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Determination of selected heavy metal and phytochemical analysis of Thymus Vulgaris

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تحديد المعادن الثقيلة المختارة والتحليل الكيميائي النباتي لنبات الزعتر الشائع (Thymus vulgaris)

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Abstract
Heavy metals, such as lead, nickel, iron, copper, cadmium, zinc, and manganese, are the main causes of heavy metal contamination in the world. Several studies have identified phytochemicals as major chemical constituents in plants, highlighting their potential anti-disease properties. In this study, we carefully selected the plant thyme, and we used flame atomic absorption spectrometry (FAAS) to measure the concentration of heavy metals: iron, lead, nickel, manganese, copper, cadmium, and zinc. A wealth of secondary chemicals, such as flavonoids, tannins, saponins, alkaloids, phytosterols, terpenoids, and phenolic compounds, were found in our phytochemical test results. The results showed that the concentrations of copper, zinc, and cadmium, nickel, iron, copper, all within safe limits; while lead levels exceeded the permissible limit in acid digested extract. On the other hand, the extraction of heavy metals using water extract, as per the conventional prescription, was found to be within acceptable levels, as were other metals like manganese and nickel.

Keywords: Heavy metals, Phytochemicals, thyme, herbal plant.

الملخص
تُعدّ المعادن الثقيلة، كالرصاص والنيكل والحديد والنحاس والكادميوم والزنك والمنغنيز، من الأسباب الرئيسية لتلوث التربة بالمعادن الثقيلة في العالم. وقد حددت العديد من الدراسات المركبات الكيميائية النباتية كمكونات كيميائية رئيسية في النباتات، مُسلطةً الضوء على خصائصها المحتملة المضادة للأمراض. في هذه الدراسة، اخترنا نبات الزعتر بعناية، واستخدمنا مطياف الامتصاص الذري باللهب (FAAS) لقياس تركيز المعادن الثقيلة: الحديد، والرصاص، والنيكل، والمنغنيز، والنحاس، والكادميوم، والزنك. وكشفت نتائج اختباراتنا الكيميائية النباتية عن وجود مجموعة واسعة من المركبات الكيميائية الثانوية، مثل الفلافونويدات، والتانينات، والصابونينات، والقلويدات، والفيتوستيرولات، والتربينويدات، والمركبات الفينولية. وأظهرت النتائج أن تركيزات النحاس والزنك والكادميوم والنيكل والحديد والنحاس كانت جميعها ضمن الحدود الآمنة؛ بينما تجاوزت مستويات الرصاص الحد المسموح به في المستخلص المُهضّم بالحمض. من ناحية أخرى، وُجد أن استخلاص المعادن الثقيلة باستخدام المستخلص المائي، وفقًا للوصفة التقليدية، يقع ضمن المستويات المقبولة، وكذلك المعادن الأخرى مثل المنغنيز والنيكل.

الكلمات المفتاحية: معادن ثقيلة، المركبات الكيميائية النباتية ، الزعتر، النباتات العشبية.

1. Introduction

Particularly locally, the thyme plant is quite significant since it is said to have two uses: it is used as a flavoring in food additions and as a therapeutic remedy for colds and other illnesses. Because heavy metals build up through contaminants in the soil, it is crucial to research thyme and determine its concentration. Determining their source and the degree to which their source can be reduced depends on a number of factors, including the farming technique, the quality of the soil and water, and the degree of pollution exposure. They have herbal plants become more prevalent in both wealthy and developing nations as the main healthcare intervention in recent years. The World Health Organization (WHO) believes that between 70 and 80 percent of people worldwide still largely use unconventional treatments, the majority of which are made from herbal plants. [1,2]. Although there are many publications on the toxicity and adverse effects of herbal plants, there is still concern regarding their safety and toxicity despite the growing interest in their advantages. This is because people often assume that herbal plants are safe. [3] The detrimental effects of trace metals on the environment and human health have garnered a lot of attention lately. The primary pathway by which heavy metals are transferred from contaminated soil to people is through plants. It is common for heavy metals to build up in the food chain. Even at very low doses, heavy metals

may have harmful effects on humans due to their low kidney excretion rates. Essential nutrients, metals including zinc, copper, iron, manganese, cadmium, lead, nickel and chromium are critical for the physiological and biological processes of the human body. But if its intake is increased above some acceptable thresholds, it may become harmful [4,5]. Generally speaking, the qualities and characteristics of the herbal plants and their formulations can be greatly impacted by the location. Air, as well as other growing, transportation, and storage conditions [6]. Soils have a high ion conversion capability and are now a major source of heavy metal pollution. Some significant HMs turn into essential components that are needed in minuscule amounts for a plant's healthy growth [7]. These HMs are essential to plant physiochemical activities. Through the process of diffusion, HMs are taken up by plant roots from the soil [8]. These HMs are absorbed via the apoplast and symplast mechanisms after dissolving into their intricate structures surrounding the surface of root tissues [9]. On the other hand, a variety of biological processes cause the biological molecule iron to be quickly reduced and oxidized.

2. Experimental

2.1. Sample collection and preparation Wild thyme sample was gathered from nearby spice stores, where the plant's papers were the only source of the material. The samples are washed and allowed to dry in the shade. second portion of the sample is left unground so that it can be extracted in methanol and made ready for phytochemical screening.

2.2. Chemicals and Reagents All chemicals and reagents with analytical grades were used in this study. Concentrated nitric acid and 30% hydrogen peroxide were used for plant sample digestion. Distilled water was used throughout the experiment for sample preparation, dilution, and rinsing.

2.3. Sample preparation for analysis

- Extract as used in the aqueous extraction
- Acid-digested extract (extraction according to EPA protocol)
- Extraction by methanol for qualitative phytochemical analysis

All the atomic measurements are carried out with FAAS.

3. Result and Discussion

3.1. FAAS analysis results of heavy metals in Thyme

The obtained results of the metal concentrations in thyme are illustrated in Table 1.

Table 1. FAAS results for heavy metals in Thyme (µg/g) water and acid extract.

Element analyzed	Acid digest	water extract
Pb	1.437	0.308
Ni	0.277	0.022
Mn	0.959	0.191
Fe	21.58	0.224
Cu	3.811	0.207
Cd	0.034	0.025
Zn	2.265	0.022
Pb: Lead, Ni: Nickel, Mn: Manganese, Fe: Iron, Cu: Copper, Zn: Zink, Cd: Cadmium.		

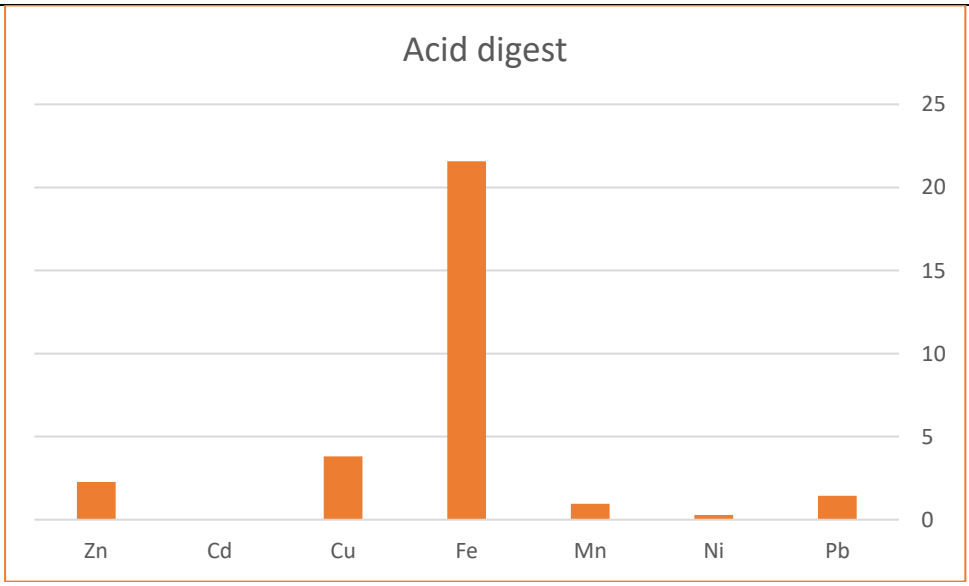

Figure 1. Concentration of metal presented in Thyme acid extract.

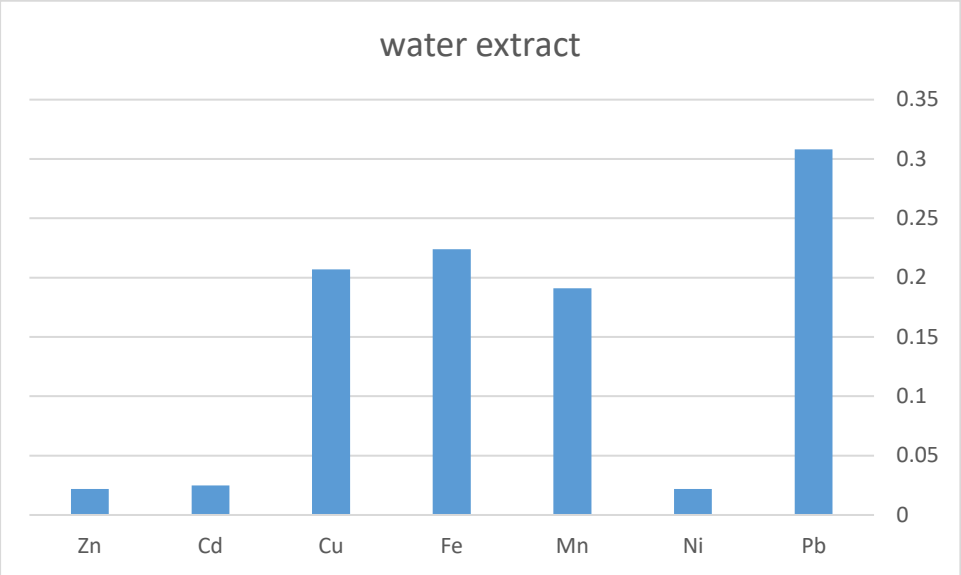

Figure 2. Concentration of metal presented in Thyme water extract.

3.2 Qualitative estimation of bioactive phytochemicals in thyme:

Table 2. Qualitative phytochemicals result in Thyme .

Phytochemical	Result
Flavonoids	+
Terpenoids	++
Steroids	+
Phenolic	+++
Saponins	++
+: low quantity, ++: medium quantity, +++high quantity.	

Phenolic are found in the highest amount, but terpenoids, saponins are approximately found in the middle range, while steroids and flavonoids amounts are approximately the lower.

Flavonoids are among the most important and extensively studied phenolic compounds. These phytochemicals are plant secondary metabolites, commonly found in a wide variety of foods, including fruits, vegetables, and certain beverages. In recent years, flavonoids have been associated with numerous beneficial biochemical and antioxidant effects, particularly in relation to conditions such as cancer, Alzheimer's disease, diabetes, and atherosclerosis. [10]

Terpenes are a large and diverse group of organic compounds produced by a variety of plants, particularly conifers, as well as certain insects. These compounds are hydrocarbons that often have potent aromas and can serve protective functions for the plants that produce them, as they attract predators and parasites of herbivores while deterring herbivores themselves. Although the terms terpenes and terpenoids are sometimes used interchangeably, terpenoids (or isoprenoids) are modified forms of terpenes that contain additional functional groups, frequently including oxygen.[11]

Phenols represent the largest group of natural products, characterized by a chemical structure that includes an aromatic ring and a hydroxyl group (C6H5OH). Studies have identified phenols as major chemical constituents in plants, highlighting their role in protecting against oxidative stress and providing improved protection against diabetes. Phenols are well-recognized for their health benefits, including antioxidant, antiinflammatory, antidiabetic, anti-ulcer, and anti-cancer effects. Natural compounds such as resveratrol, curcumin, chlorogenic acid, gallic acid, and ellagic acid are particularly noted for their potential antidiabetic properties. [10]

Saponins are a significant group of plant secondary metabolites that are widely distributed across the plant kingdom. These phytochemicals are commonly found in various vegetables, beans, and herbs. [12]

3.3. Heavy metals and their interaction with Phytochemicals:

Lead exposure is toxic and can lead to oxidative stress, inflammation, and damage to various organs [13]. The presence of phenolics and flavonoids in thyme could be particularly beneficial in counteracting Pb toxicity by reducing oxidative damage. Additionally, alkaloids and tannins could chelate Pb ions and reduce its bioavailability, minimizing its harmful effects.

Nickel toxicity can also lead to oxidative stress and disrupt cellular functions [14]. Terpenoids, saponins, and phenolic compounds in the plant could potentially mitigate the effects of Ni by acting as antioxidants and chelating agents, thus protecting cells from damage.

While iron is vital for human health, excessive iron can lead to oxidative stress and organ damage [15]. The high concentration of phenolic compounds in Thyme suggests that it could help manage iron overload by binding to free iron and preventing it from causing oxidative damage.

Copper is another essential metal that can become toxic in high concentrations, leading to oxidative stress and cell damage [16]. The plant's phenolic compounds, along with alkaloids and tannins, could play a role in mitigating copper toxicity by chelating copper ions and reducing oxidative damage.

4. Conclusion

In this research, we focused on Thyme , a plant traditionally used . It has been determined concentration of heavy metals (Fe, Ni, Mn, Pb, Zn, Cu, Cd) in this plant by using FAAS. The phytochemical analysis revealed the presence of flavonoids, saponins, phytosterols, terpenoids, and phenolic compounds in the studied sample, which potential sources for new drugs development. The chemical extraction of heavy metals through acid digestion indicated a lead contamination in Thyme , which raises significant concerns regarding contamination within the food chain. In contrast, other metals such as manganese, nickel ,were found to be within acceptable limits, and extraction of heavy metals through water extract as used in the traditional prescription were found to be within acceptable limits.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

References

1. Sahoo, N., Manchikanti, P., & Dey, S. (2010). Herbal drugs: standards and regulation. Fitoterapia, 81(6), 462-471.
2. World Health Organization. (2002). WHO traditional medicine strategy 2002 2005. In WHO traditional medicine strategy 2002-2005.
3. Ernst, E. (2002). Toxic heavy metals and undeclared drugs in Asian herbal medicines. Trends in pharmacological sciences, 23(3), 136-139.
4. Korfali, S. I., Hawi, T., & Mroueh, M. (2013). Evaluation of heavy metals content in dietary supplements in Lebanon. Chemistry Central Journal, 7, 1-13.
5. Korfali, S. I., Mroueh, M., Al-Zein, M., & Salem, R. (2013). Metal concentration in commonly used medicinal herbs and infusion by Lebanese population: health impact. Journal of food research, 2(2), 70.
6. Saad, B., Azaizeh, H., Abu-Hijleh, G., & Said, O. (2006). Safety of traditional Arab herbal medicine. Evidence-Based Complementary and Alternative Medicine, 3(4), 433-439.
7. Alloway, B. J. (2013). Heavy metals and metalloids as micronutrients for plants and animals. Heavy metals in soils: trace metals and metalloids in soils and their bioavailability, 195-209.
8. Peralta-Videa, J. R., Lopez, M. L., Narayan, M., Saupe, G., & Gardea Torresdey, J. (2009). The biochemistry of environmental heavy metal uptake by plants: implications for the food chain. The international journal of biochemistry & cell biology, 41(8-9), 1665-1677.
9. Hossain, M. A., Piyatida, P., da Silva, J. A. T., & Fujita, M. (2012). Molecular mechanism of heavy metal toxicity and tolerance in plants: central role of glutathione in detoxification of reactive oxygen species and methylglyoxal and in heavy metal chelation. Journal of botany, 2012(1), 872875.
10. Ardalani, H., Hejazi Amiri, F., Hadipanah, A., & Kongstad, K. T. (2021). Potential antidiabetic phytochemicals in plant roots: A review of in vivo studies. Journal of Diabetes & Metabolic Disorders, 1-18.
11. Awuchi, C. G. (2020). The biochemistry, toxicology, and Uses of the acologically active phytochemicals: Alkaloids, terpenes, polyphenols, and glycosides. Merit Research Journals, 5(1), 6-21.
12. Agidew, M. G. (2022). Phytochemical analysis of some selected traditional medicinal plants in Ethiopia. Bulletin of the National Research Centre, 46(1), 87.
13. Valko, M., Rhodes, C. J., & Izakovic, M. (2005). Free radicals, metals, and antioxidants in oxidative stress-induced cancer. Chemico-Biological Interactions, 160(1), 1-40. https://doi.org/10.1016/j.cbi.2005.01.003
14. Zhang, S., Chen, H., Wang, A., Liu, Y., Hou, H., & Hu, Q. (2017). Assessment of genotoxicity of four volatile pollutants from~ smoke based on the in vitro γH2AX assay using high content screening. Environmental Toxicology and Pharmacology, 55, 30-36.
15. Hentze, M. W., Muckenthaler, M. U., & Galy, B. (2010). A story of the iron ages: Regulation of mammalian iron metabolism. Nature Reviews Molecular Cell Biology, 11(9), 607-615. https://doi.org/10.1038/nrm2958
16. Reddy, M. M., & McKeown, D. A. (2016). Copper toxicity in the brain: Role of oxidative stress. Toxicology and Applied Pharmacology, 305, 113-121. https://doi.org/10.1016/j.taap.2016.04.004