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Determination of Some Heavy Metals and Elements in Honeybee and Honey Samples from Saudi Arabia

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ABSTRACT

Honeybees and honey have become important tools for ecotoxicity because of their extraordinary ability to bioaccumulate of mineral element and toxic metals from the environment. The present study aimed to evaluate and detect the mineral element and pollution levels of honeybees and their product, honey, by heavy metals. These minerals include heavy metals; cadmium, chromium, copper, iron, manganese, nickel, lead, zinc) and elements (calcium, potassium, magnesium, sodium). The levels of heavy metal pollution are collected from different regions in Saudi Arabia using foraging bees of Apis mellifera jemenatica. For this purpose, bee and honey samples were collected directly from different geographic regions in Saudi Arabia. The results of this study showed that the highest contamination level among the heavy metals in question was the iron (Fe). In the honey bee samples, the highest Fe concentrations were in Makkah region (8.794) Asir (6.222) Jazan (6.205)Al-Baha(2.088). In the honey samples, the highest Fe concentrations were found in Asir (1.904) Jazan (1.843)Al-Baha(1.340) and Makkah (0.907). In addition, we found that the most concentrated mineral element is potassium (K) in all four agricultural areas from which the samples were collected in this study. The results showed that metal levels are within the limits of international standards in bee and honey in Saudi Arabia.

Keywords: Honeybees; Honey; heavy metals; elements; *foragers* honeybee workers; *Apis mellifera jemenatica*; Saudi Arabia.

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INTRODUCTION

Honeybees (*Apis mellifera* L.) are among the most important living organisms that are affected by environmental conditions and have a great ability to sense environmental changes, they are considered a biological indicator of many toxic environmental factors that exist in nature [1]. They can monitor and evaluate the level of pollution ; due to its extensive food search behavior.In addition, honey can be contaminated from different sources [2,3]. For instance, it may be an internal source of pollution resulting from the malpractice by some beekeepers and/or bees can be transported to the beehive contaminated by the external environment through water, plants, soil and air pollution [4].

Honeybees and their product (honey), are affected by the surrounding environmental factors and act as an of environmental pollution. The main sources for contamination of honey are represented by placing hives near unsuitable urban areas [5]. Previous studies have shown that the concentrations of minerals in the bodies of honeybees living in industrial area and urban were much higher [6, 7].
Mineral elements are considered to be the smallest components of honey, and their levels vary according to the source of the flowers that collected nectar and pollen from it [8-11]. The quality and quantity of mineral elements in honey depend on the elemental composition of the flowers collected by the honeybee, which in turn vary according to the source of vegetation and the of the spatial distribution [12,13].
Heavy metals are chemical elements, which are characterized by high relative density and are found in waste collection areas, industrial complexes and places where agricultural

chemicals are used frequently [14]. The ecosystem is heavily affected by heavy metals and has been found to be affecting negatively on plant growth and the life of microorganisms [15]. Pollution of honey with heavy metals presents poses a danger to human who consume it, especially when the pollution accumulates to toxic levels. Furthermore, sources of pollution from minerals vary from external sources such as an industrial source or from incorrect methods the honey processing, and/or may be due to agricultural chemicals and pesticides [16-18].

The sources of heavy metals that are released in the environment vary and they are present continuously in such that they do not decompose quickly. Although these metals poison the bodies of honey bees, the honey bees are still able to travel great distances in the search for food and may not die directly from the poisoning of these metals. The metals, however, accumulate in their bodies and therefore play Honey bees play an important role in detecting the presence of heavy metals [19]. Thus, it is possible to rely on bees and their products to monitor and track the level of pollution with heavy metals because of their high sensitivity to these pollutants; and the easy sampling and collecting procedure of bees that allow us to conduct appropriate tests to determine the extent of pollution in specific areas [20].

In recent years, the concentrations of different metals in honey have been determined in some countries, such as China [18], Italy [14], France [21], Croatia [22] ,Slovenia [23], Poland [24] and Turkey [25-27]. Analyses of trace elements in honey samples provide a more accurate indication for the presence of contaminants in the environment [28].

So, honey bees and their products are therefore important for conducting various studies. Study was by [29]. Since the beginning of the industrial revolution, the amount of heavy metals has increased and man is the main source of such increase [30]. Nevertheless, there are a few publications addressing the honey bees and metal pollution [20].

The objective of this study is to detect and determine the level of mineral elements and heavy metals in honey bees and honey in the most important agricultural areas that are famous for bee breeding in the Kingdom of Saudi Arabia.

MATERIALS AND METHODS

This study used foragers honeybee workers (local species) *Apis mellifera jemenatica* (Hymenoptera: Apidae) and honeybees and honey samples were collected in March 2017 from four various agricultural areas in Kingdom of Saudi Arabia.

Study areas

The study areas involve four different geographical localities, extending from the Jazan region(Sabya)(17°09′N 42°38′E), to the south, Asir region(Abha) (18° 13′ 24" N, 42° 30′ 26" E), and Al-Baha (Al Mandaq) (20° 0′ 0" N, 41° 30′0″ E), to the Makkah region (Taif)(21°.16'00" N, 40° 25′ 00" E) in the west. Where beekeeping is common were included in this survey. This region is characterized by fertile soil and quality of agricultural production where there are many crops that are essentials to human life, good source of food, flowers, for bees to produce many types of honey, and finally the region is characterized by the quality of production of natural honey(Fig. 1).

Fig. 1. Map showing the location of the samples collection from four regions of Saudi Arabia.

Sampling

Honeybee and honey samples

Samples of honeybees (*Apis mellifera jemenatica*) were collected from the same cells from which honey were taken that collected in March 2017 from four various agricultural areas in Kingdom of Saudi Arabia, and were collected 50 (mg/g) of bees and 20 (mg/L) of honey. Were determined in the samples of known weight in three replicates and stored in clean and dry glass containers, after which it was stored at 4 °C until analysis [29]. Measurements of metal concentrations in honeybees and honey were conducted in research laboratory at the Department of Ecology, King Abdulaziz University, Jeddah, Saudi Arabia.

Minerals

In the analysis of honeybees and honey samples to detect and identify of twelve minerals; eight of heavy metals (Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc) and four elements(Ca: calcium; K: potassium; Mg: magnesium; Na: sodium).

METHOD

The implementation phase of the preparation of samples was done through the decomposition method of wet microwave digestion system. The verification of the method standard reference material accuracy; tea leaves (INCY-TL-1) and NIST-SRM 1515 apples. Analysis of minerals in honeybees and honey samples were prepared so that 5 gm of samples was burned until turned into ashes and the rest was calcined 13 hr. in a furnace at 450^{o}C.

- Residual ash was dissolved in 10 mL 0.5 M HNO3.
- And filtered through quantitative filter paper, and according to the (US EPA, 1983).
- During analysis of all samples to create calibration standards, the basic standards of concentration 1000 ppm, Merck were used (Mujic, et al., 2011).
- Minerals were determined by Optical Emission Spectrometer (ICP-OES) Varian 720-ES.

Statistical analysis

The collected data was statistically analyzed to assess the relationship between concentrations for 12 trace elements (8 heavy metals and 4 elements) on honeybee (mg/g) samples and honey(mg/L)samples from four regions in Saudi arabia. The mean values of the three replicates per honeybee and honey (mean ± SD). In addition, samples analyzed by Standard error (Std. Error).

RESULTS

1. Honeybee.

1.1. Heavy metals in honeybee.

The results showed that the concentrations (mg/g) of heavy metals in honeybees were detected in four important agricultural regions in Saudi Arabia it was found that the heavy metals Cd, Cr, Ni, Pb do not exist in samples of honey bees and all samples were free from any contamination. The (mean ± SD) ratio reached (0.000 ± 0.000) in all studied areas. As for the heavy metal Cu , its concentrations were converged in the regions of Jazan (0.109 ± 0.000) , Al-Baha(0.159 ± 0.001), as well as its, Asir (0.268 ± 0.004) and Makkah (0.253±0.002). The Fe and Mn highest concentrations were in Makkah region (8.794 ±0.027)and (2.0669 ± 0.018) respectively, and the lowest concentrations were in Al-Baha area(2.088 ± 0.009) and(0.248 ± 0.001) for Fe and Mn, respectively. The Zn highest concentrations were in Jazan, Asir and Makkah,(1.272 ± 0.002),(1.179 ± 0.013) and (1.038 ± 0.006) respectively. The Zn lowest concentration was found in Al- Baha area (0.503 ± 0.002). (Table 1). These current results show that Fe metal was the most widespread and highest concentration in all regions followed by Mn , Zn and the lowest Cu. (Fig.2).

1.2. Elements in honeybee.

As for mineral elements ,which are considered as less dangerous to honey bees, they have been detected in honey bees in four regions in the Kingdom of Saudi Arabia. The highest concentration was for Ca in both Makkah(18.691 ± 0.076) and Jazan(17.131 ±0.113), and the lowest concentration was in the Al-Baha area(6.044 ± 0.029). The elements K, Mg had the highest concentrations in the Makkah region(66.556 ± 0.449) and (14.012 ± 0.105) respectively. The least concentrations was in the Al-Baha area (43.895± 0.375) and (6.152 ± 0 .018) respectively. The Na component was the highest concentration in Jazan (13.939± 0.152), and the lowest concentration in the Al-Baha area (3.875 ± 0 .018). (Table 1).

The current results of the detection of mineral elements in honey bees show that K was the most common and highest concentration in all regions followed Ca, Mn and the lowest Na (Fig. 3).

The concentration of 8 heavy metals and 4 measured elements in honey bee samples indicated by the data that heavy metals and elements. Where it was found that the value of Standard Error (Std. Error) is approximately (0.0) and this indicates that the results of the concentrations were more accurate and homogeneous. Except the value of K was the highest in regions. For example, was In Al-Baha (0.217), Asir (0.364), Jazan (0.834) and Makkah (0.259)(mg/g). Also, the element of Mg was in Jazan Almost arrived to (0.1)(mg/g) (Table 2).

2. Honey

2.1. Heavy metals in honey.

The current results show that when the concentrations of heavy metals were detected in honey samples in four important agricultural areas in Saudi Arabia it was found that; Heavy metals Cd, Mn and Pb were not present in honey samples. All samples were free of any contamination with these minerals and (Mean ± SD) ratio reached (0.000 ± 0.000) in all areas studied. Heavy metals Cr and Ni Also almost all the samples collected in the regions of the Saudi Arabia were free of any contamination with these minerals and did not exist in honey samples and (Mean ± SD) ratio reached (0.000 ± 0.000) except the Al-Baha area of the Al-Baha where Cr and Ni was found with very little concentration(0.1599 ±0.000) and (0.037 ± 0.001) respectively. Heavy metals Cu was a region of Asir free of any pollution and not found in honey samples and the mean ± SD reached (0.000 ± 0.000) and the area of Jazan was found in the concentration(0.039 ± 0.001). Heavy metals Fe is one of the most widespread and concentrated metals in all four areas of study and equal to (1.904 ±0.009),(1.843 ±0.007),(1.341 ± 0.005) and (0.907± 0.001) in Asir, Jazan, Al-Baha and Makkah respectively. In the upper Asir region, Zn was concentrated in honey samples and (mean ± SD) ratio was (0.101 ±0.001). Makkah was the least concentrated area where it was found and concentrated (0.030 ± 0 .000**)** (Table 3).

When the heavy metals were detected in the honey samples collected, Fe was the most widespread and highest concentration in all areas followed by Zn and the lowest Cu. While Ni and Cr were rarely present in the Al-Baha area (Fig. 4).

2.2. Elements in honey.

As for mineral elements, which were detected in honey samples in four regions of Saudi Arabia, it was found that ; The elements Ca, Mg, Na were in the highest region of Asir (8.284 ± 0.033), (5.178 ±0 .012) and (4.831 ± 0.056) respectively, and the lowest incidence in the region of Makkah (4.079 ± 0.016),(1.383 ± 0.004) and(1.154 ± 0.006) respectively. But, K was the highest concentration in the area of Makkah (35.873000 ± 0.285564) and the lowest concentration in the Al-Baha(5.590 ± 0.024) area (Table 3).

When mineral elements were detected in honey samples collected from the four regions of Saudi Arabia, it was found that K was the most widespread and highest concentration in all regions followed by Ca, Na and the lowest Mg (Fig. 5).

This data shows the heavy metals and elements in honeybee and honey from beehives. In (Tables 4), were shown and the data shows that the value of Standard Error is approximately(0,0)(mg/L). Which indicates that the results of the concentrations were more accurate and homogeneous. Except in the Makkah region, the concentration value of element K reached (0.1) a value which is Converged to (0.0)(mg/L).

It can be concluded that the most widely spread heavy metal is iron in honey bee and honey samples and the most concentrated mineral elements is potassium in all four agricultural areas from which the samples were collected. This can be explained by the large use of iron tools by farmers and beekeepers in beekeeping (cages of beekeeping and sorting honey.. and others). As for potassium, it may be due to its abundance in the environment. However, it is still within the permissible limits.

Table 1. Trace element concentration (mg/g) of honeybee samples (mean ± SD).

Regions / **Element**	**Jazan**	**Asir**	**Al-Baha**	**Makkah**
Cd	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Cr	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Cu	0.109 ± 0.000	0.268± 0.004	0.159 ± 0.001	0.253 ± 0.002
Fe	6.205 ± 0.009	6.222 ± 0.056	2.088 ± 0.009	8.794 ±0.027
Mn	1.385 ± 0.002	1.714 ± 0.021	0.248 ± 0.001	2.066 ± 0.018
Ni	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Pb	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000	0.000 ± 0.000
Zn	1.272 ± 0.002	1.179 ± 0.013	0.503 ± 0.002	1.038 ± 0.006
Ca	17.131 ±0.113	8.175 ± 0.015	6.044 ± 0.029	18.691 ± 0.076
K	66.709 ± 1.445	57.871 ± 0.631	43.895200± 0.375	66.556 ± 0.449
Mg	12.524±0.243	8.751 ± 0.056	6.152 ± 0 .0176	14.012 ± 0.105
Na	13.939 ± 0.152	4.963 ± 0.037	3.875 ± 0 .018	7.625 ±0.037

Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc ; Ca: calcium; K: potassium; Mg: magnesium; Na: sodium.

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Table 2. Trace element concentration (mg/g) of honeybee samples (mean ± SD.

Std. Error												
	Heavy metals								Elements			
Element / Region	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Ca	K	Mg	Na
Al-Baha	0.000	0.000	0.000	0.006	0.001	0.000	0.000	0.001	0.017	0.217	0.010	0.010
Asir	0.000	0.000	0.003	0.032	0.0123	0.000	0.000	0.007	0.009	0.364	0.032	0.022
Jazan	0.000	0.000	0.000	0.005	0.001	0.000	0.000	0.001	0.065	0.834	0.140	0.088
Makkah	0.000	0.000	0.001	0.016	0.010	0.000	0.000	0.003	0.044	0.259	0.061	0.021

Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc.

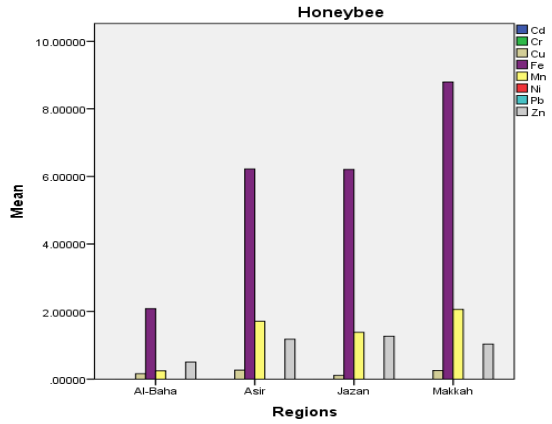

Fig. 2. The concentration(mg/g) of heavy metals in honeybee from four regions in Saudi Arabia. Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc.

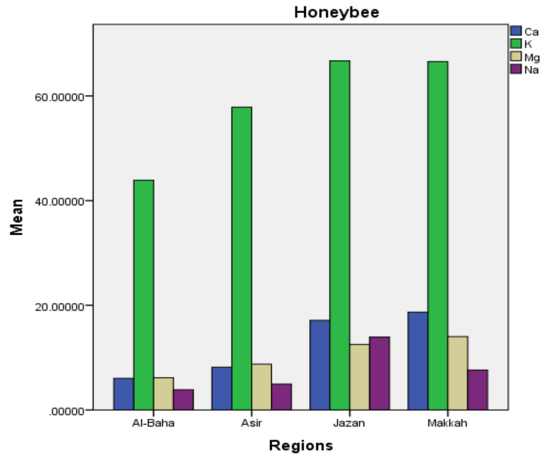

Fig. 3. The concentration(mg/g) of elements in honeybee from four regions in Saudi Arabia. Ca: calcium; K: potassium; Mg: magnesium; Na: sodium.

Regions / Element	Jazan	Asir	Al-Baha	Makkah
Cd	0.000± 0.000	0.000± 0.000	0.000± 0.000	0.000± 0.000
Cr	0.000± 0.000	0.000± 0.000	0.159 ± 0.000	0.000± 0.000
Cu	0.039 ± 0.001	0.000 ± 0.000	0.000 ± 0 .001	0.013 ± 0.001
Fe	1.843 ±0.007	1.904±0.009	1.341 ± 0.005	0.907 ± 0.001
Mn	0.000± 0.000	0.000± 0.000	0.000± 0.000	0.000± 0.000
Ni	0.000± 0.000	0.000± 0.000	0.037 ± 0.001	0.000± 0.000
Pb	0.000± 0.000	0.000± 0.000	0.000± 0.000	0.000± 0.000
Zn	0.077 ± 0.001	0.101 ±0.001	0.056 ± 0.001	0.030 ± 0 .000
Ca	4.918 ± 0.046	8.284 ± 0.033	5.812 ± 0.040	4.079 ± 0.016
K	11.710 ± 0.140	7.825 ± 0.075	5.590 ± 0.024	35.873 ± 0.286
Mg	4.379 ± 0.029	5.178 ±0 .012	1.890 ± 0.014	1.383 ± 0.004
Na	5.753 ± 0.077	4.831 ± 0.056	2.099 ± 0.028	1.154 ± 0.006

Table 3. Element concentration (mg/g) in honeybee samples analyzed by Standard error (Std. Error) for 12 trace elements, Samples collected from four regions in Saudi Arabia.
Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc ; Ca: calcium; K: potassium; Mg: magnesium; Na: sodium.

Table 4. Element concentration (mg/L) in honey samples analyzed by Standard error (Std. Error) for 12 trace elements, Samples collected from four regions in Saudi Arabia

Std. Error												
Element / Region	Heavy metals								Elements			
	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Ca	K	Mg	Na
Al-Baha	0.000	0.000	0.001	0.003	0.000	0.001	0.000	0.000	0.023	0.014	0.008	0.016
Asir	0.000	0.000	0.000	0.005	0.000	0.000	0.000	0.001	0.019	0.043	0.007	0.032
Jazan	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000	0.027	0.081	0.017	0.045
Makkah	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.009	0.165	0.002	0.003

Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc ; Ca: calcium; K: potassium; Mg: magnesium; Na: sodium.

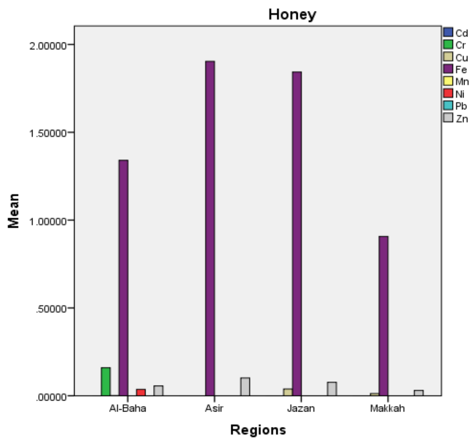

Fig. 4. The concentration(mg/L) of heavy metals in honey from four regions in Saudi Arabia.
Cd: cadmium; Cr: chromium; Cu: copper ; Fe: iron; Mn: manganese; Ni: nickel ; Pb: lead; Zn: zinc.

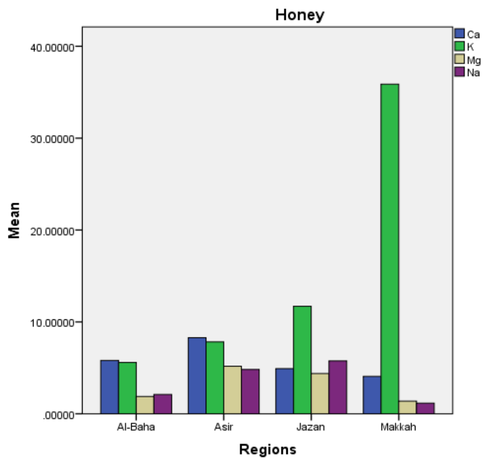

Fig. 5. The concentration(mg/L) of elements in honey from four regions in Saudi Arabia.

Ca: calcium; K: potassium; Mg: magnesium; Na: sodi

DISCUSSION

Honeybees and honey has increasingly been employed to to detect and determine the level of mineral elements and heavy metals in honey bees and honey in the most important agricultural areas that are famous for bee breeding in the Kingdom of Saudi Arabia , monitor environmental pollution by heavy metals in that and honey bees act as a detector of environmental pollution. The main aspect that distinguishes the heavy metals from other contaminants, such as pesticides, are entered into the territory and environmental fate , that are released continuously in different environment and natural resources, as they decay are inherent toxicity, they exist in the environment and engage in biological cycles [14].

The results of this study found that heavy metals Cd, Cr, Ni, Pb do not exist in samples of honey bees and all samples were free from any contamination of these metals with mean ratio reached (0.000) in all areas studied. As can be seen from the data for a study by [12, 25].

Regression analysis of pooled data by [23] yielded negative relationship between the concentration of Cd in honeybees, no significant relationship was found between the concentration of Pb in honeybees, significant differences in concentration between locations were found for Cd .

The current results of the detection of heavy metals in honeybees show that Fe was the most widely spread metal with the highest concentration in all regions followed Mn ,Zn and the lowest Cu .This corresponds to what he found by [18].

We found in the current study that the concentrations mean(mg/g) of Cu metal were converged in the regions of Jazan(0.109), Al-Baha (0.159), Asir(0.268) and Makkah(0.253). In addition, the highest concentrations of Zn metal were in Jazan, Asir and Makkah, (1.272),(1.179) and (1.038) respectively, and the lowest concentration was found in Al- Baha area (0.503). The values of Zn and Cu in this study were lower than the levels found in honeybees in a study carried out by [31], which showed that the maximum levels of Cd, Pb, Zn, and Cu were 1.8 , 18, 100 and 41 mg/g respectively. In another study [33], reported that levels of Pb, Cd, and Cr in honeybees were 45, 630 and 102 mg/g respectively [20].

In addition, the data obtained from this study showed that K had the highest concentration followed by Ca, Mn and the lowest was found to be Na. Among all four important agricultural areas in Saudi Arabia, there were no significant differences recorded between the concentrations of the different metals. The results by [33] did show that minerals were differentiated: elements that were very abundant, elements in a medium concentration, and trace elements. That consisted of K and Na, with a range from 41.857 to 47.871, and 12.653 to 16.183 ppm, respectively. However, there are a few publications dealing with honeybees and metal pollution [34, 20].

In regard to the concentrations of heavy metals detected in honey samples in the four agricultural areas in Saudi Arabia, the results of this study showed that the metals Cd and Pb were not present in honey samples. All samples were free of any contamination with these minerals and mean ratio reached (0.000)(mg/g) in all areas studied. In a previous study by [35], the researchers found that the concentrations of lead and chromium were usually between 1 and 23.5 (mg/g), whereas the other heavy metal, cadmium, had content uneven. It is important to analyze the content of cadmium in honey samples in view of its toxicity. In a study by [24], honey produced in Italy had an average cadmium content of 15(mg/g).

When the heavy metals were detected in the honey samples collected, Fe was the most widespread with the highest concentrations in all areas followed by Zn with Cu being the lowest. Also Ni and Cr were rarely present in the Al-Baha area. In a study conducted by [36], the honey samples analysis showed that the samples do not pose any health risk to the consumer for the heavy metal analysis, the concentrations were in the order of : Cd 0.02 <Zn 0.22 < Pb 0.84 < Fe 2.30 < Cu 3.23 (mg/L),Cadmium recorded the lowest concentration of 0.03 mg/L whereas Cu recorded the highest concentration of 3.23 (mg/L). Honey contains many elements and trace elements that are transported from the plant nectar. Mean values of minerals for honeydew honeys for K, Na, Ca, Mg, Fe, copper (Cu), and Mn were given as 1676, 76, 51, 35, 9.4, 0.56, and 4.1 (mg/L) respectively [37].

The current study have shown that there are differences in concentrations of heavy metals components in various regions, This is consistent with previous studies in Turkey that found the convergence of Cd was bring down in nectar honeys from Middle Anatolia (1.1–21.2 mg), Aegean (5.1–7.2 mg) Black Sea (0.28–9.82 mg), Mediterranean (1.1–6.5 mg), east Anatolian (1.1–6.8 mg), and Southeast (0.31–0.34 mg) [25, 26,28]. In addition, the contents of these elements in the studied honey are below the allowable limits of the Codex Alimentarius Commission. Unfortunately, there are no specific values at the maximum residue level, but values of 0.1 mg for Cd and 1 mg for Pb has been suggested for the European Union. The FAO/WHO Expert Committee on Food Additives (JECFA) recommended weekly intakes are acceptable of Cd and Pb of 7 mg kg^{-1} b.w. and 25 mg kg^{-1} b.w., respectively [35]. Also, the levels of copper , manganese, zinc, chromium in the honey samples (0.37–0.40) were lower than those recorded in other studies for Turkish, Macedonian, Swiss, and Italian honey [38, 12, 39]. The levels of heavy metals found in this study were less than the security threshold and internationally allowed concentrations in certified reference material (Certified value (mg) (NIST SRM 1515 Apple Leaves), in honey samples; Cd (0.013), Cr (0.3), Cu (5.64), Fe (83), Mn (54), Ni (0.91), Pb (0.47), Zn (12.5) (Silici, et al.,2013).

Some metals play important roles in biological systems, So it was followed and detected are very important for life but can also have harmful effects, and are therefore referred to as essential elementsfor instance (iron, zinc, copper, and manganese), while others are non-core elements (lead, cadmium). Non-essential elements can be toxic even in small amounts, while basic minerals can also be harmful if taken in larger amounts than recommended [40]. Differences arise from different climatic conditions, as well as, sources of honey bee flowers extracting nectar. Plants absorb these minerals from water and soil, and honey bees absorb nectar from these plants which contains these minerals [21]. The results indicate that honey bees can detect temporal and spatial patterns in environmental mineral concentrations, even at relatively low levels of pollution [6].

Honeybee and honey are often contaminated with trace metals, some of which are associated with food resources. However, in some cases metal contamination may be coming from within the hive. Based on preliminary observations, we hypothesized that steel foundation wire negatively affects honey bee brood health. To test our hypothesis we quantified the elemental content and measured the removal rates of honey bee brood developing in cells overlapping foundation wires and in control cells adjacent to cells that overlapped foundation wires. We found evidence that brood positioned in cells overlapping the wires contained significantly more iron and was removed at a significantly higher rate compared to control brood. Our study identifies the harmfulness of the common modern beekeeping practice of placing steel wire in beeswax foundation, which if avoided may increase colony population size and improve the health of managed honey bee colonies [41]. The Food and Agriculture Organization (FAO) and the World Health Organization (WHO) have put an end to the consumption of heavy metals based on body weight (Joint FAO/WHO Expert Committee on Food Additives 1999).

In a study by [42] Samples of honey were collected directly from honeybees in different geographical areas and analyzed and compared on the basis of physical and chemical properties, nutritional and total characteristics, microbial content and pollen, mineral levels. Wild honey samples extracted by two different methods (centrifugation and pressed processing) were characterized and compared minerals (K, Ca, Mg, Na, Fe, Li, Zn) it were higher in pressed honey [43].

In principle, pollutants can be collected in soil and plants [44] and are collected by bees along with nectar and pollen (Roman, 2004 and Roman, 2009). Depending on the chemical properties of the material, nectar contaminates pollutants to a higher or lesser degree. Therefore, if nectar functions in a polluted environment, plant products used by bees may also be contaminated. As a result, part of these pollutants will accumulate in the body of the organism. Bee products can be contaminated from various sources [2 ,3]. Pollution can arise from the environmental conditions of beekeeping practices. [45]. Pollutants can reach the raw materials of bee products by air, water, plants and soil, and then transferred to the beehive by bees [4].

CONCLUSION

According to the food safety and food quality standards, results of this study indicate that mineral elements and heavy metals in honeybees and honey within levels and within the limits of international standards in Saudi Arabia. And heavy metal residues were very few and within the permissible limits. This also denote that the areas is not polluted by these chemicals. To maintain this quality, it is essential that public authorities, in cooperation with beekeepers organization, establish and ensure the implementation of the guide to "good beekeeping practices" which describes standardization and rationalization of beekeeping techniques.

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