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Heavy Metals, Micronutrients, and Medicinal Properties of Ricinus communis and Glycyrrhiza glabra

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Abstract:
Heavy metals are located in nature, derived from both natural and human-made sources as they accumulate in soil, flora, and fauna. Some metals like iron, zinc, and copper are essential as micronutrients for both plants and animals, while others such as cadmium, mercury, and arsenic are dreadful for one's health. The absorption of heavy metals by plants is dependent on the soil composition and plant variety, resulting in an increase in the food chain and the risk of having toxicity. \n\nMicronutrients are responsible for the metabolism of the plant, and if absent, results in stunted growth, chlorosis, and decreased productivity. However, the surplus of them can contribute to toxicity which could disturb the normal cellular process and cause oxidative stress. The balance between the levels of micronutrient supply and the respective toxicity caused is managed through homeostasis, which when dysfunctional can harm the health of the plant and its productivity. \n\nThese two plants, Ricinus communis and Glycyrrhiza glabra are well-known as two medicinal plants for their pharmacological uses. For instance, Ricinus communis can be used in traditional medicine because it has bioactive ingredients that possess antimicrobial, anticancer, antidiabetic, and anti-inflammatory purposes which makes it truly remarkable.

Index Terms: *Heavy metals, micronutrients, toxicity, Ricinus communis, Glycyrrhiza glabra, medicinal plants, phytochemicals*.

Introduction

Heavy metals are chemical elements with a specific gravity above 5gcm-3, which are crucial for the normal growth of animals, plants, and humans as they regulate metabolic processes (1). Herbal medicine in the Indian subcontinent has been used for over two thousand years, with high concentrations of nickel and zinc found in some plants' shoots in the early nineteenth century. The type of metals and their uptake by plants depend on the type of plant and the presence of metals in the soil. Various processes are used to remove heavy metals from various sites, including recycling contaminated water and using zeolites natural. The primary contact site for heavy metal uptake is the plant's roots, while the entire plant is the stationary contact site. Heavy metals can accumulate in plants, human organs, and the food chain, contributing to their toxic effects (2). To reduce their toxic effects, it is essential to understand the processes of their accumulation in living beings.

Non-essential heavy metals like cadmium, mercury, and arsenic are highly poisonous and can cause toxicity and even death. Heavy metal pollution in the environment can be caused by manmade processes like smelting, mining, and agriculture, which have polluted large areas of the earth. Natural sources of heavy metals include rock outcroppings and geologic parent material, with sedimentary rocks being a small source due to their unremovable nature (3). Igneous rocks, such as hornblende, olivine, and augite, are a significant source of heavy metals, providing soil with essential minerals. Volcanic emissions, fires, and natural vegetation processes also contribute to heavy metal pollution. Seasprays and aerosols generated during ocean activities contribute to the detection of heavy metals in inland coastal areas. Overall, the presence of heavy metals in the environment is influenced by both manmade and natural factors.

Heavy metals are primarily found in agricultural soil through organic and inorganic fertilizers, such as sewage sludge, pesticides, and irrigation waters. Cadmium, a harmful heavy metal, accumulates in plant leaves and can be consumed by humans and animals (4). Other sources include manures, sewage sludge, and limes. Heavy metals can accumulate in agriculture soil if used repeatedly and allowed to stay in the soil for long periods. Animal manure provides Mn, Cu, In, and Co, while sewage sludge contributes Cr, Cd, Cu, In, Ni, and Pb. Industrial sources of heavy metals include mining and refinement processes, which produce various types of heavy metals. Power-producing stations, textiles, plastics, wood, paper, and microelectronics industries also contribute to heavy metal contamination in soil and water bodies. Plants growing beneath power lines can have toxic effects on grazing animals.

Heavy metals like iron, zinc, copper, cobalt, molybdenum, and manganese are essential for living organisms, but at higher concentrations, they can become toxic (5). The oxides of these metals are usually not toxic. Mercurous mercury, also known as calomel, is used in various applications. Gold preparations like unaniKushtaTila Kalan and ayurvedic Swarna Bhasma have various properties and are used in modern medicine for immune system effects. Gold compounds like auranofin and gold disodium thiomalate are also used for their analgesic, anti-cataleptic, anti-depressant, and anti-anxiety activities. TamraBhasmais, a time-tested metallic ayurvedic preparation, has been shown to inhibit LPO in a biphasic manner.

Heavy metals, found in plants, soil, and drinking water, are essential elements for human health but can be toxic when accumulated in the body. These toxic effects can occur due to inhalation of lead-based paints, improperly coated food and medicine, water and air pollution, and exposure to industrial effluents. Some heavy metals are considered carcinogenic and highly toxic. Acute zinc toxicity can cause abdominal pain, nausea, vomiting, electrolyte imbalance, lethargy, drowsiness, dehydration, renal failure, and muscular incoordination. Chronic zinc toxicity can lead to anemia, hypercholesteremia, Alzheimer's disease symptoms, and damage to the pancreas. Copper toxicity can cause blue-green saliva, stool, diarrhea, and abnormal renal function (6). These toxic heavy metals contaminate the environment and pose a concern for evolutionary, environmental, ecological, and nutritional reasons.

Heavy metals, such as copper, lead, manganese, cadmium, cobalt, nickel, iron, chromium, zinc, silver, arsenic, and platinum, have atomic densities of over 4 g/cm3. They are found in rock formations and have increased anthropogenic contributions due to industrialization and urbanization. Some heavy metals are toxic for plants, but some have important functions for plant growth. The toxic effects depend on factors like plant species, metal type, chemical form, concentration, and soil characteristics. Heavy metals like iron, zinc, and copper are essential for animals and plants, but their accessibility varies. Some heavy metals are essential micronutrients, but excessive absorption can be toxic.

Micronutrients are essential components required by plants in small amounts but are highly necessary for their proper growth (7). They help regulate metabolic and cellular functions and maintain homeostasis. Excessive concentration of micronutrients can cause ectopic binding of metals with proteins, disrupting protein structure, and causing the production of Radical Oxidant Species (ROS), causing cell toxicity. Micronutrients in plants and animals are trace substances required in small amounts for proper growth. Higher plants require eight micronutrients, while cobalt is required by legume roots for nitrogen fixation. Essential micronutrients, also known as essential trace elements, are required by plants to complete their cyclical procedures. Homeostatic systems regulate the bioavailable amounts of all micronutrient heavy metals, and deficiencies or toxicities can emerge when these processes fail.

Micronutrients are essential for plant growth and yield, with a modest amount needed between 5mg kg-1 DM and 100mg kg-1 DM. Deficits can lead to physiological stress, growth retardation, discoloration, necrotic patches, and chlorosis. Symptoms of micronutrient deficiencies include stunted growth, chlorosis, and prolonged cell death (8). Primary micronutrients are consumed more than secondary ones. Symptoms include smaller or curled leaves, reduced turgor, and green veins on young leaves. Less severe deficits may not appear until the plant is further along in development. Visible symptoms can help diagnose micronutrient deficit problems quickly and cost-effectively, but they may be mistaken for other micro or macronutrient shortages, metal toxicity, illness signs, drought, heat stress, or chemical fertilizer damage.

Micronutrient deficiencies in plants can cause visible symptoms such as copper disruption, iron chlorosis, mangonese loss, morphological changes, and chlorosis on leaves (9). Nitrogen deficiency in plants results in color and vigor loss, reduced growth, and leaf falling. Potassium plays a crucial role in water regulation, photosynthesis, and cell tissue strength. Phosphorus is essential for root growth, energy storage, and transportation. Secondary macro-nutrients include sulphur, magnesium, and calcium. Sulphur is essential for chlorophyll formation, protein synthesis, tissue formation, and photosynthesis. Calcium is necessary for plant growth and development, causing brown and yellow spots on leaves. Phosphorus transportation and absorption promote plant growth and development (10)

Micronutrient toxicity can cause various symptoms in plants, such as chlorosis, deformation or stunted roots, dark green leaves, necrotic brown spots, brown margins, white tips, and general retardation in toxicity. Ricinus communis, a soft wooded shrub in the Euphorbiaceae family, has been used for thousands of years for its therapeutic benefits (11). Its phytochemical content includes flavonoids, alkaloids, tannins, sterols, and terpenes. Ricinus communis has been used for its pharmacological activities, including antimicrobial, antifungal, hepatoprotective, antinociceptive, antidiabetic, anticancer, antifertility, insecticidal, larvicidal, anti-oxidant, anti-inflammatory, antiviral, bone regenerative, and wound healing properties. Maintaining a proper dose is crucial for its therapeutic potential (12).

Glycyrrhiza glabra, a perennial herb found in Eurasia, western Asia, and northern Africa, contains flavonoids, saponins, phenolic constituents, volatile components, and essential oil. Glycyrrhizin and its aglycone glycyrrhetinic acid are the most powerful components in Glycyrrhiza glabra. Human metabolism converts glycyrrhizin into glycyrrhetinic acid, which has health benefits for treating respiratory diseases, digestive ailments, epilepsy, sexual debility, fever, paralysis, leucorrhoea, rheumatism, psoriasis, malaria, prostate cancer, jaundice, and hemorrhagic diseases. This study aims to document the medicinal plants Apium graveolens and Colchicum autumnale for the detection of heavy metals and macronutrients, their role in various diseases, and evidence of their use in herbal products (13).

Conclusion

Human health, the environment, and the wellbeing of living organisms are all interlinked with metals and micronutrients in some way. The fundamental plant micronutrients iron, zinc, and copper fuel phytohormonal production and trigger physiological activities, but can become toxic at higher concentrations. The environmental supply of heavy metals, which stem primarily from industrial and agricultural sources, has given rise to concerns over their concentrations in medicinal plants and related health impacts.

Two common medicinal plants, Ricinus communis and Glycyrrhiza glabra, are used extensively in medicine but have the potential to cause harm if heavy metals are absorbed from contaminated soils. On one hand, they are promising sources for therapeutic agents because of their bioactive constituents, on the other hand, their safety and therapeutic efficacy depend on the concentration of heavy metals. Their safe and sustainable use in herbalism requires understanding how these metals influence plant metabolism.

Studies on the impact of heavy metals on other medicinal plants and human health are warranted. Strategy formulation for soil decontamination, restriction in cultivation, together with increased control of metal concentration in medicinal plants need to be acted upon to reduce risks.

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المعادن الثقيلة، والعناصر الغذائية الدقيقة، والخصائص الطبية لنباتي الخروع والعرقسوس

الملخص

توجد المعادن الثقيلة في الطبيعة، وتنشأ من مصادر طبيعية وبشرية المنشأ، حيث تتراكم في التربة والنباتات والحيوانات. وتُعد بعض المعادن -مثل الحديد والزنك والنحاس- عناصر غذائية دقيقة ضرورية لكل من النباتات والحيوانات، في حين تُشكل معادن أخرى -مثل الكادميوم والزئبق والزرنيخ- خطراً جسيماً على الصحة. وتعتمد عملية امتصاص النباتات للمعادن الثقيلة على تركيب التربة ونوع النبات، مما يؤدي إلى تراكمها في السلسلة الغذائية وزيادة مخاطر التسمم. تلعب العناصر الغذائية الدقيقة دوراً حيوياً في عمليات التمثيل الغذائي للنبات؛ إذ يؤدي غيابها إلى توقف النمو، واصفرار الأوراق (الكلوروز)، وانخفاض الإنتاجية. وفي المقابل، قد تؤدي زيادة هذه العناصر عن الحد المطلوب إلى حدوث تسمم يخل بالعمليات الخلوية الطبيعية ويسبب الإجهاد التأكسدي. وتتم عملية الموازنة بين مستويات توفر هذه العناصر ومخاطر التسمم الناجمة عنها من خلال آلية التوازن الحيوي (الاستتباب)، التي يؤدي اختلالها إلى الإضرار بصحة النبات وإنتاجيته. يُعد كل من نبات الخروع (*Ricinus communis*) وعرق السوس (*Glycyrrhiza glabra*) من النباتات الطبية المعروفة بخصائصها العلاجية والدوائية؛ فعلى سبيل المثال، يُستخدم نبات الخروع في الطب التقليدي لاحتوائه على مركبات نشطة بيولوجياً تتمتع بخصائص مضادة للميكروبات، ومضادة للسرطان، ومضادة للسكري، ومضادة للالتهابات، مما يجعله نباتاً استثنائياً ومميزاً.

الكلمات المفتاحية: المعادن الثقيلة، المغذيات الدقيقة، السمية، نبات الخروع، نبات عرقسوس، النباتات الطبية، المركبات الكيميائية النباتية.