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Quantitative determination of some heavy metals in children herbal preparations available in Syrian market

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ABSTRACT

The aim of this study was to evaluate the presence of toxic heavy metals in Syrian herbal preparations specialized for children. Ten dry children medicinal preparations were collected both from herbalist and pharmacies in the Syrian market, the samples were subjects to an acid digestion method followed by Graphite Furnace Atomic Absorption Spectrophotometer analysis in order to specify the concentration for seven toxic heavy metals: Lead, Nickel, Zinc, Copper, Chrome, Cobalt, and Cadmium. The result of study indicated that the content of Lead, Nickel, Cobalt and Cadmium were above the USP 2010 permissible limits in 90%, 80%,70% and 60% respectively in the tested samples, while no studied samples of Zinc, Copper, Chrome were over the permissible limits. This study concludes that there is a major safety concern for the children and it is due to the content of heavy metals in medicinal children preparations available in the market so it must be checked for its safe children consumption.

Key words: medicinal plants, children herbal preparations, heavy metals, atomic absorption spectrophotometer, acid digestion

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INTRODUCTION

Herbal medicines are currently used by large sections of the population. Because they are not regulated as medicines and are freely available to everyone [1], serious safety concerns might be associated with these herbal medicines especially with children who are more susceptible to exposures to environmental toxins than adults and may be more vulnerable to their effects [2].

There are two types of medicinal herbal preparations licensed and unlicensed: most medicinal products are unlicensed, their efficacy, safety and quality are still undetermined [3]. However, the licensed ones may contaminate during growing and processing stages [4], so they may lead to health risk due to the presence of contaminants like toxic metals [5].

Children herbal preparations are widely used in Syrian market starting the first month of birth, but the level of expression of Cytochrome P450 shows a wide inter-individual variability depending on the age so many cytochromes isoforms P450 are absent or barely detectable in the foetal liver and develop postnatally [6].

Among phase II enzymes, epoxide hydrolase and glutathione S-transferase Π are very active in the foetal liver, whereas glutathione S-transferases μ and UDP-glucuronosyltransferases develop within 3 months after birth [6].

Also, the morphology and the function of the gastrointestinal tract are not constant but vary according to age such as: the gastric PH, the gastric emptying time and the intestinal motility [7].

The toxicological consequences of chemical exposure including heavy metals will depend on the balance between phases I and II reactions [6].

Damage caused to children can be devastating and permanent and the latency period for certain effects can be decades [2].

EXPERIMENTAL SECTION

Sample collection and processing

Ten samples of finished herbal preparation were obtained from local market of Damascus in January 2015 (Table 1). The samples were stored in the plastic food grade containers kept at room temperature until analysis. The samples were dried at 70◦C for 48 h in a hot air oven and ground prior to chemical analysis.

Table (1): List of medicinal herbal preparation

Type of herbal preparation	Therapeutic Use	Main Active Compound
Licensed	Calm baby mixture	*Matricaria chamomilla, Foeniculum vulgar, Lippa citriodora.*
Licensed	Anti spasmodic mixture and respiratory supportive mixture	*Matricaria chamomilla, Foeniculum vulgare, ,Lippa citriodora, Thymus Vulgaris, Pimpinella Anisum, Carum Carvi.*
Licensed	Calm baby	*Pimpinella Anisum*
Licensed	Anti spasmodic	*Matricaria chamomilla*
Unlicensed	Anti spasmodic mixture	*Matricaria chamomilla, Pimpinella Anisum.*
Unlicensed	Calm baby mixture	*Pimpinella Anisum, Foeniculum vulgar.*
Unlicensed	Anti spasmodic mixture	*Matricaria chamomilla, Carum Carvi, Cuminum cyminum.*
Unlicensed	Anti spasmodic mixture	*Matricaria chamomilla, Anethum graveolens*
Unlicensed	Calm baby mixture	Rosemarinus officinalis, *Pimpinella Anisum.*
Unlicensed	Anti spasmodic, Carminative mixture	*Matricaria chamomilla, Cuminum cyminum.*

Analysis

Heavy metals analysis was done according to method 3050b [8]. For this, 5.0 g powder of each sample was digested in HNO_3(65%) and H_2O_2(30%) (2:1) using the wet digestion method by heating slowly on a hot plate in the fume hood chamber until a clear solution was obtained. The final volume of the solution was made up to 50 ml with deionized water. All necessary precautions were adopted to avoid possible contamination of the samples. Analysis was done using the Graphite Furnace Atomic Absorption Spectrophotometer (Varian GTA 100). The standard reference material of all the metals (E. Merck) was used for calibration and quality assurance for each analytical batch. The efficiency of digestion of plant samples was determined by adding standard reference material of metals to different samples. After addition of standards, samples were digested, and metals were estimated as described above. Three replicates were analyzed to assess precision of the analytical techniques, and results were averaged**.**

RESULTS AND DISCUSSION

The concentration of Pb, Ni, Zn, Cu, Cr, Co, Cd in studied samples are mentioned and shown in Table (2).

Table (2): Heavy metals concentration in the tested children herbal preparation

	Sample number	Pb ppm	Ni ppm	Zn ppm	Cu Ppm	Cr ppm	Co ppm	Cd ppm
Licensed	1	1	2.08	8.989	10.54	0.43	2	0.59
	2	1.1	1.72	5.26	13.37	0.61	1.95	0.54
	3	0.6	0.21	10.137	10.08	0.71	0.72	0.35
	4	1.6	1.73	7.434	8.47	0.45	1.61	0.21
	Average	1.075	1.435	7.955	10.615	0.55	1.57	0.4225
Unlicensed	5	1.2	1.68	9.345	9.07	0.72	1.1	0.15
	6	1.3	0.97	5.607	2.33	0.39	0.28	0.58
	7	1.1	1.04	6.602	10.03	0.41	0.19	0.48
	8	2.2	3.1	6.656	14.69	0.81	2.37	0.47
	9	1.5	1.98	5.66	15.56	0.79	1.62	0.15
	10	1.7	2.04	5.184	13.1	0.76	2.13	0.29
	Average	1.5	1.801	6.509	10.796	0.6466	1.281	0.353
Average (Total)		1.33	1.655	7.0874	10.724	0.608	1.397	0.381
SD		0.42	0.74	1.74	3.61	0.16	0.74	0.16

The next table shows the permissible limits of the seven tested toxic heavy metals according to WHO 2007, the EC 2019 and the USP 2010 for herbal preparations. Table (3).

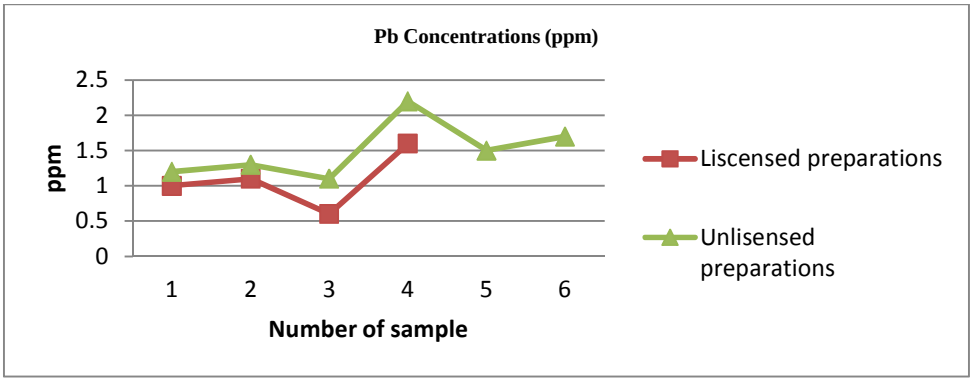
Table (3): List of Limit References in medicinal herbal preparation

		Pb ppm	Ni ppm	Zn ppm	Cu Ppm	Cr ppm	Co ppm	Cd ppm
Limit References ppm	**WHO 2007**	10	NA*	50	20	2	NA*	0.3
	EC 2009	3	NA*	NA*	NA*	NA*	NA*	1
	USP 2010	1	1.5	NA*	NA*	NA*	1	0.5

**NA: Not Mentioned*

According to the averages the licensed preparations (3 of 4) and the unlicensed preparations (6 of 6) both have Lead concentrations above the USP 2010 permissible limit which is 1ppm but within the WHO2007 and the EC2009 limit which is 10ppm, 3ppm respectively. Fig (1).

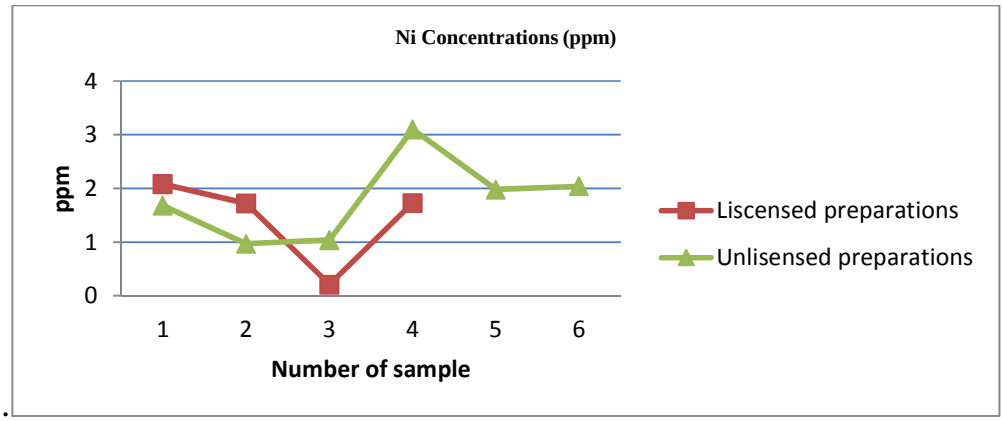
Fig (1): Lead concentrations in tested children medicinal plants



The presence of lead may be due to contamination of air and soil. These medicinal plants may grow in polluted soils, irrigate with contaminated water or contaminate by automotive Pb emissions to atmosphere, by sewage sludge, by smelter emissions, by pesticides, and by metal-enriched manure in addition to manufacturing processes for the licensed samples.

However, the average of Nickel concentration for the licensed preparations (3 of 4) was within the permissible USP 2010 limit which is 1.5 ppm while the average of unlicensed preparations (5 of 6) exceeded this permissible value as shown in Fig(2).

Fig (2): Nickel concentrations in tested children medicinal plants



High Nickel concentrations may due to its large presence in both industrially contaminated and pristine soils whether in lime stones, argillaceous sediments or serpentine soil affecting anthropogenic activities leading to accumulation in plants. Also, the use of stainless steel containers in assembling and producing the licensed herbal preparations can be a possible source of Nickel contamination.

All the tested samples were within the WHO limits for the Zinc, Copper, Chrome which is 50, 20, 2 ppm respectively. Fig (3) (4) (5).

Fig (3): Zinc concentrations in tested children medicinal plants

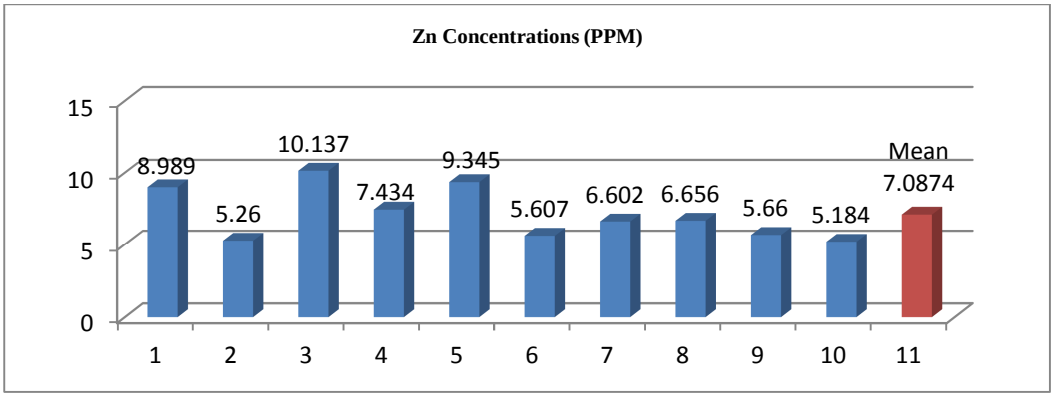


Fig (4): Copper concentrations in tested children medicinal plants

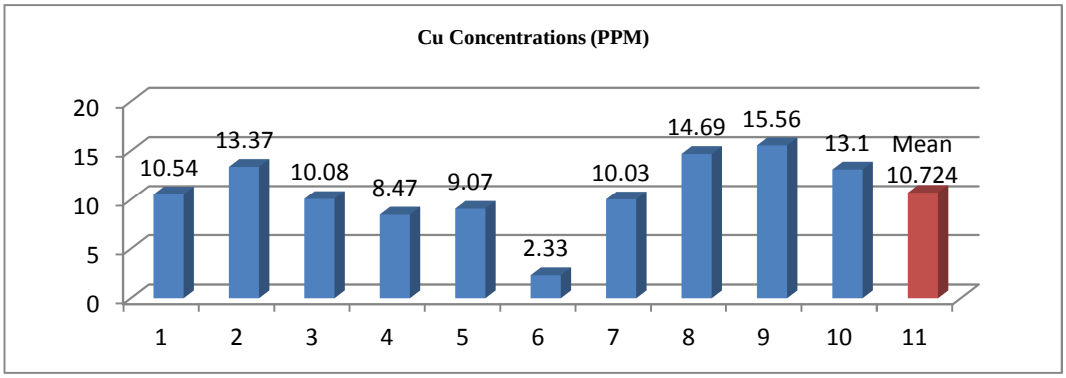
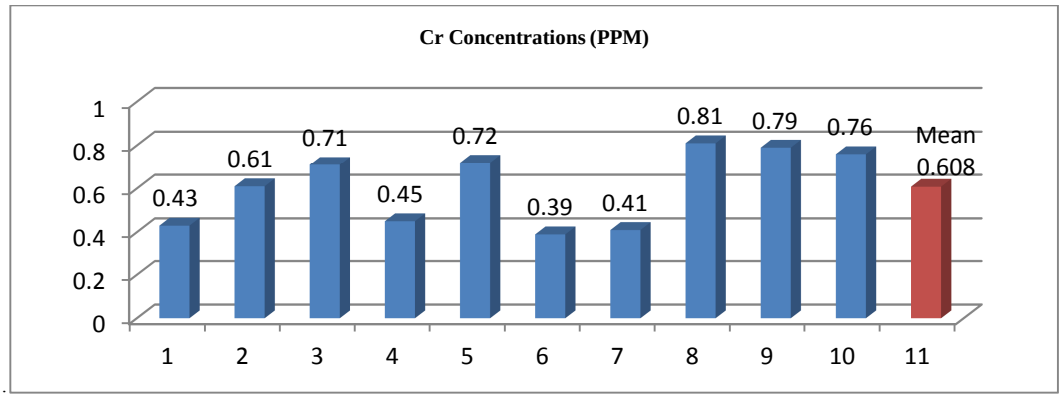


Fig (5): Chrome concentrations in tested children medicinal plants



Also, both the licensed (3 of 4) and the unlicensed (4 of 6) preparations with their averages have Cobalt concentrations above the USP 2010 permissible limits which is 1ppm,Fig(6). The contamination of cobalt may be related to the excessive use of cobalt fertilizers or from polluted air and soil.

Fig (6): Cobalt concentrations in tested children medicinal plants

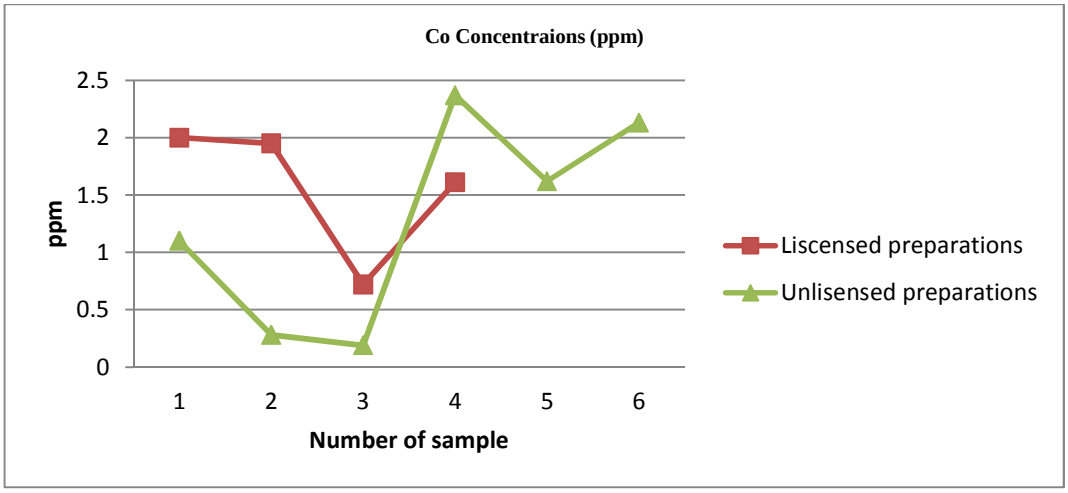
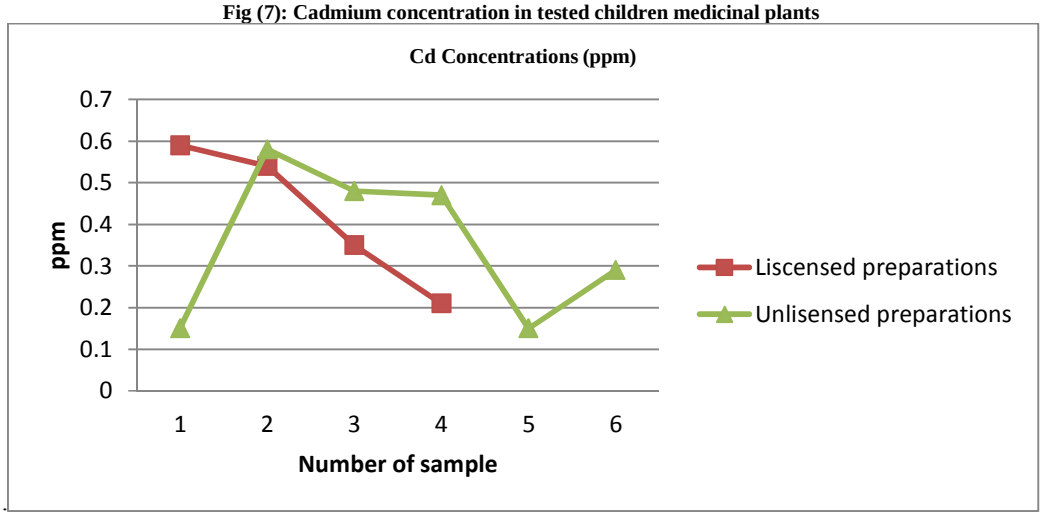


Fig (7): Cadmium concentration in tested children medicinal plants



However, The average of cadmium concentrations for licensed preparations (3 of 4) and the unlicensed preparations (4 of 6) were above the WHO 2007 permissible limits which is 0.3 ppm, while no tested samples exceeded the EC 2009 permissible limits which is 1 ppm. In addition, both averages of the licensed samples (2 of 4) and the unlicensed samples (1 of 6) exceeded the USP (2010) permissible limits. Fig (7).

Because of its high solubility the main source of Cadmium pollutant may be the irrigation with contaminated water which makes the Cadmium absorption easy by the roots as well as the excessive use of Cadmium based fertilizers, pesticides and herbicides as the areas are performing extensive agriculture.

CONCLUSION

- 90% of the children herbal preparations have Lead concentrations above the USP 2010 permissible limits but within the WHO 2007 and the EC 2009 permissible limits.
- 80% and 70% of the children herbal preparations have both Nickel and Cobalt concentrations above the USP 2010 permissible limits respectively.
- 60% of the children herbal preparations have cadmium concentrations above both the USP 2010 and the WHO 2007 limits.
- Zinc, Copper and Chrome values were within the WHO 2007 limits.
- The heavy metals exceeding the USP 2010 limits were in order: Lead > Nickel > Cobalt > Cadmium.

Acknowledgments
The objective of this study was to quantify seven toxic heavy metals in medicinal herbal preparations designed especially for children and available without prescription in the Syrian market. The results suggest that medicinal plants used for children consumption or for preparation of children herbal products and standardized extracts should be checked for heavy metals limits in order to avoid their toxic effects to the child and benefit from their therapeutic use.

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