding of samples

Chips samples were ground into a powder by blender and prepared for acid digestion.

Acid Digestion

Acid digestion procedure was made to extraction of heavy metals depending on method described by [18] as follows:

- 20 g of the dry weight of each sample was weighed into a digestion tube.
- Samples were fired with the burner to fuge stopping.
- Samples were put in the oven (550 C) to gray color appeared then let until cold.
- 10ml of 98% nitric acid was added.
- Tubes were putting in a water bath and allowed to boil for about 72 hours.
- Yellow obtained solution was diluted to 50ml with deionized water and stored.
- Applied the equation follow to get the concentration of heavy metals in samples

$$Con. = DV * R / W$$

Con.: Concentration of heavy metals in samples

DV: Diluted volume

R: AAS recorded

W: Weight of tested sample

Account of Daily consuming

Special questioner form study was created to determine the daily consuming of chips for Iraqi population and randomly distributed in different places. The results of a questioner study performed to survey the consuming of chips in Iraqi population were recorded that the mean of consuming was 20 g /week for 20 years aged population sample of 190 individuals.

Daily Intake (DI) calculation

The daily intake (mg/ kg/day) was calculated depending on the equation

$$DI = 0.01 * 20 / 33 / 1 \quad [4]$$

The daily intake based on the following assumptions:

- 1- The average weight for each child was 33 kg.
- 2- The mean child intake from chips per day was 20 g.

The daily intake (mg/ kg/ day) = Metal concentration in sample (mg/g) x mean sample intake (g / average child weight / day).

Statistical analyses

Results were analyzed for statistical significance by analysis of variance [19]. Three duplicates with a replicate performed this research.

The dependent Criteria

The study was dependent on Iraqi Criteria number 3782/2001 Device Standardization and Quality Control, Council of Ministers, Iraq.

Results and Discussion

1. Heavy metals level in Corn chips (Pufack and Snack trademarks)

The results of the recent study found that the level of heavy metals (Pb, Co, and Cu) in the corn chip type Snack trademark more than the levels in the chip Pufack trademark. However, the levels of Cd in the trademark Pufack were noticed to be more than in the trademark Snack. The range of Cu level (1.4462ppm) was the highest among the studied metals. As well as the mean, mean upper confidence level (UCL), and the sum of Cu levels were the highest among tested metals. In opposite, the metal Cd was the lowest levels of the sum, mean, and mean upper confidence level (UCL) among tested metals. The range of Co level (0.0022ppm) was the lowest recorded among tested metals, Table-1.

Table 1-Quantity and analysis of heavy metals of corn chips manufactured in Jordan.

Pufack & Snack	Pb	Co	Cu	Cd
Sum ± SD	0.2485±0.1	0.1082±0.002	2.7322±1.4	0.0285±0.02
Total Sum Sq.	0.036547	0.005856	4.778206	0.000784
Minimum (Pufack)	0.071	0.053	0.643	0.0005
Maximum (Snack)	0.1775	0.0552	2.0892	0.028
Range	0.1065	0.0022	1.4462	0.0275
Mean ±SE	0.12425±0.05	0.0541±0.001	1.3661±0.72	0.01425±0.01
Mean LCL	-33.7757	-0.64618	-458.973	-8.73926
Mean UCL	34.02422	0.754381	461.7055	8.767765
Variance ± SE	0.005671±0.075	2.42E-06±0.001	1.045747±1.02	0.000378±0.01
Coefficient of Var.	0.606092	0.028755	0.748567	1.364592

In general attitude, the corn chip type Pufack trademark has fewer levels of metals than the Snack trademark in all tested metals, Figure-1 (A, B, C, and D).

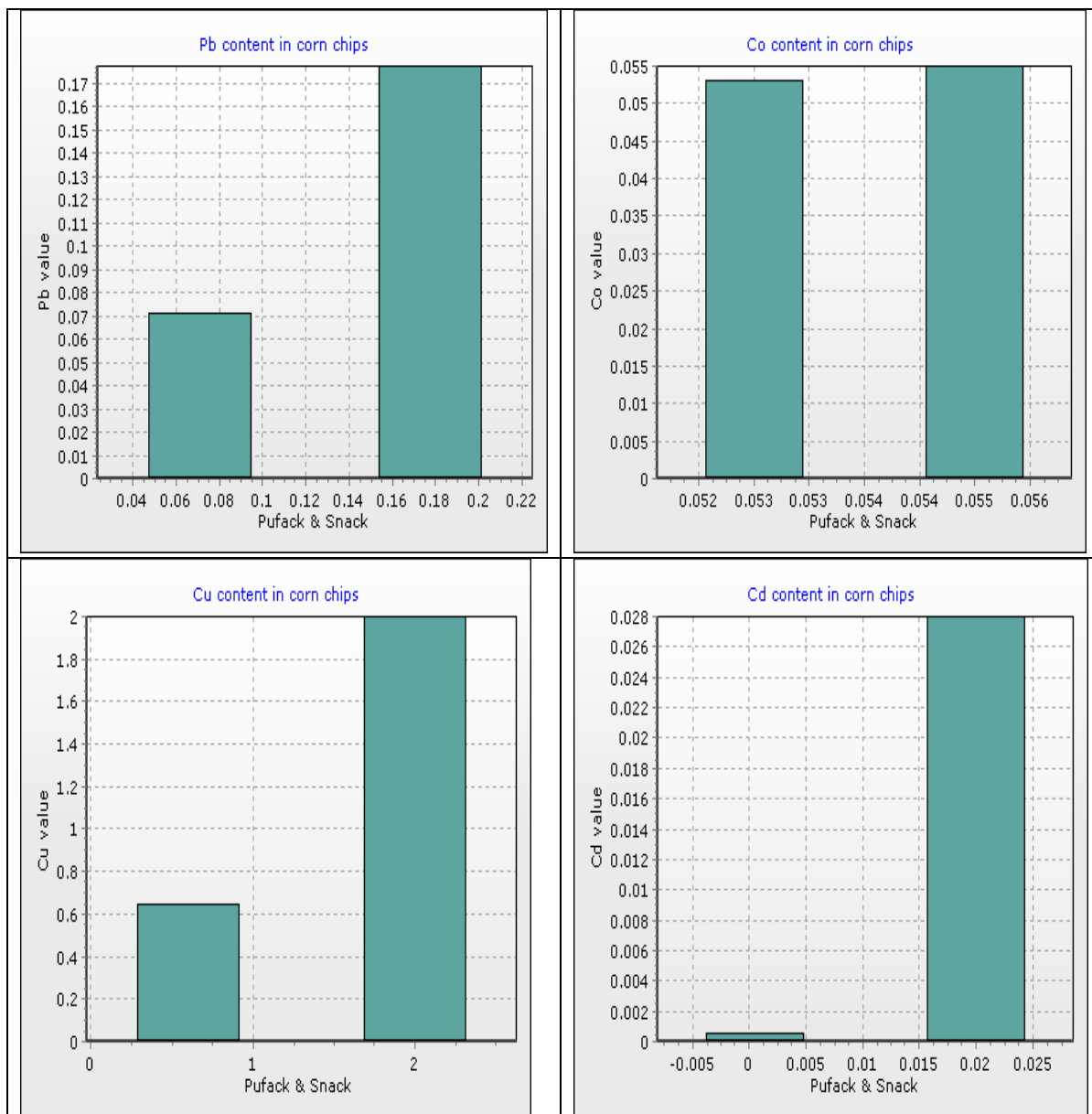


Figure 1-Heavy metal content (mg/kg) in Pufack and Snack corn chip types.

2. Heavy metals level in Corn chips (Fantasia and Baz trademarks)

The results of the recent study found that the level of heavy metals (Pb, Cu, and Cd) in the corn chip type Fantasia trademark more than the levels in the chip Baz trademark. However, the levels of Co in the trademark Baz were noticed to be more than in the trademark Fantasia. The range of Cu level (0.174ppm) was the highest among the studied metals. As well as the mean, mean upper confidence level (UCL), and the sum of Cu levels were the highest among tested metals. In opposite, the metal Cd was the lowest levels of the sum, mean, and mean UCL among tested metals. The range of Co level (0.001ppm) was the lowest recorded among tested metals, Table-2.

Table 2- Quantity and analysis of heavy metals of corn chips manufactured in Iraq.

Fantasy &Baz	Pb	Co	Cu	Cd
Sum± SD	0.4024±0.1	0.1052±0.03	4.2165±0.1	0.005±0.0007
Total Sum Sq.	0.0910	0.0064	8.9046	1.51E-05
Minimum (Fantasia)	0.1302	0.074	2.021	0.0022
Maximum (Baz)	0.2722	0.0312	2.195	0.0032
Range	0.142	0.0428	0.174	0.001
Mean ±SE	0.2012±0.07	0.0526±0.02	2.108±0.08	0.0027±0.0005
Mean LCL	-44.9987	-13.5711	-53.4368	-0.3156
Mean UCL	45.4011	13.6762	57.6532	0.321
Variance	0.0100	0.0009	0.0152	5.00E-07
Coefficient of Var.	0.6060	0.5753	0.0585	0.26

The results of this study reported that the corn chip type Fantasia trademark has less level of metals than the Baz trademark in all tested metals, Figure- 2.

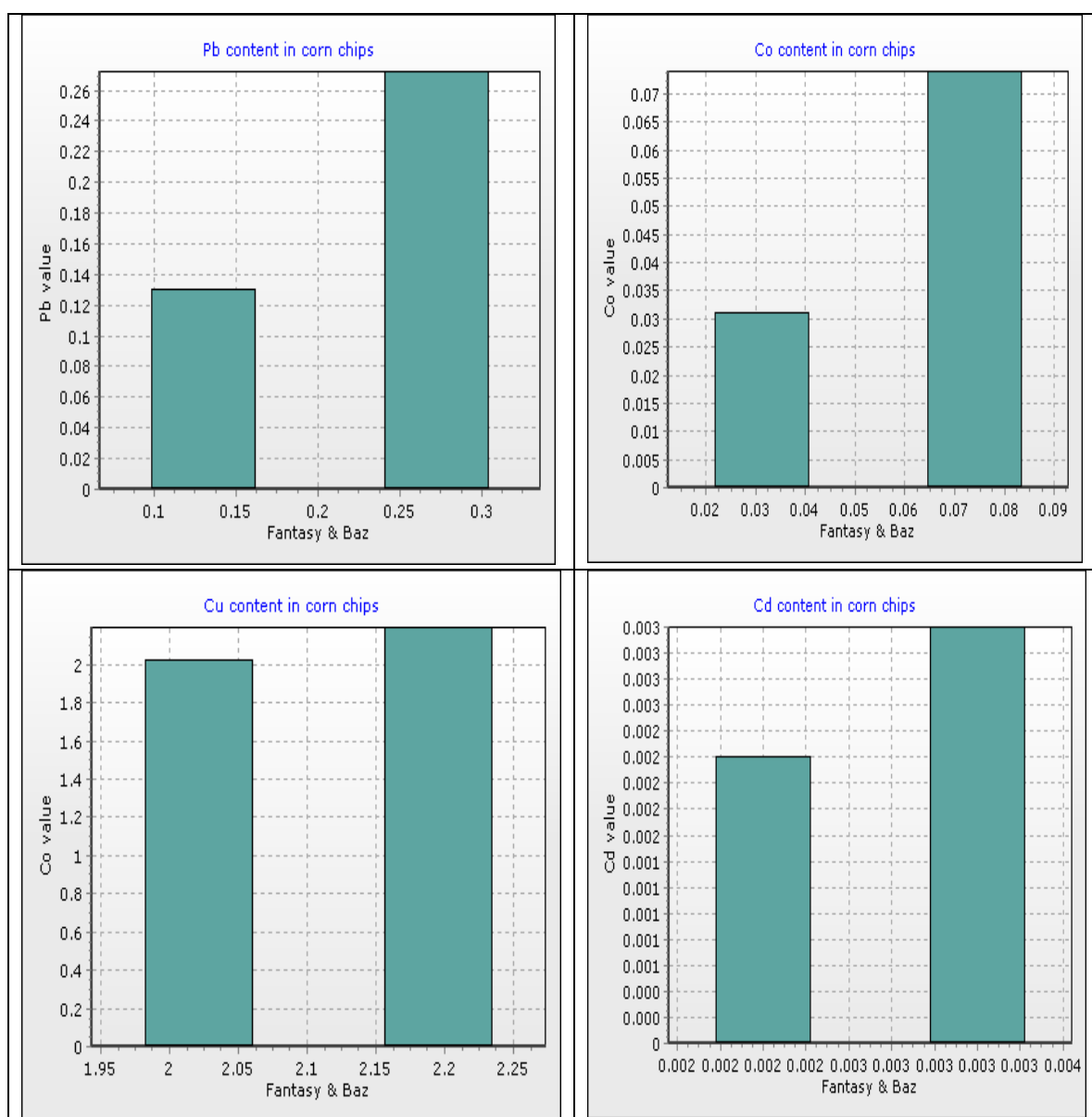


Figure 2- Heavy metal content (mg/kg) in Fantasia and Baz corn chip types.

Abstractly, the chip types manufactured in Iraq were containing more levels of heavy metals than the types which manufactured in Jordan. The concentration of **Pb** in study types of chips marks which being as follow: **Baz**> **Snack**> **Fantasia** >**Pufack**, for **Co** was: **Fantasia** > **Snack**> **Pufack**> **Baz**, for **Cu** was: **Baz**> **Snack**> **Fantasia** > **Pufack**, and for **Cd** was: **Snack**> **Baz**> **Fantasia** > **Pufack**.

The highest level of Pb in all tested trademarks which recorded in this study was supported by other studies that recorded the levels of Pb in this type of food may probably be attributed to pollutants come from many resources like irrigation water, farm soil or due to pollution from the highways traffic [20]. Although the analysis of heavy metal was showed present levels of Pb in chips, but these levels have stayed under safety limit (2mg/kg) according to (FAO 2002 criteria). Pb is a serious cumulative body poison which enters into the body system through air, water, and food and cannot be removed by washing [3].

Generally, the SCOOP reports were referred to lowness of the levels of lead in most consumed foodstuffs. However, lead can accumulate in liver or kidney and the consumers may be exposed to an unacceptable level. The United States FDA reports the value regulations for lead in food consumed by children. In order to keep consumers’ right, to provides information to consumers, to promote the manufacturing of good products and to protect the public’s health. The U.S. FDA was limited the tolerable concentration of lead to a lower level of 0.1 ppm [21].

The highest level of Cu was noticed in the chip corn type, mark (Pufack) while the lowest level of Pb was noticed in the chip marks (Snack, Fantasia, and Baz).The highest level of Cu was noticed in the chip corn type; trademark (Baz) while the lowest level of Pb was noticed in the chip mark (Snack).These results were similar to the same study which detected that the levels of Cu in corn and potato chips were varied from 1.5 to 3.6 mg/kg [10]. Although the study recorded little amounts of Cd metal but as known presence of Cd in food is risk because the Cd is a non-essential element in foods and natural waters and it accumulates principally in the kidneys and liver [3].

3. Heavy metals level in Potato chips (Mrsticks and Shepisco trademarks)

The results of the recent study found that the level of heavy metals (Pb, Cu, and Cd) in the potato chip type Mrsticks trademark more than the levels in the chip Shepisco trademark. However, the levels of Co in the trademark Shepisco were noticed to be more than in the trademark Mrsticks. The range of Cu level (0.0635ppm) was the highest among the studied metals. As well as the mean, mean UCL, and the sum of Cu levels were the highest among tested metals. In opposite, the metal Cd was the lowest levels of the sum, mean, and mean UCL among tested metals. The range of Co level (0.0005ppm) was the lowest recorded among tested metals, Table-3.

Table3- Quantity and analysis of heavy metals of potato chips manufactured in Jordan

Mrsticks & Shepisco	Pb	Co	Cu	Cd
Sum± SD	0.2247 ±0.04	0.012 ±0.004	1.7429 ±0.04	0.0029 ±0.0003
Total Sum Sq.	0.02700329	9.65E-05	1.52086633	4.33E-06
Minimum (Shepisco)	0.0827	0.0095	0.8397	0.0012
Maximum (Mrsticks)	0.142	0.0025	0.9032	0.0017
Range	0.0593	0.007	0.0635	0.0005
Mean ±SE	0.11235 ±0.02	0.006±0.003	0.87145 ±0.03	0.00145 ±0.0002
Mean LCL	-2.222167371	-13.5711	-19.34121115	-0.157704812
Mean UCL	2.234167371	13.6762	21.08411115	0.160604812
Variance	0.001758245	2.45E-05	0.002016125	1.25E-07
Coefficient of Var.	0.37322147	0.824957911	0.051524793	0.243829925

The results of this study reported that the corn chip type Mrsticks trademark has fewer levels of metals than the Shepisco trademark in all tested metals, Figure- 3.

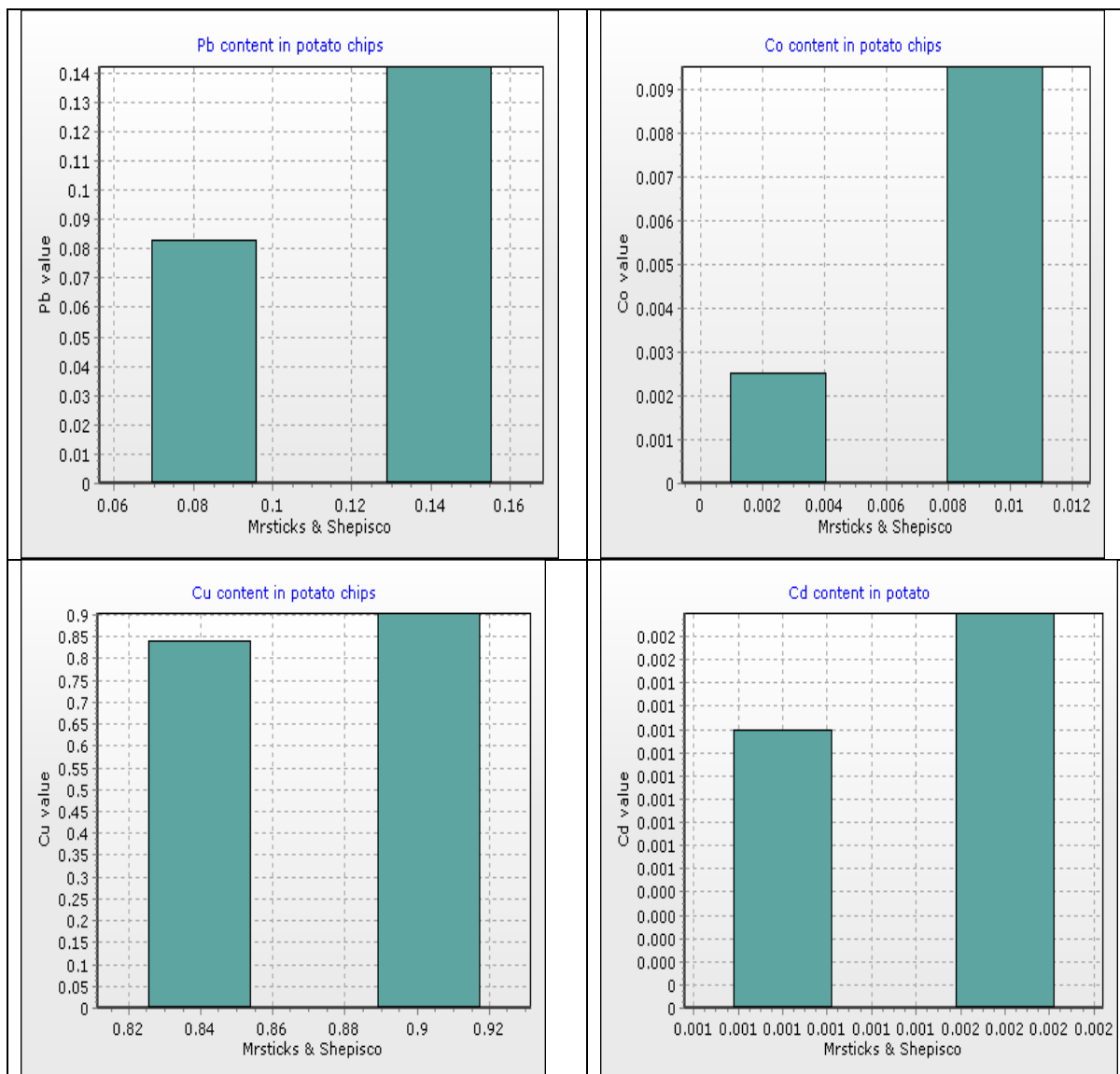


Figure3- Heavy metal content (mg/kg) in Mrsticks and Shepisco potato chip types.

4. Heavy metals level in Potato chips (Hlla and Karada trademarks)

The results of the recent study found that the level of heavy metals (Pb, Co, Cu, and Cd) in the potato chip type Hlla trademark more than the levels in the chip Karada trademark. The range of Cu level (0.4255ppm) was the highest among the studied metals. As well as the mean, mean UCL, and the sum of Cu levels were the highest among tested metals. In opposite, the metal Cd was the lowest levels of the sum, mean, and mean UCL among tested metals. The range of Cd level (0 ppm) was the lowest recorded among tested metals, Table- 4.

Table 4- Quantity and analysis of heavy metals of potato chips manufactured in Iraq

Hlla & Karada	Pb	Co	Cu	Cd
Sum± SD	0.225 ±0.07	0.0769 ±0.01	2.0225 ±0.212	0.001 ±0.0005
Total Sum Sq.	0.0371705	0.00351793	2.13577825	1.00E-06
Minimum (Karada)	0.0355	0.0217	0.7985	0
Maximum (Hlla)	0.1895	0.0552	1.224	0.001
Range	0.154	0.0335	0.4255	0.001
Mean ±SE	0.1125 ±0.07	0.03845 ±0.01	1.01125 ±0.212	0.0005 ±0.0007
Mean LCL	-48.90718216	-10.62492242	-134.4294952	-0.317809624
Mean UCL	49.13218216	10.70182242	136.4519952	0.318809624
Variance	0.011858	0.000561125	0.090525125	5.00E-07
Coefficient of Var.	0.967950616	0.616074829	0.297526759	1.414213562

The results of this study reported that the corn chip type Hlla trademark has less level of metals than the Karada trademark in all tested metals, Figure-4.

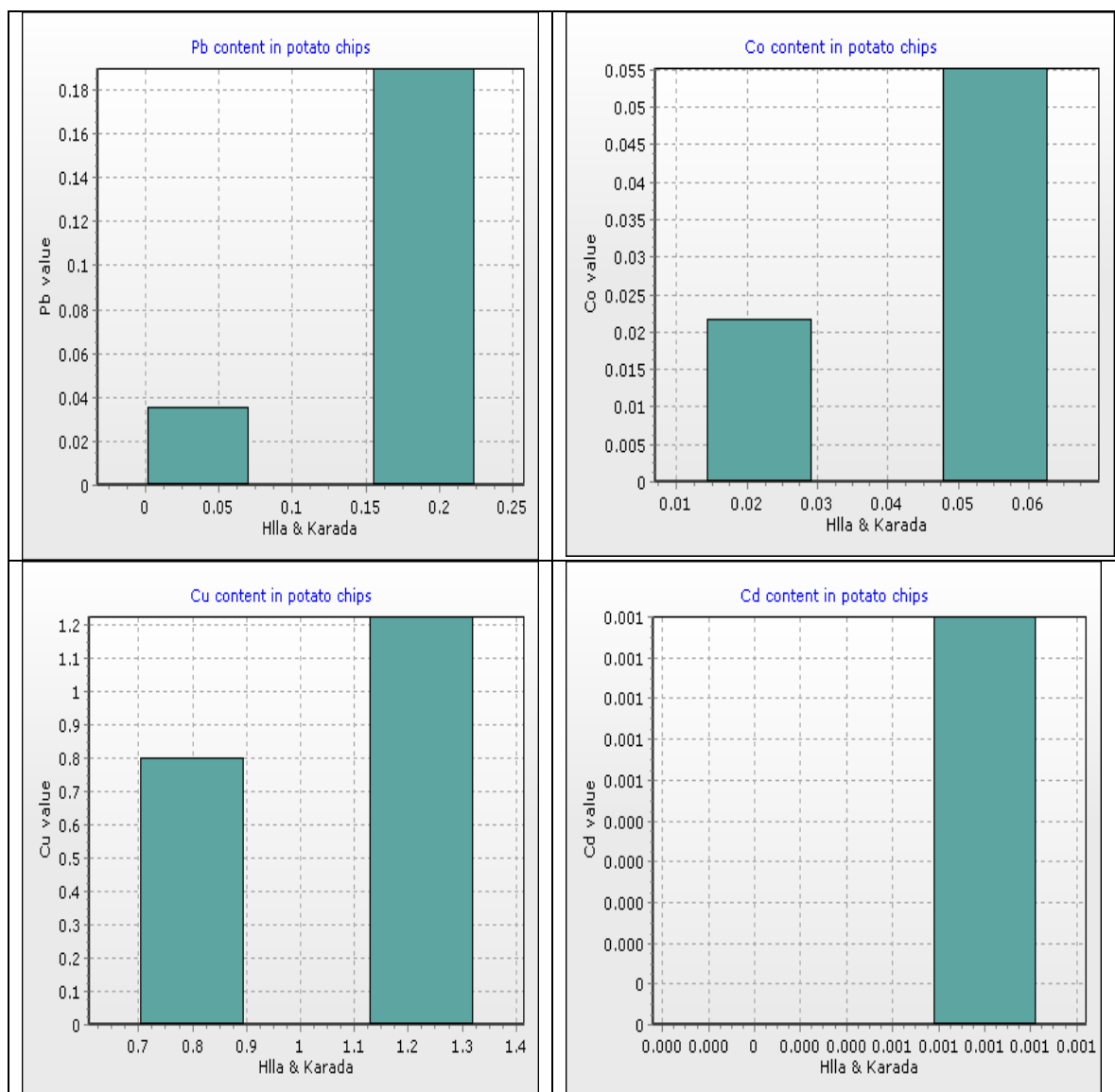


Figure3- Heavy metal content (mg/kg) in Hlla and Karada potato chip types.

The concentration of Pb in Potato chips marks which being as follow: **Hlla>Mrsticks>Shepisco>Karada**, for **Co** was **Hlla> Karada> Shepisco> Mrsticks**, for **Cu** was: **Hlla> Mrsticks> Shepisco> Karada**, and for **Cd** was: **Mrsticks> Shepisco> Hlla> Karada**.

According to the results of this study, the chip type Shepisco trademark has little content of heavy metals than the Mrsticks trademark (Pb, Cu and Cd) was less than the content of the type Pufack.

The levels of heavy metals (Pb, Co and Cu) in the potato chip type Karada trademark were noticed to be more than the levels in the Hlla trademark. But, the level of (Cd) in the Hlla trademark was noticed to be more than in the Karada trademark. These two types manufactured in Iraq. The chip Karada trademark has the lower content of metals than the Hlla trademark.

The highest level of Pb was noticed in the potato chip type; mark (Hlla) while the lowest level of Pb was noticed in the chip mark (Karada).

It can be stated that the site of potato growth influences the heavy metal uptake by potato. Generally, Pb contaminations occur in vegetables grown on contaminated soils. Lead poisoning is a global reality, and fortunately is not a very common clinical diagnosis yet in Iraq except for few occupational exposures [22].

Generally, the levels of heavy metals were observed to be lower than those of previously published works and regulatory standards. This may be in due partly to the absence of pollution in the area under investigation as it explained by other publication was detect the level of Cd as 0.03mg/kg [23].

The mean of accumulation trend for **corn and potato** chips was in the following order: **Cu>Pb>Co>Cd**, Figure-4.

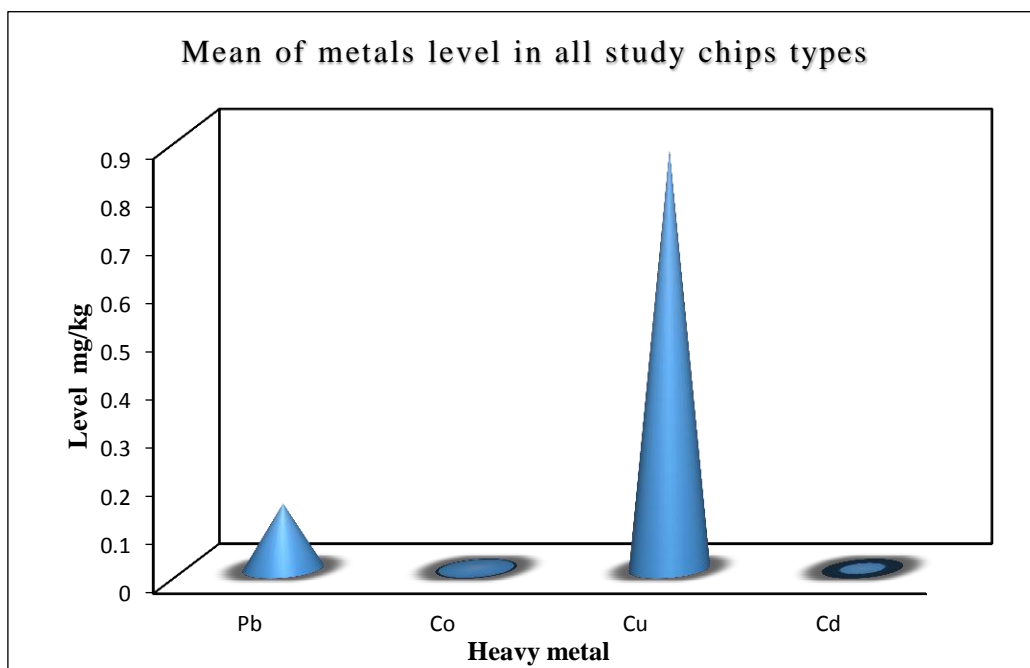


Figure 4- Summary of the mean content of heavy metals in potato and corn chip for tested types.

The results of a questioner study performed to survey the consuming of chips in Iraqi population were recorded that the mean of consuming was 20 g /kg/week (2.8 g/kg/day) for average 20 years aged population sample of 190 individuals.

According to the results of Iraqi daily consuming for all types of tested chips, there are no risks of consuming the chips from **Pb** and **Cu** content if the human intake is about 20 g of the investigated chips per day as a normal level A and risk from Pb as a normal level B which reported by [24]. In contrast, there is a danger of consuming the chips from **Co** and **Cd** content as a normal level A and B, Table-5.

Table 5- Reference levels (mg/kg/day) of heavy metals in tested types (ASTDR).

Reference level	Pb	Cu	Co	Cd
Mean consume (g/kg/day)	2.8	2.8	2.8	2.8
Normal level (A) (mg/kg/day)	20	20	1	1
Warning threshold	50	100	3	3
Normal level (B) (mg/kg/day)	0.3	73.3	0.2	0.2

According to the estimates of ATSDR (2001), the lowest risk level for dangerous Pb, Cd, Cu, and Co enter the body through oral route way and acute effect were 0.0002, 0.0002, 0.02, and 0.0002 mg/kg/day, respectively.

The corn chip contains more levels of heavy metals than the potato chip. The corn chips have three natural sources of heavy metals pollution or contamination which are soil, air, and manufacture operations whereas the potato chips have two sources which are soil and manufacture operations. Many rural and urban low-income families in Iraq consume large quantities of chips on a daily basis and this exposes them to the health risks associated with heavy metals ingestion. According to ATSDR (2001), the minimal risk level for hazardous Pb, Co, Cu, and Cd through oral route and acute effect was 0.0002, 0.0002, 0.02, 0.07 and 0.3 mg kg⁻¹ day⁻¹, respectively. There are differences among the international organizations in an estimation of heavy metal content in food. For example, FDA 1994 and 1995 has set an action level of 0.5 µg/mL for Pb in products intended for use by infants and children and has banned the use of lead-soldered food chains Cited in [24].

Conclusion

From this preliminary study we concluded:

- The chips potato manufactured has less metal content than the chips corn manufactured.
- According to Iraqi criteria, all tested trademarks of potato chips were under the allowed levels of heavy metals in chips.
- Most of the types of corn chips which manufactured in Jordan were contain less than the types which manufactured in Iraq.
- The authors are recommended making analysis like the present study for more trademarks and types with other ways of analysis.

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