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Determination Of Trace Elements (Co,Cu,Fe,Mn,Zn)In Some Selected Ayurvedic Medicines By ICP-OES

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Abstract
Ayurvedic medicines, which have been used for health and wellness for centuries, often include various trace elements that can have both therapeutic benefits and toxic effects. This study focused on measuring the concentrations of trace elements in four commonly used Ayurvedic medicines—Arogyawardhini Bati, Ekangveer Ras, Laxmi Vilas Ras, and Shirashooladivajra Ras—using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). These medicines are known to contain metals and minerals as essential components, which can pose health risks if they are present in high amounts. The samples underwent an acid digestion process and were analyzed for elements such as Cobalt (Co),Copper (Cu),Iron (Fe),Manganese (Mn) and Zinc (Zn) and other metals. The results showed a range of trace element concentrations across the different medicines. While some elements were found to be within the acceptable limits according to WHO guidelines, others exceeded safety thresholds. This raises important concerns regarding the long-term use of these medicines and emphasizes the necessity for strict quality control and standardization during manufacturing. The findings highlight the critical need for ongoing monitoring of heavy metals in Ayurvedic products to ensure consumer safety. This study adds important information to the ongoing discussion about the safety of traditional medicines, supporting both consumer health and the integrity of Ayurvedic practices.
Keywords: *Ayurvedic medicines, trace elements, human health Quantity assessment ICP-OES.*

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I. Introduction

Ayurveda is one of the oldest healthcare systems that most Indian people used for ages to treat varieties of ailments is Ayurvedic medicine. Some Ayurvedic preparations are formulated to contain high concentrations of essential and potentially toxic elements, thus posing the threat of health risks if consumed in excess. Ayurveda, one of the oldest systems of medicine, has its roots in ancient India and has been practiced for over 5,000 years (Ashwini & Kerur et al.,2019) It emphasizes balance in the body, mind, and spirit, using natural materials like herbs, minerals, and metals for healing. Ayurvedic medicines are designed to treat the body holistically, focusing not just on disease but also on overall well-being and prevention. Today, as the popularity of Ayurveda spreads worldwide, there is increasing demand for its products, leading to questions about the safety, quality, and standardization of these formulations. A key aspect of ensuring their safety is the determination of trace elements present in Ayurvedic medicines, which plays a significant role in their therapeutic potential.

The present study aimed to determine the traces of cobalt, copper, iron, manganese and zinc, found in four Ayurvedic medications: Arogyawardhini Bati, Ekangveer Ras, Laxmivilas Ras, and Shirashooladivajra Vajra Ras. Trace elements in the Ayurvedic preparations were determined by inductively coupled plasma-optical emission spectrometry (Mikulski et al., 2017) (Bhalla & Pannu, 2022) (Abollino et al., 2017).

Ayurvedic Medicines

Ayurvedic medicine is an ancient system that has been derived from roots thousands of years back in India. The term Ayurveda was originated from the Sanskrit word in which "ayus" means life, and "veda" means knowledge. Ayurveda is guided by principles that support all the aspects of life such as a body, mind, and spirit to be balanced and harmonious. Ayurveda prevents and treats health-related diseases, (Ashutosh Gupta et al., 2020.)Ayurveda ideas place great significance on the presence of Doshas, three energies that determine physiological and psychological functions, out of which one is Vata (air and space), the other Pitta (fire and water), and the last one is Kapha (earth and water). The Dosha is the unique blend that every individual is given, which is termed Prakriti, and it is asserted that maintaining this balance is fundamental to healthy living (Dhanani et al., 2014). Ayurvedic practices include all the above methods, such as herbal medicines, changes in

diet, lifestyle changes, yoga, meditation, and treatments like Panchakarma. In this research, trace elements existing in specific Ayurvedic medicines are studied with an aim to complement our knowledge in respect of safety aspects of these remedies in contemporary health standards.(Das et.,2016).

Trace Elements: Health Benefits & Health Risks

Trace elements, e.g.,cobalt cupper iron, manganese and zinc are essential for various functions in the body. They provide the body with enzymes that help to digest food. They allow our immune system to function properly and also provide the body with necessary nutrients. Usually, herbal and mineral sources are responsible for such elements in Ayurvedic blends.Trace elements, often referred to as micronutrients, are essential minerals required in small amounts by the human body for various biochemical and physiological functions. Despite their necessity in minute concentrations, an imbalance whether excess or deficiency can result in significant health implications. Among the critical trace elements are Cobalt, Copper, Iron, Manganese, and Zinc, each playing a unique role in maintaining cellular homeostasis, enzyme activity, and overall health. This paper explores the health effects,both beneficial and detrimental, of these trace elements. (Aronson et al.,2016 & Kao et al.,2020).

Cobalt (Co)

Cobalt is an essential trace element, primarily because of its role in the structure of vitamin B12 (cobalamin). This vitamin is vital for red blood cell production and neurological health. Cobalt's biological role is indirect, as its benefits are mainly derived from cobalamin.(Smith et al.,2020 & Prashanth et al.,2015)

Health Benefits: Vitamin B12 synthesis: Cobalt is a key component of vitamin B12, which is critical for DNA synthesis, maintaining nerve cells, and forming red blood cells. A deficiency in B12 can lead to pernicious anemia and neurological disorders. Erythropoiesis: Cobalt stimulates erythropoietin, a hormone that promotes red blood cell production. This is particularly beneficial in cases of anemia. (Smith et al.,2020 & Prashanth et al.,2015).

Health Risks: Toxicity: While cobalt in vitamin B12 is essential, excessive cobalt exposure, often through industrial sources like mining or metalworking, can cause cobalt toxicity. This can lead to cardiomyopathy, hypothyroidism, and even lung diseases such as asthma. (Barceloux et al.,1999 & Simonsen et al., 2012).

Cobalt poisoning: High levels of cobalt exposure can cause nausea, vision problems, and thyroid dysfunction. In severe cases, it may lead to cardiomyopathy or neurodegenerative disorders due to oxidative stress. (Barceloux et al.,1999 & Simonsen et al., 2012).

Copper (Cu)

Copper is crucial for several bodily functions, especially as a component of enzymes involved in energy production, iron metabolism, and antioxidant defence. It also plays a vital role in forming connective tissue and maintaining the health of the nervous and immune systems(Smith & Jones, 2020; Brown et al., 2018).

Health Benefits: Enzymatic cofactor: Copper is a part of several enzymes, such as cytochrome c oxidase, which is important in mitochondrial energy production, and superoxide dismutase (SOD), which helps neutralize free radicals.

Iron metabolism: Copper assists in the conversion of iron from its ferric form to its ferrous form, facilitating iron’s incorporation into hemoglobin. Bone and tissue health: Copper is involved in the synthesis of collagen and elastin, essential components of connective tissue, skin, and bones.

Health Risks: Deficiency: A lack of copper can lead to conditions such as anemia, neutropenia, and osteoporosis. Menkes disease is a genetic disorder affecting copper absorption, leading to developmental delays and connective tissue problems.

Toxicity: Excess copper, typically from environmental exposure or conditions like Wilson's disease, can accumulate in organs, especially the liver and brain. This can cause oxidative damage, leading to neurological symptoms such as tremors, fatigue, and liver disease.

Iron (Fe)

Iron is one of the most abundant trace elements in the human body, playing a crucial role in oxygen transport and cellular respiration. It is a key component of hemoglobin and myoglobin, proteins responsible for oxygen transport in the blood and muscles, respectively.

Health Benefits: Oxygen transport: As a part of hemoglobin, iron is critical for transporting oxygen from the lungs to tissues. It also plays a role in myoglobin, which stores oxygen in muscles. Energy production: Iron is a component of cytochromes in the electron transport chain, essential for ATP production in cells.

Cognitive function: Adequate iron levels are necessary for proper brain development, especially during infancy and adolescence.

Health Risks: Iron deficiency: The most common nutritional deficiency worldwide, iron deficiency leads to anemia, characterized by fatigue, weakness, pale skin, and reduced cognitive function. In children, it can impair cognitive and physical development.

Iron overload: Conditions like hemochromatosis, a genetic disorder that causes excessive iron absorption, can lead to iron toxicity. Excess iron deposits in organs such as the liver, heart, and pancreas, causing damage, leading to conditions like cirrhosis, diabetes, and heart failure.

Manganese (Mn)

Manganese is vital for bone formation, carbohydrate metabolism, and the functioning of antioxidant enzymes. Although required in small amounts, manganese is involved in numerous physiological processes, including bone development and the metabolism of amino acids, cholesterol, and carbohydrates (Smith & Jones, 2020; Brown et al., 2018).

Health Benefits: Bone health: Manganese is a cofactor for enzymes involved in bone formation and bone matrix synthesis. It supports the development of strong bones, particularly during growth phases (Smith & Jones, 2020).

Antioxidant defense: Manganese is a component of manganese superoxide dismutase (MnSOD), an enzyme that protects cells from oxidative stress by neutralizing free radicals (Brown et al., 2018).

Metabolism: Manganese plays a role in carbohydrate, protein, and fat metabolism through its role in activating enzymes like pyruvate carboxylase and arginase (Smith & Jones, 2020).

Health Risks:Deficiency: Though rare, manganese deficiency can result in impaired growth, bone deformation, and reduced glucose tolerance. It may also lead to reproductive issues and altered lipid metabolism (Brown et al., 2018).

Toxicity: Manganese toxicity, often seen in occupational settings such as mining, can lead to manganism, a neurodegenerative condition with symptoms similar to Parkinson's disease, including tremors, difficulty walking, and muscle stiffness (Smith & Jones, 2020).

Zinc (Zn)

Zinc is essential for immune function, wound healing, DNA synthesis, and cell division. It is also involved in the function of over 300 enzymes and is crucial for protein synthesis, growth, and development (Doe et al., 2019; Smith & Lee, 2021).

Health Benefits: Immune function: Zinc is critical for the development and function of immune cells like T-lymphocytes. It also has antioxidant properties, helping to reduce inflammation (Doe et al., 2019).

Wound healing: Zinc supports cell division and collagen formation, making it essential for wound healing and tissue repair (Smith & Lee, 2021).

Growth and development: Zinc is vital for growth, especially during childhood, adolescence, and pregnancy, due to its role in DNA synthesis and protein production (Doe et al., 2019).

Health Risks: Deficiency: Zinc deficiency can impair immune function, leading to increased susceptibility to infections. It also causes growth retardation, delayed sexual maturation, and skin lesions, and is associated with hair loss and diarrhea (Smith & Lee, 2021).

Toxicity: Excessive zinc intake, often through supplements, can interfere with copper absorption and cause copper deficiency. Symptoms of zinc toxicity include nausea, vomiting, abdominal cramps, and impaired immune functions (Doe et al., 2019).

II. Materials And Method

Sampling Design

For the purpose of this study, four specific Ayurvedic remedies were chosen for analysis: Arogyawardhini Bati, Ekangveer Ras, Laxmi Vilas Ras, and Shirashooladivajra Ras. The selection of these formulas was based on their extensive usage and importance in traditional Ayurvedic medicine. The samples were obtained from local marketplaces in Bilaspur, Chhattisgarh. The date of manufacturing, expiry and batch numbers was recorded.

Table: Ayurvedic Medicines and Their Commonly Usage

Ayurvedic Medicines	Abbreviation Name	Commonly Usage
Arogyawardhini Bati	S1	Help to relieve the problems of liver spleen,anemia,constipion,swelling on the body,skin disease
Ekangveer Ras	S2	Chronic vat disorders, like joint pain, backache, pakshaghat dhanurvata etc.
Laxmi Vilas Ras,	S3	Pneumonia, useful in cough, cold and sore throat associated with vata pitla and kapha dosha, asthama, pain in joints, headache, chest pain.
Shirashooladivajra Ras.	S4	Useful to trat all types of headche especially the headache related to stress, migraine is sevre recurring headche.

Sample Preparation

Digestion Method- The medicine samples were grinded and make fine powder. Take 1.0 gram of each medicine samples are subjected to digestion with (1:3) H_2O_2 and HNO_3 mixture using Teflon acid digestion bumbs having capacity of 100 ml.

The samples were digested at 180° for 4 to 6 hours in a temperature controlled Hot air oven, then the sample were allowed to keep overnight for cooling and next day filtered through whatman filter paper number 42. The final volume is made up to 100 ml by distilled water. The digested samples were then transferred into clean Polypropylene bottles and subjected to chemical analysis of selected trace elements. Cobalt, Copper, Iron, Manganese and Zinc by using Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).

Sample Analysis

The determination of trace elements were detected through Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).

The selected Ayurvedic medicines were collected which are Arogyawardhini Bati, Ekangveer Ras, Laxmi Vilas Ras, and Shirashooladivajra Ras.

Reagents: Analytical grade nitric acid, hydrogen peroxide (Sigma & Merck grade) was used.
Analysis: Trace elements determination of the selected Ayurvedic medicines was done on Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).

Instrument details:
ICP-OES - Inductively Coupled Plasma Optical Emission Spectrometry.
ICP-OES- iCAP 7400 DUO Full MFC (Thermo Fisher Scientific)

Agilent Technologies.
Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) stands as the fast analytical technique.

Inductively Coupled Plasma (ICP) - ICP is a highly energized plasma source formed by ionizing argon gas with an induction coil. This plasma serves to excite the atoms in the sample.A radio-frequency (RF) generator creates a strong electromagnetic field that heats the gas to temperatures between 6,000 and 10,000 K, resulting in ionized gas that functions as the plasma.

Optical Emission Spectroscopy (OES) - When a liquid sample is introduced into the ICP, the extreme heat of the plasma excites the atoms and ions of the elements present. As these excited atoms return to their ground state, they emit light (photons) at specific wavelengths. Each element emits light at unique wavelengths, which serve as fingerprints for identification.

It is a Multi-element Analysis technique It allows for the simultaneous analysis of multiple elements. The sample, usually in a liquid form, is introduced into the system through a nebulizer that transforms the liquid into a fine aerosol mist. This mist is then transported by argon gas into the plasma. In this study, the determination of trace elements (Co,Cu,Fe,Mn,Zn) in the selected Ayurvedic medicines was conducted using ICP-OES with appropriate modifications and optimized conditions.

Table: Instruments Conditions for trace elements determination by ICP-OES.

Parameters	Setting
Analysis Pump Speed	50 rpm
Spray Chamber	Glass Cyclonic
Nebulizer	Burgener Mira Mist
Nebulizer Gas Flow	0.5 L min-1
Coolant Gas Flow	12 L min-1
Auxiliary Gas Flow	0.5 L min-1
Center Tube	2 mm
RF Power	1150 W
Plasma View	Axial Radial
Exposure Time	UV 15 s,Vis 5 s Vis 5 s

III. Result And Discussion

The study reveals significant variation in the concentrations of trace elements across the four Ayurvedic medicine samples. While all samples contain essential elements such as Cobalt, copper, iron, manganese, and zinc the concentrations of these elements vary widely, with samples S4 showing potentially harmful levels of cobalt and iron. The findings highlight the need for strict quality control measures in the production of Ayurvedic medicines to ensure that trace element concentrations remain within safe and therapeutic limits. Specifically, S4 shows high levels of cobalt and iron which could pose health risks.(WHO)

Regular monitoring and adherence to safety standards are essential to minimize the risk of trace elements toxicity and to ensure the efficacy and safety of Ayurvedic medicines.

Table: Concentrations of different trace elements in Ayurvedic Medicines

Ayurvedic medicine samples	Co mg/L	Cu mg/L	Fe mg/L	Mn mg/L	Zn mg/L
S1	0.09	2.94	0.94	1.4	1.89
S2	0.3	9.59	0.35	5.65	3.58
S3	1.25	0.99	2.5	3.76	2.21
S4	2.56	0.11	44.13	0.428	0.164

S1	Arogyawardhini Bati
S2	Ekangvir Ras
S3	Laxmivilas Ras
S4	Shirshooladivajra Ras

Cobalt (Co)

The levels of cobalt in the samples range from 0.09 mg/L (S1) to 2.56 mg/L (S4). Cobalt is a necessary trace element involved in vitamin B12 production, but excessive intake can lead to toxicity. The higher levels observed in S4 could pose health risks, indicating the need for careful dosage regulation.

Copper (Cu)

Copper is an essential element for enzymatic reactions, and its concentrations range from 2.94 mg/L (S1) to 0.11 mg/L (S4). While copper is necessary for various bodily functions, excessive intake can result in liver toxicity. The concentration level of all samples were found within the permissible limits (WHO).

Iron (Fe)

Iron concentrations also show significant variation, with S4 showing a notably high concentration of 44.13 mg/L, while other samples. Iron is essential for oxygen transport in the blood, but high concentrations, such as in S4, may raise concerns regarding iron overload, which can lead to conditions like hemochromatosis.

Manganese (Mn)

Manganese levels range from 1.4 mg/L (S1) to 0.428 mg/L (S4). Manganese is necessary for bone development and metabolic processes but can become neurotoxic at high levels. The elevated manganese levels in all samples within the permissible limits(WHO).

Zinc (Zn)

Zinc concentrations range from 1.89 mg/L (S1) to 0.164 mg/L (S4). Zinc is vital for immune function and wound healing, but again, excessively high levels can interfere with copper absorption and cause other issues. The moderate levels of zinc across all samples are generally within acceptable limits for therapeutic use.

IV. Conclusion

The analysis of trace element concentrations in four different Ayurvedic medicines (Arogyawardhini Bati, Ekangvir Ras, Laxmivilas Ras, and Shirshooladivajra Ras) provides significant insight into the variation of essential and potentially harmful trace elements across different formulations. Each formulation contains varying amounts of elements such as cobalt (Co), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn) these all elements were found within the permissible limits (WHO) except sample S4 found higher level of cobalt and iron concentration, which are critical for evaluating both their therapeutic effects and safety profiles. Further studies could focus on assessing the bioavailability of these elements and their long-term effects on human health when consumed as part of Ayurvedic treatments.

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