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Original Research Article

Trace metal concentrations in herbal medicine sole in abalaliki metropolis

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ABSTRACT

Herbal medicines have been in use before conventional drugs in Nigeria and Ebonyi state in particular. Their uses have been on the increase due to its efficacy. The knowledge on the concentrations of trace metals is important for determining the effectiveness of the plants in treating various diseases. In this study, the concentration of trace metals in herbal medicine sold in Abakaliki metropolis was determined using varian spectra AA55B atomic absorption Spectrophotometer. The results obtained from the sample gotten from the international market showed that sample A ranged from 0.3±0.06 Cu to 7.15±0.145 Fe. Sample B ranged from 0.9±0.018 Cd to 5.8±0.116 Fe, while sample C, D, E, and F ranges from 0.75±0.015 Cd to 24.1±0.482 Fe, 5.65±0.113 Cd to 15.4±0.308 Fe, 1.2±0.024 Cd to 18.2±0.364 Fe, and 0.15±0.01 Cd to 5.2±0.112 Fe, respectively. Among all the studied samples, Fe has the highest concentrations. The Fe concentration in samples C, D, and E were above the permissible limit of W.H.O, while the Zn concentrations were within the acceptable limit of W.H.O. The Cd concentrations in the samples were above the standard limit except sample F. The Zn concentrations in all the studied samples fell within the acceptable limit of WHO. From kpirikpiri sample, the obtained results showed that the Cd concentrations of all the samples studied were within the acceptable limit of WHO except in samples A, B,C, and D which ranged from 0.1±0.01 sample F to 1.3±0.02 sample A. The World Health Organization acceptable limits for the concentration of Cd, Zn, and Fe in herbal medicine are 0.3, 100, and 15 µg/g, respectively.

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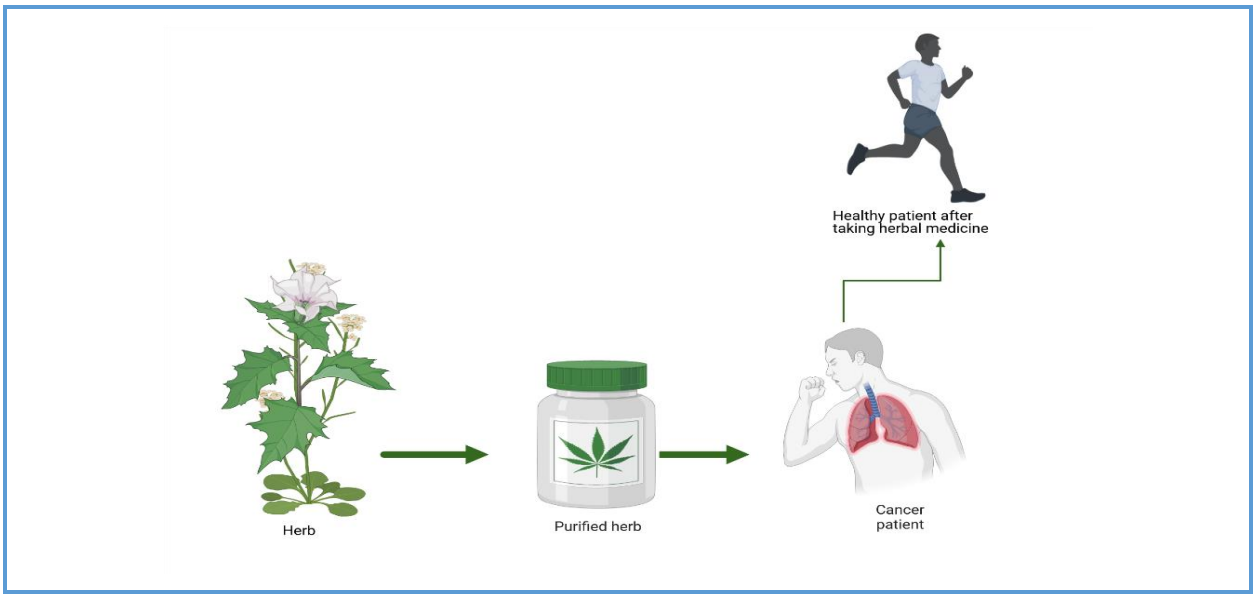
Graphical Abstract



Introduction

Herbal medicine is the use of plants for the diseases treatment and enhancement for the general health and wellbeing. The herbal use as medicine has been in existence as old as humanity and has been used in all cultures throughout history [1]. Herbal medicine is the use of herbs for disease control. They can be obtained from any parts of plant such as leaves, roots, bark, latex, seeds, and flowers. They are eaten, swallowed, drunk, inhaled, or applied to the skin. They are used to treat any kinds of diseases such as pile, ulcer, malaria, typhoid, infections, and rheumatism, etc. [2]. Herbs used in formulating these medicines can pose a health risk due to the presence of toxic ingredients like the heavy metals. The toxicity of heavy metals depends upon the chemical form of the elements. Heavy metals are dangerous in the form of their cations and are highly toxic when bonded to the short chains of the carbon atoms [3]. Plants may absorb heavy metals from soil, water, or air. The medicinal herbs may be easily contaminated during growth and processing. The ability of plants to selectively accumulate essential elements is different for different species and subjected to certain geochemical characteristics depending on the type of soil [4]. Plants readily assimilate trace metals through the roots. The metallic ions get dissolved in water and retained. Another source of these trace metals deposition to plants are through rainfall, atmospheric, and dusts. The heavy metal toxicity need to be paid special attention globally due to neurotoxin, carcinogenic, and several other impacts on human arising from the consumption even at the lower levels [5]. The heavy metals, such as cadmium, copper, lead, chromium, and mercury are the important environmental pollutants. Heavy metals, in general, are not biodegradable, have long biological half-lives and have the potential for accumulation in different body organs leading to the unwanted side effects [6]. Lead and cadmium are among the most abundant heavy metals and are particularly toxic. The excessive amount of these metals in food is associated with various numbers of diseases such as kidney problem, cancer, and or

cardiovascular diseases [7]. There are no guidelines to establish a permissible level of metals in herbs. By monitoring the metals level in medicinal plants one can be able to indicate the level of metallic toxicity associated with herbs.

Experimental

Materials and methods

Study area and sampling locations

The study was carried out in Abakaliki metropolis, Ebonyi State. Triplicate herbal medicine samples were collected from Abakaliki with sample IDs, as indicated in Table 1.

Sample collection

As displayed in Five 5, different samples used to cure different diseases namely ulcer, malaria/typhoid, pile, infection, rheumatism with sample IDs A, B, C, D, and E, respectively, were collected randomLy within Abakaliki Metropolis, Ebonyi State.

Sample digestion

The method used by Nnaji and Ogbuewu was employed [8]. 10 mL of the sample was placed into 250 mL beaker. The 10 mL of the freshly prepared acid (HNO_3/$HClO_4$) in the ratio of 1:1 v/v was add into the beaker and covered with watch glass for the initial reaction to subside. The beaker was then placed on a hot plate and heated at temperature not exceeding 160 °C for 20 minutes as to obtain a clear solution. It was cooled and filtered into 50 mL volumetric flask. The volume was made with distilled water and transferred to 120 mL plastic bottle and sent for the metal analysis. The blank sample was prepared by digesting the same proportion of the reagents used in the sample digestion under the same experimental condition without the sample.

Preparation of stock solution

Aqueous stock solution of the metal of interest (Cd, Cu, Zn, and Fe) were prepared with appropriate salts of these metals in which 1 g of each of the metal was weighed into 1000 mL volumetric flask and dissolved in 2 mL nitric acid, the resulting solution was made up to the mark with distilled water.

Table 1. Name of disease and Sample ID

S/N	Name of disease	Sample ID
1	Ulcer	A
2	Malaria/typhoid	B
3	Pile	C
4	Infection	D
5	Rheumatism	E
6	Blank	F

Serial dilution and calibration curve

Five standard solutions for each metal were prepared in triplicate for each metal from respective stock solutions by serial dilution. In this case, the stock solutions with concentration of 100 ppm were diluted to obtain the standard solutions of low concentration. The absorbance obtained from the AAS instrument for each standard of a particular metal was used in drawing calibration curve.

Conversion factor

The obtained results were in mg/L but were converted into µg/g using the formula [9]:

$$metal(\mu g/g) = \frac{C \times V \times d.f}{W}$$

Where,
C = Concentration of the sample solution (mg/L)
V = Volume of the sample solution (µL)
W = Weight of the sample in grams
d.f = Dilution factor

Statistical analysis

Statistical analysis was done using SPSS version 20 for windows software package. The mean concentrations and standard deviations were calculated for each metal. The results were analyzed using single factor analysis of variance (ANOVA).

Results and Discussion

Table 2 presents the AAS analytical conditions that were used during the analysis of the herbal medicine. The analytical conditions include the wavelength, slit width, and flame type for each metal analyzed with the AAS.

Table 3 and Figure 1 demonstrate the obtained results in the five studied different samples. The obtained results showed that sample A ranged from 0.3±0.06 Cu to 7.15±0.145 Fe. Sample B ranged from 0.9±0.018 Cd to 5.8±0.116 Fe, while sample C, D, E, and F ranges from 0.75±0.015 Cd to 24.1±0.482 Fe, 5.65±0.113 Cd to 15.4±0.308 Fe, 1.2±0.024 Cd to 18.2±0.364 Fe, and 0.15±0.01 Cd to 5.2±0.112 Fe, respectively. Among all the studied samples Fe has the highest concentrations. The Fe concentration in samples C, D, and E were above the permissible limit of WHO. The Cd concentrations in the samples were above the standard limit except sample F which is the blank. The Zn concentrations in all the studied samples fell within the acceptable limit of WHO. The World Health Organization acceptable limits for the concentration of Cd, Zn, and Fe in herbal medicine are 0.3, 100, and 15 µg/g, respectively. Samali *et al.* in their study of heavy metals concentration in Kano herbal preparations for the major diseases conditions obtained 216.49±0.30, 16.83±0.60, and 10.03±0.53 µg/g for Fe, Zn, and Cu, respectively, for anti-malaria drug [9] which is higher than the obtained results from the anti-malaria/typhoid in this study.

In Table 4 and Figure 2, the obtained result revealed that in sample ID A, Fe had the highest metal concentration of 3.8±0.06 µg/g. Sample B ranged from1.1±0.02 Cd to 3.4±0.09 Cu, while the range of sample C, D, E, and F were 0.8±0.01 Cd to 8.4±0.21 Fe, 0.5±0.01 Cd to 7.5±0.2 Fe, 0.2±0.01 Cd to 9.2±0.27 Fe, and 0.12±0.01 Cd to 2.2±0.02 Fe, respectively. Fe had the highest concentration in all the studied samples, but fell within the acceptable limit of the WHO guidelines. Furthermore, Zn fell within the permissible limit of WHO in all the samples. The Cd concentration in the studied samples were also within the acceptable limit except in the samples A, B, C, and D which were slightly above the recommended limit. The obtained result from samples gotten from Int'l market was quite higher than the obtained results from sample gotten from Kpirikpiri market. This discrepancy of the obtained result from different trace metals studied could be as a result of handling the herbal medicine during the preparation and the environment through which the plant grows.

Table 2. Analytical conditions for AAS analysis

S/N type	Metals	Wavelength (nm)	Slit width (nm)	Flame
1	Cd	228.8	0.7	A-A
2	Cu	324.7	0.7	A-A
3	Zn	213.9	0.7	A-A
4	Fe	248.3	0.7	A-A

A-A = Air-acetylene flame

Table 3. Mean trace metal concentrations (±SD) in herbal medicine sampled at Int'l market

			Metal Concentrations (µg/g)			
S/N	Sample IDs	Diseases	Cd	Cu	Zn	Fe
1	A	Ulcer	1.6±0.032	0.3±0.006	2.45±0.049	7.15±0.145
2	B	Malaria/Typhoid	0.9±0.018	5.75±0.115	3.25±0.065	5.8±0.116
3	C	Pile	0.75±0.015	1.3±0.026	1.65±0.033	24.1±0.482
4	D	Infection	5.65±0.113	9.2±0.184	14.9±0.298	15.4±0.308
5	E	Rheumatism	1.2±0.024	1.65±0.033	15.25±0.305	18.2±0.364
6	F	Blank	0.15±0.01	1.2±0.038	2.4±0.045	5.2±0.112
7	G	[10]	0.3	-	100	15

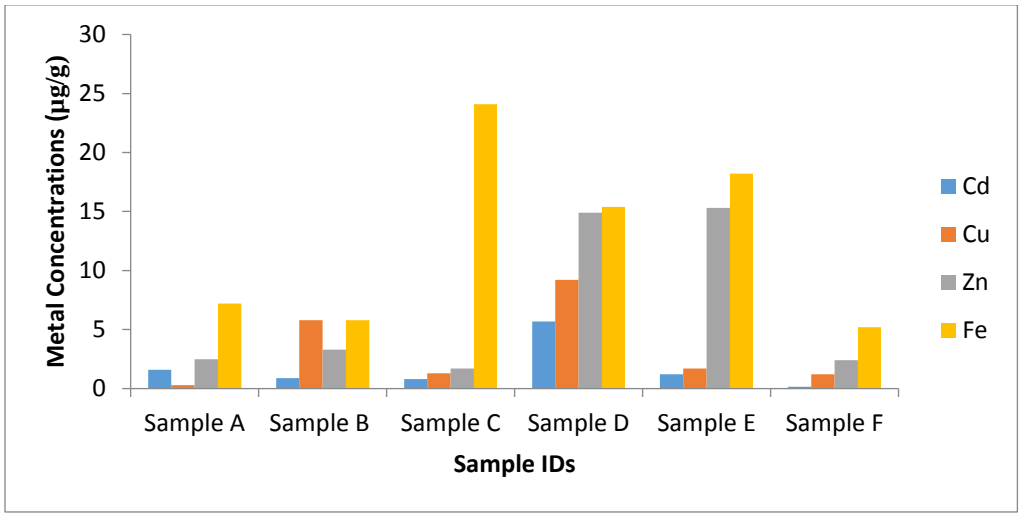


Figure 1. Bar chart of trace metal concentrations in herbal medicine sampled at Int'l market

Table 4. Mean trace metal concentrations (±SD) in herbal medicine sampled at Kpirikpiri market

			Metal Concentrations (µg/g)			
S/N	Sample IDs	Diseases	Cd	Cu	Zn	Fe
1	A	Ulcer	1.3±0.021	1.5±0.03	2.0±0.04	3.8±0.06
2	B	Malaria/Typhoid	1.1±0.021	3.4±0.09	2.00±0.04	3.3±0.03
3	C	Pile	0.8±0.01	4.2±0.21	1.8±0.03	8.4±0.21
4	D	Infection	0.5±0.01	1.4±0.03	2.9±0.08	7.5±0.23
5	E	Rheumatism	0.2±0.01	0.4±0.01	3.0±0.10	9.2±0.27
6	F	Blank	0.1±0.01	1.3±0.03	1.8±0.05	2.2±0.02
7	G	[10]	0.3	-	100	15

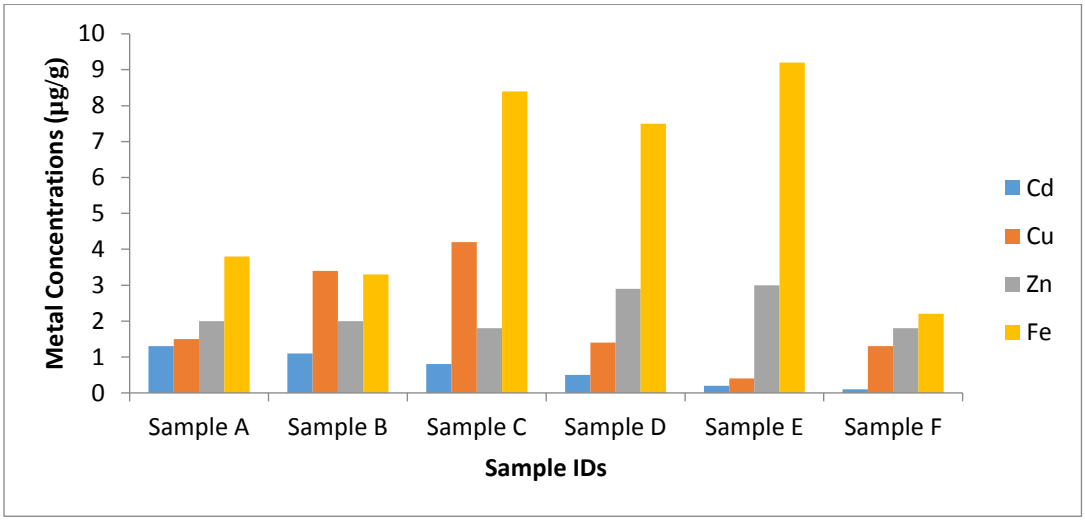


Figure 2. Bar chart of trace metal concentrations in herbal medicine sampled at kpirikpiri market

Conclusion

Cd, Cu, Zn, and Fe were found in all the studied herbal medicines. The average concentrations of Cd was above the tolerable intake level in all the studied samples except the blank, while that of Zn fell within the permissible limit of WHO. The Fe concentrations in samples C, D, and E were above the standard limit. The high Cd and Fe contents observed in majority of the samples had the potential of posing health risks to the consumers of these medications. Therefore, due to the high patronage of these herbal products by the populace, there is need for their constant monitoring by the government authorities like National Agency for Food and Drugs Administration and Control (NAFDAC) in their routine programs to safeguard the human health since unsupervised use of herbal medicine could have the cumulative health effect which in turn may lead to toxicity.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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Authors' contributions

All authors contributed to data analysis, drafting, and revising of the paper and agreed to be responsible for all the aspects of this work.

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