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Determining the amount of lead heavy metal in licorice and fennel medicinal plants

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A B S T R A C T

Objective: Medicinal plants and herbal medicines are usually safer than chemical medicines, but their arbitrary use may be associated with side effects. Some people think that medicinal plants and medicines that have a plant base cannot cause health problems and are not harmful, while medicinal plants and herbal medicines, like any chemical medicine, have their own side effects. The food chain, including edible and medicinal plants, can be one of the important sources of heavy metals transfer to the human body and endanger human health. The aim of this study is to determine the amount of lead heavy metal in licorice and fennel medicinal plants using furnace atomic absorption spectrometry.

Methods: In this study, 10 dry samples of licorice (Glycyrrhiza glabra) and fennel (Foeniculum vulgare) were collected from Chamestan, Mazandaran. The samples were analyzed using GC-MS in SIM mode with a carrier gas speed of 1 mL/min and an injection temperature of 250°C. For element analysis, the samples were digested using methods from Agrawal et al. (2011) and Manutsewee et al. (2007), and the metal concentrations were measured with ICP-OES and ICP-MS, expressed in mg/Kg.

Results: The results of this study showed that the average heavy metal concentration of lead in licorice and fennel was 21.63 ppb and 23.45 ppb, respectively.

Conclusion: The results obtained in this study are higher than the limit set by WHO. Based on the results, consumption of licorice and fennel medicinal plants has dangerous health consequences for consumers, especially children and pregnant women. Heavy metals enter the body by consuming food such as medicinal plants, contaminated water and other sources and can lead to toxic effects in different organs. Considering the potential risk of heavy metal contamination for public health and their carcinogenic effects, obtaining information regarding the concentration of heavy metals in medicinal plants can be helpful.

Key words: Heavy metal, Toxic, Carcinogenic, Medicinal plant, Licorice, Fennel

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Introduction

The importance of plants from the historical background, the extent of consumption, the health of patients and the issue of economy have been investigated and cannot be denied [1]. Plants were the basis of medical treatment in most of human history and are widely used in traditional medicine today [2].

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Medicinal plants, which are one of the important forms of traditional medicine treatments, have been considered as a model in the treatment of various diseases since thousands of years before the industrial revolution and the era of discoveries and inventions. With the beginning of the new era in modern medicine and the discovery of chemical drugs, the use of traditional medicine and medicinal plants gradually faded [3]. But over time, when people became familiar with the harms and side effects of chemical drugs, people's attention was again drawn to traditional medicine and medicinal plants. Today, the use and application of plants requires comprehensive and complete information about knowing its properties and characteristics [3]. Studies show that the contamination of soil, water and ecosystems by heavy metals has affected many countries and places [4].

Environmental pollution, including heavy metals, are one of the quality control criteria of medicinal plants and their processed products [5]. Heavy metals are defined as metals with an atomic number higher than 20 and a density higher than five grams per cubic centimeter [6]. Heavy metals in two categories of heavy metals essential for plants include copper, nickel, zinc, and iron, and some of them are unnecessary and toxic, such as lead, mercury, cadmium, and chromium [7].

Heavy metals are among the stable and durable environmental pollutants that enter the environment mainly through improper and unsanitary disposal of municipal sewage and industrial effluent. Human exposure to some of them through water and food can cause chronic and sometimes acute and dangerous poisoning [8]. With the industrialization of the world, soil and water pollution by heavy metals and their entry into the human food chain is one of the biggest problems. Industries are the main polluting sources related to heavy metals, of which factories such as electroplating, battery manufacturing, and electronic parts production are among the most important of them [8]. One of the important results of the stability of these metals is the bioaccumulation of metals in the food chain, which is considered as a threat to the health of plants and animals that use these foods [9].

By creating multiple mechanisms, metals disrupt the balance in living organisms, especially humans, and cause a wide range of complications and disorders. Among their most important disorders and complications, we can mention carcinogenesis, effect on central and peripheral nervous system, skin, hematopoietic system, cardiovascular system, damage to kidneys and accumulation in tissues [10].

Licorice with the scientific name Glycyrrhiza glabra is a carob plant from the herb family, native to Southern Europe, North Africa and temperate regions of Asia [11].

Contrary to its name, licorice is bitter, but it has wonderful properties. Treating mouth ulcers or ulcers, treating stomach disorders, protecting the liver, reducing stress, treating joint rheumatism, relieving menopausal symptoms and premenstrual syndrome, preventing cancer, treating tuberculosis, treating infections, strengthening the immune system, treating disorders breathing, reducing atherosclerosis, helping to lose weight, helping to detoxify the body, increasing women's fertility, treating stomach ulcers, treating hepatitis, taking care of skin and hair, increasing the health of the heart and blood vessels, etc. [12]. Fennel with the scientific name Foeniculum vulgare is a flowering plant belonging to the order Apiales of the genus [13]. In Iranian traditional medicine, fennel is used as an anti-phlegm and anti-bilious plant, stomach slimming, anti-inflammatory, anti-fungal (14).

These two plants are used a lot in traditional medicine, so the purpose of this study is to investigate the amount of lead in the medicinal plant's licorice and fennel.

Material and method

The studied medicinal plant

In this study, 10 samples of dry licorice and fennel plants were collected from pharmacology area in Chamestan, Mazandaran province.

The botanical characteristics of licorice and fennel are known in Table 1.

Table 1. Herbal Plants and Their Scientific Classification

Herb	Plant family	English name	scientific name
licorice	Fabaceae	Liquorice	Glycyrrhiza glabra
fennel	Apiaceae	Fennel	Foeniculum vulgare

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Plant sample conditions

The samples were transferred to the laboratory and analyzed with a GC-MS machine in selected ion mode (SIM mode) and carrier gas speed of 1 mL/min. One microliter of the extracted samples were injected splitless at the temperature of the injection chamber at 250 degrees Celsius.

Preparation of samples

For analysis, gas chromatography-mass spectrometry was performed according to standard number 17026.

Digestion and measurement

The elements in the plant were determined using an inductively coupled plasma device.

Method of digestion

The digestion of plant samples was done by the method of Agrawal et al. (2011) and Manutsewee et al. (2007) (15, 16). After the digestion stage, the samples were cooled to the desired volume with distilled water and the amounts of metal elements were measured by ICP-OES and ICP-MS. After measuring the concentration of elements in the digested samples (mg/L), considering the initial circuit of the plant sample and the volume of the acidic mixture used, the concentration of elements in the plant sample was calculated in terms of mg/Kg (12).

Results

The present study is a descriptive study of measuring the concentration of lead metal in the lavender medicinal plant, the result of which is shown in Table 1.

Table 2. Average lead concentration in lavender plant

Sample	Average lead concentration (ppb)
Licorice	21.63 ppb
Fennel	23.45 ppb

Discussion

The use of medicinal plants is increasing among people, and the presence of pollutants and toxic substances such as heavy metals in them can affect the health of consumers of these natural products. Therefore, the aim of this study was to determine the amount of lead heavy metal accumulation in two commonly used medicinal plants. Heavy metals in low concentrations are toxic to living organisms and do not break down in their bodies, and after deposition and accumulation in body tissues and organs, they cause numerous diseases and complications [17, 18]. Although there are claims about the usefulness and lack of side effects of using medicinal plants, poisonings due to the presence of heavy and toxic metals have been reported after their use [19]. Kohzadi et al. investigated that examining the concentration of heavy metals for human health in medicinal plants in 16 types of medicinal plants supplied to the Sanandaj city market showed that the overall average reported for most heavy metals is almost similar to the results of the present study, and very It was below the permissible and dangerous limit. They reported that the amount of THQ estimated related to heavy metals arsenic, cadmium, copper, iron, mercury, manganese, nickel, lead and zinc in 16 types of medicinal plants supplied to the market of Sanandaj city was less than the permissible limit, while THQ estimated related to aluminum and chrome metals was more than the permissible limit [20]. In the study of Karimi et al. investigated that of the risk of arsenic accumulation in medicinal plants offered in the market, it was found that the average of arsenic in four widely used medicinal plants, including Shirazi thyme, Violet, oregano and jujube respectively, is equal to 0.035 ± 0.026. 0, 0.033 ± 0.029, 0.029 ± 0.02, and 0.018 ± 0.016 µg/kg, all of these values were lower than the average of arsenic in medicinal plants examined in this study [21]. Lawi et al. showed that the amount of lead in plant samples from Texas drugstores was 26.68 mg/kg [22]. Karahan et al. showed that the average concentration of lead in the medicinal plants of Eastern Mediterranean region of Turkey was between 1.311 and 16.238 [23]. Adusei-Mensah et al. examined the content of heavy metals and assessed the health risk of herbal medicinal products in Kumasi, Ghana. Their results indicated that the amount of THQ associated with all heavy metals except copper in all 6 types of medicinal plants examined for both the age groups of adults and children was lower than the permissible amount [24]. Another study in the south of Iran (Shiraz city) showed that the amount of lead and cadmium in plant samples was higher than the reference limit [25]. The results of the study in Pakistan showed that the average concentration of lead in the medicinal plants of this country is 0.99 mg/kg [26]. The

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World Health Organization has declared the permissible limit for the use of lead in medicinal plants to be 10,000 µg/kg. It reports the high concentration of heavy metals in medicinal plants, which can be caused by the type of soil or environmental pollution created in these areas. Because many studies have shown that many types of plants have the ability to absorb and accumulate heavy metals in their structure [27-29].

Conclusion

The widespread use of various forms of herbal medicines requires stricter supervision and monitoring of the production and supply of herbal products such as chemical compounds, heavy metals and chemical pollutants. Because toxic metals enter the plant in different ways and must accumulate. Monitoring should be continuous to avoid the dangers of using these natural products containing harmful metals.

Statements and Declarations

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