



**DETECTION AND ANALYSIS OF MEDICINAL PLANT SAMPLES
FOR TRACE ELEMENTS USING ED-XRF**

YELMATE AA^{1*}, KADAM KB², SATPUTE KL³, SABNE AB⁴, EKLINGE SS⁵

- 1: Assistant Professor, Dayanand College of Pharmacy, Latur, Maharashtra, India
- 2: PG Scholar, Department of Pharmaceutics, Dayanand College of Pharmacy, Latur, Maharashtra, India
- 3: Assistant Professor, Dayanand College of Pharmacy, Latur, Maharashtra, India
- 4: PG Scholar, Department of Pharmaceutics, Dayanand College of Pharmacy, Latur, Maharashtra, India
- 5: PG Scholar, Department of Pharmaceutics, Dayanand College of Pharmacy, Latur, Maharashtra, India

***Corresponding Author: Dr. Yelmate Archana Ashok: E Mail: archanavelmate1@gmail.com**

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ABSTRACT

The goal of this research is to find out how many tiny substances are present in particular therapeutic plants that are used to heal skin conditions. Using the ED-X-ray Florescence (XRF) method, the trace element study was conducted on the plants *Indigofera tinctoria*, *Psoralea corylifolia*, and *Nigella sativa*. Implementing a 3MV pelletron accelerator, the tests were conducted. The sample contained the metals K, Ca, Cr, Mn, Fe, Cu, Zn, Rb, Sr, and Pb. The highest concentrations of K and Ca were found. These medicinal plants' proportional amounts of various elements have been listed. The medicinal plants chosen for this research contain trace elements in varying amounts in all four plants. The different trace elements found in vegetation are thought to be crucial in the treatment of skin conditions. The information provided will be useful in recommending the right kind, dosage, and combination of these plants' extracts. The findings support the use of such plants in conventional medical practices for the management of skin disorders because they contain the right quantities of Fe, Zn, Cu, etc.

Keywords: ED-XRF, *Indigofera tinctoria*, *Psoralea corylifolia*, *Nigella sativa*

1. INTRODUCTION:

Herbal remedies employ a variety of plants that are well-known for their therapeutic properties. XRF elemental analysis is performed on these plants. These medicinal plants' chemical contents are wholly responsible for the medical effects they produce. Around the world, herbal medicines are utilised to treat a variety of illnesses and conditions [1].

Due to their safety, affordability, and greater compatibility with the human body, phytomedicines and Ayurvedic medicines are receiving more attention nowadays. Numerous synthetic medications are produced at these plants. The creation of various chemical components has reportedly been attributed to the trace elements found in plants. Additionally, plant nutrients such as potassium (K), phosphorus (P), and sulphur (S) are crucial for controlling a number of processes, including tissue growth, carbon respiration, and photosynthesis. However, relatively little is known about the elemental makeup of plants, with the majority of studies focusing on components found in plants including essential oils, vitamins, glycosides, and other organic components [2, 3, 18].

According to a review of the literature, The importance of trace elements in the treatment of a number of illnesses and disorders. Changes in trace elements within an organism have been shown to directly

correlate with a variety of clinical diseases. The identification of potentially dangerous trace metals in plants as well as the screening of the bioactive elements contained in plants and determination of the elemental composition of commonly used therapeutic plants are therefore of utmost importance. The biological importance of these trace elemental compositions of plants has received particular emphasis in this work, which is important for the creation of novel medications derived from natural sources. The goal of the current study is to shed light on various therapeutic plants' trace elements composition [4, 5].

The X-Ray Fluorescence (XRF) analysis technique, a quick method for the identification and determination of elements, was used for this work. The examination of nutritional plants using XRF is a potent method for estimating trace elements contents. In studies on the element composition analysis of plants, soil contamination, and agriculture, XRF has been successfully used. The majority of these studies used pressed powder pellets to conduct XRF analysis. With the loose powder used in the X-ray fluorescence method (EDXRF), analytical time and expenses are reduced [19].

This study's major goal is to find out how many trace elements are present in particular medicinal plants that the tribal people utilise

to cure skin conditions. The four plants were selected for the present study mentioned here *Indigofera tinctoria*, *Psoralea corylifolia*, *Nigella sativa* [5-7].

2.TOXIC EFFECTS OF HEAVY METALS ON ANIMALS, PLANTS, AND HUMANS:

When certain metals build up in the body via exposure to food, water, industrial chemicals, or other sources, it is known as heavy metal poisoning. While your body needs trace amounts of some heavy metals, such as zinc, copper, chromium, iron, and manganese, to function correctly, excessive levels of these substances are dangerous. Humans need proper levels of iron, cobalt, copper, manganese, molybdenum, and zinc. These heavy metals are transported and segregated into bodily tissues and cells, where they bind to proteins and nucleic acids, damaging the macromolecules and impairing cellular processes. In two different ways, heavy metals impair metabolic processes: first, they build up in the body's most important organs and glands, such as the liver, kidneys, heart, and bones, impairing their ability to operate. They prevent them from performing biologically by displacing the essential nutritional elements from their native location. The results of research on the lead, zinc, copper, and cadmium absorption and accumulation by several plant species near a smelter revealed that the types of plants and

portions of those plants had different rates of metal accumulation [7].

In the soil ecosystem, heavy metals can assemble and move about. With their roots and vascular systems, plants may take up metal contaminants from the soil. Once ingested, heavy metals can build up over time in your bones, liver, brain, kidneys, and heart. Excessive levels of heavy metals in the body can harm important organs, affect behaviour, and impair thinking and memory. Lead, mercury, arsenic, and cadmium are the heavy metals that are most often linked to human toxicity. Foods, pharmaceuticals, inadequately protected food containers, exposure to heavy metals at work, lead-based paint consumption, air or water pollution, and industrial exposure are all potential causes of heavy metal poisoning. High dosages of zinc can result in a copper deficit since they decrease the amount of copper your body absorbs. Some of the consequences caused by the toxic effects of heavy metals include gastrointestinal and renal dysfunction, neurological system diseases, skin lesions, vascular damage, immune system malfunction, birth defects, and cancer. Another cause of liver illness is heavy metal poisoning. This cause is very important since heavy metals can be ingested by people unknowingly and because they can be found in food, water, the environment, and the workplaces of those who are afflicted. The uncommon cause of

the troubles for a guy who instantly lost his vision and even became colorblind was thallium poisoning. Thallium is a metal that can cause neurological issues when absorbed via the skin.

Heavy metals, both necessary and non-essential, often cause common toxic effects on plants, such as poor biomass accumulation, chlorosis, suppression of growth and photosynthesis, altered water balance and nutrient absorption, and senescence, which eventually result in plant death.

Plants have developed detoxifying systems in order to reduce the negative consequences of heavy metal exposure and buildup. Chelation and subcellular compartmentalization are the primary tenets of such systems. A common detoxification

method used by a wide range of plants is chelation of heavy metals. Mercury, lead, cadmium, nickel, and zinc are some of the most important heavy metals from a health standpoint [6-8].

3. MATERIAL AND METHOD:

With the assistance of specialists, samples of medicinal plants were gathered from various parts of Maharashtra for the study, and a botanist verified the samples. Before drying in an oven at 60°C for around 2-3 days, all the samples were cleaned under running water from the faucet and rinsed with deionized water to get rid of any earthy material. Using dried samples of medicinal herbs No.1 on No.3, (No.1- *Indigofera tinctoria* , No.2- *Psoralea corylifolia*, No.3- *Nigella sativa*) experiments were conducted [19-25].



Indigofera tinctoria



Psoralea corylifolia



Nigella sativa

Table 1: Selected plant information

S. No.	Local name	English name	Scientific name	Family	Part used	Medicinal uses [21-26]
1	Neel	Indigo	<i>Indigofera tinctoria</i>	Fabaceae	Leaves	Anti-inflammatory agent, Antipsoriatic Anti-inflammatory agent, Antipsoriatic Anti-inflammatory, Anti-psoriatic activity,
2	Babchi	Babchi	<i>Psoralea corylifolia</i>	Fabaceae	Seeds	Anti-psoriatic activity, Anti-inflammatory, Antibacterial activity, Anti-fungal Activity
3	Kalaunji	Black cumin	<i>Nigella sativa</i>	Ranunculaceae	Seeds	Anti-inflammatory, Antiparasitic, Acne vulgaris, Wound healing

4. AUTHENTICATION OF PLANTS

The greatest supply of medications, according to the WHO, are medicinal plants. The study's plants are widely accessible all year long and in almost every region of India. They are affordable and simple to obtain, and they can also be found in the environment. They used newly dried particular plant sections instead of whole plants because they do not retain their potency and stability for an extended period of time. We have selected *Indigofera tinctoria* leaves, *Psoralea corylifolia* Seeds, *Nigella sativa* seeds. Based on a thorough review of the literature, the plants were chosen because they have historically been used to treat a variety of skin conditions. Different phytoconstituents with antibacterial and anti-inflammatory properties can be found in the chosen plant sections. These herbs have historically been utilized in the ayurvedic medical method. Additionally, this old and well-respected

Ayurvedic and Unani textbook, CHARAK SAMHIT [6-7]. A, has written on these plants. A. *Nigella sativa* seeds, *Psoralea corylifolia* Seeds, were collected from the local region of local market of Latur in the month of august, *Indigofera tinctoria* leaves, in the month of October respectively and authenticated under the supervision of expert botanist by submitting herbarium of each sample. According to WHO standards, authenticated plant parts were assessed for their morphological qualities, such as colour, odour, taste, size, form, and nature of the exterior and interior surfaces. The plant pieces were mechanically ground into powder after being shade-dried for a month, then kept in airtight containers [8].

5. MORPHOLOGIC EVALUATION:

After Authentication, all plants are subjected for morphological parameters like colour, odour, taste, size, shape, etc. The results are recorded in **Table 2**.

Table 2: Morphological observation of selected plants

Sr. No	Characters	Name of plant samples		
		<i>Indigofera tinctoria</i> Linn	<i>Psoralea corylifolia</i> Linn	<i>Nigella sativa</i> Linn
1.	Color	Green	Red-brown	Black
2.	Odour	Characteristics	Unpleasant	Aromatic
3.	Taste	Bitter taste	Bitter taste	Slightly bitter
4.	Size	1 to 2 cm diameter	Length 7mm , 5mm width	Length 2.73 mm ,1.72 mm width
5.	Shape	Elliptic to obovate	Kidney shaped	Triangular

6. STANDARDIZATION OF PLANTS:

The quality of the beginning material is crucial for producing a finished product of reproducible quality. As a result, the standardization of the plant samples used in

the research was carried out in accordance with the detailed instructions of WHO publications. The World Health Organization has stressed the importance of using various contemporary methods and

appropriate standards to ensure the quality of herbal medicines. The following variables served as the standardization parameters [8, 9].

7. EXTRACTIVE VALUES:

After solvent extraction, the extractive value of a medicine can be used to estimate how many soluble components are present in a medicinal plant substance. Any unrefined medication can be extracted with a specific solvent to produce a solution having various molecular components that are only soluble in that particular solvent. The character of the phytoconstituents as well as their solubility in the solution used for extraction determine the makeup of these chemical components in a solvent [8-9].

8. WATER SOLUBLE EXTRACTIVE:

Each desiccated 250 ml conical beaker was filled with precisely weighted 5 g of crude drug sample made up of *Indigofera tinctoria* leaves, *Psoralea corylifolia* seeds, and *Nigella sativa* seeds. The chloroform water for water soluble extractives was added until the delivery mark was reached in each beaker. All containers were tightly sealed and left aside for 24 hours. Then it was filtered, and 25 ml of the filtrate were moved to a narrow ceramic plate after enough filtrate had accumulated. dried out completely on a water immersion and then dried in a 1000°C kiln. Cool in desiccators, and extractive percentage that is water soluble was determined [8, 9, 10].

9. ALCOHOL SOLUBLE EXTRACTIVE

Accurately weighed 5 gm of each *Indigofera tinctoria* leaves, *Psoralea corylifolia* seeds, and *Nigella sativa* seeds powder drug taken in a weighing bottle and transfer it to separate dry 250 ml. conical flasks.

The solvent (90% alcohol) was added to each beaker until it reached the delivery line. After being tightly sealed in all containers and set away for 24 hours, it was quickly filtered to avoid alcohol loss. Take 25 ml of the filtrate and move it to a narrow porcelain plate once enough filtrate has accumulated. Drying was done in an oven set to 1000 degrees Celsius after being evaporated to nothingness on a water pan. % ethanol soluble extractive was determined while the samples were kept cool in desiccators [8, 9, 10].

Ash values:

Ash value denotes the amount of material that was left over after burning crude pharmaceuticals. It is an artificial blend of silica and metallic ions. It aids in assessing the grade and integrity of crude medicines, particularly when they are in powdered form. The goal of ash value is to eliminate all remnants of organic matter that might conflict with an analytical measurement. Ash includes mineral substances like phosphates, carbonates, silicates of sodium, potassium, magnesium, and calcium, among others. Sometimes, chemical factors like a

drug's calcium oxalate carbonate concentration have an impact on "Total ash value."

The different Types of ash values are as follows:

Total Ash: The combined amount of physiological and non-physiological debris is known as total ash. **Water Soluble Ash:** Water-soluble ash is created when a complete ash is handled with chloroform water. **Sulfated Ash:** This results from pre-ignition preparation of the substance with dilute sulfuric acid. All oxides and carbonates are changed to sulfates in this process, which also involves higher-temperature combustion in a muffle furnace. **Acid Insoluble Ash:** Acid Insoluble Ash is created when a complete ash is handled with dil. HCL. This number primarily denotes pollution from substances like grit. A triangular positioned on the ring of the retort stand will serve as the dish's support. The silica crucible was heated with a burner using a flame until almost no vapours were being produced, at which point it was lowered and the heat increased until all the carbon had been burned off. The silica crucible was then put in a desiccator to chill. After chilling, the ash and proportion were determined [8, 9, 10].

Acid Insoluble Ash: The ash from the plate used to calculate the overall ash value washed into a 100 ml container using 25 ml of diluted HCL. The aforementioned

solutions were boiled for five minutes over a Bunsen burner, filtered through ashless filter paper, and the leftover material was rinsed twice in hot water before being ignited in a crucible, cooled, and measured. After cooling the silica crucible in the desiccator, the remnant was measured, and the acid insoluble ash value was determined [8-11].

Water soluble ash: The total ash collected was simmered in 25 mL of purified water for five minutes. cooled and gathered the insoluble material on ash-free filter paper, rinsed with hot water, and then re-ignited for 15 minutes at a temperature no higher than 450°C and percentage of water-soluble ash was calculated [12, 13].

Sulfated ash: For 10 minutes, heat an unfilled silica crucible until it turns crimson. chilled and weighed before. One gram of plant powder was added to a silica crucible, treated with sulfuric acid, lit once more while moistened with sulfuric acid in a muffle furnace at about 800°C, cooled, and weighed. The percentage of sulfated ash was calculated.

Moisture and Volatilities: *Indigofera tinctoria* leaves, *Psoralea corylifolia* seeds, and *Nigella sativa* seeds about 5–6 g. In a petri plate, were precisely weighed and heated to 110°C for 4 hours. Each case's weight reduction was noted after cooling in a desiccator. Repeating this process until a consistent weight was attained.

Moisture and Volatilities (%) = Loss in weight x 100 / W, W = Weight of the leaves in grams.

DETERMINATION OF FOREIGN ORGANIC MATTER IN PLANT SAMPLES: Foreign organic matter is defined as any organic substance that was not gathered during plant collection. Foreign

organic matter is defined as insects, mold, or any other contaminated substance. Procedure: Spread 500 g of the crude drug that was gathered in an even layer on a fresh tile. After that, directly examine the sample with your eyes and remove any foreign objects that you find [14-17].

Table 3: Results of standardization of plant materials

Evaluation Parameter	Name of Plant		
	<i>Indigofera tinctoria</i> Linn	<i>Psoralea corylifolia</i> Linn	<i>Nigella sativa</i> Linn
Foreign matter	0.3	0.2	0.2
Ash values	17.5	11	21.5
Acid insoluble ash	1.53	2.17	2.5
Water soluble ash	19.4	3.57	4.32
Alcohol soluble extractive	12.21	10.11	10.23
Water soluble extractive	20.1	36.5	34.2
Moisture and volatilities	5.3	8.6	9.1

Experiments were performed with dried samples of medicinal plants No.1- No. 3 (No.1 *Indigofera tinctoria* Linn, No.2 *Psoralea corylifolia* Linn, No.3 *Nigella sativa* Linn)

Total 19 number of elements, such as potassium, calcium, phosphorus, sulfur, manganese, scandium, iodine, titanium,

iron, vanadium, cadmium etc. were identified from the three therapeutic plant samples of *Indigofera tinctoria* Linn, *Psoralea corylifolia* Linn, *Nigella sativa* Linn by ED-XRF technique. **Table 4 and Figures 1-4** lists the detected concentrations that have been identified in the samples.

Table 4: Trace element concentrations of the selected medicinal plants

Elements	<i>Indigofera tinctoria</i> Linn	<i>Psoralea corylifolia</i> Linn	<i>Nigella sativa</i> Linn
Si	0.489 %	0.118 %	0.183 %
P	2.342 %	3.046 %	5.109 %
S	1.953 %	2.903 %	4.522 %
Cl	3.690 %	4.741 %	9.212 %
K	25.441 %	48.66 %	28.796 %
Ca	56.118 %	33.786 %	47.998 %
Ti	0.898 %	0.967 %	0.494 %
Mn	0.728 %	0.520 %	0.594 %
Fe	7.299 %	4.244 %	1.384 %
Ni	0.032 %	0.035 %	0.045 %
Cu	0.046 %	0.071 %	0.106 %
Zn	0.107 %	0.108 %	0.335 %
Br	0.025 %	0.017 %	0.012 %
Rb	0.028 %	0.020 %	0.052 %
Sr	0.194 %	0.088 %	0.101 %

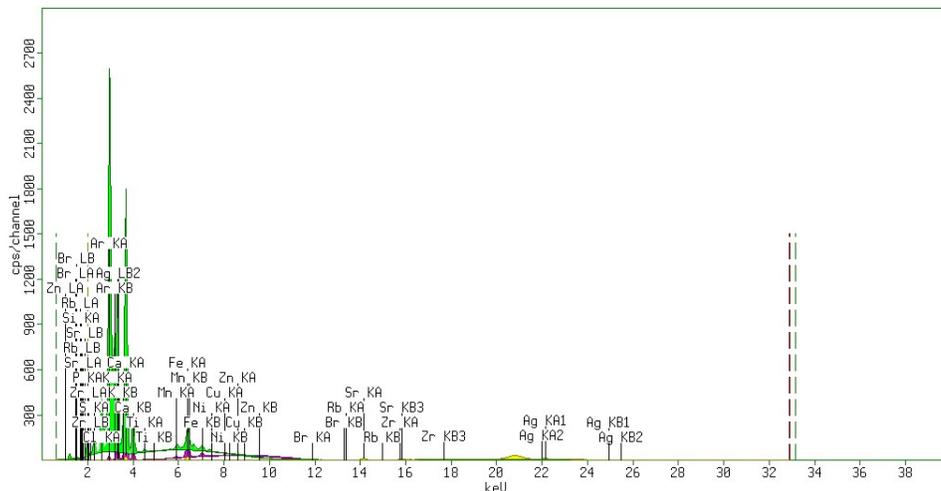


Figure 1: ED-XRF analysis of *Indigofera tinctoria* Linn

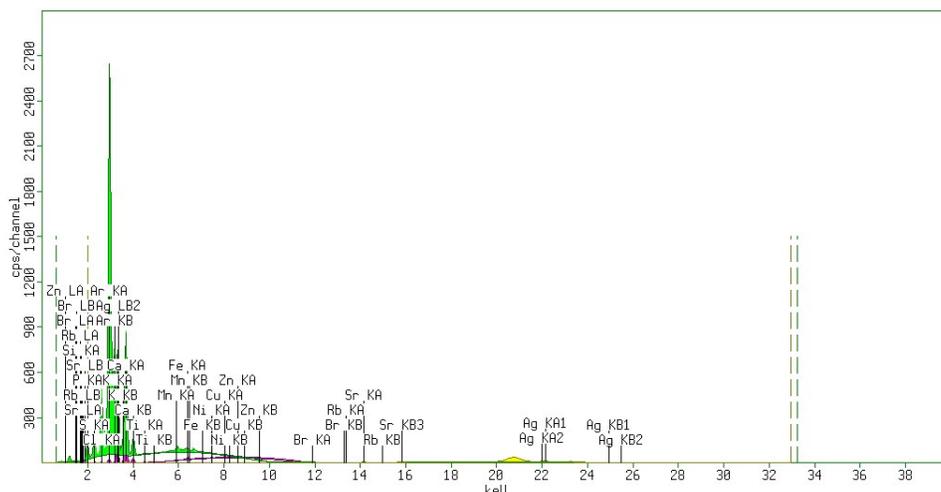


Figure 2: ED-XRF analysis of *Psoralea corylifolia* Linn

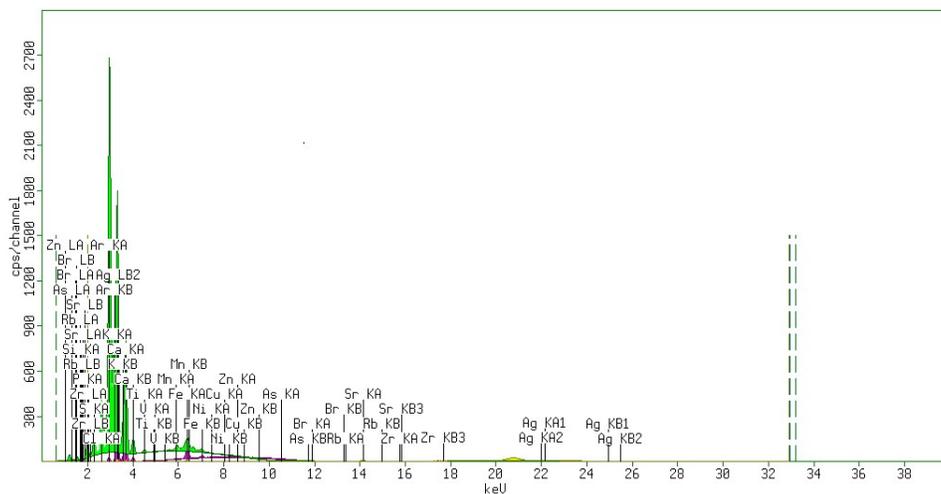


Figure 3: ED-XRF analysis of *Nigella sativa* Linn

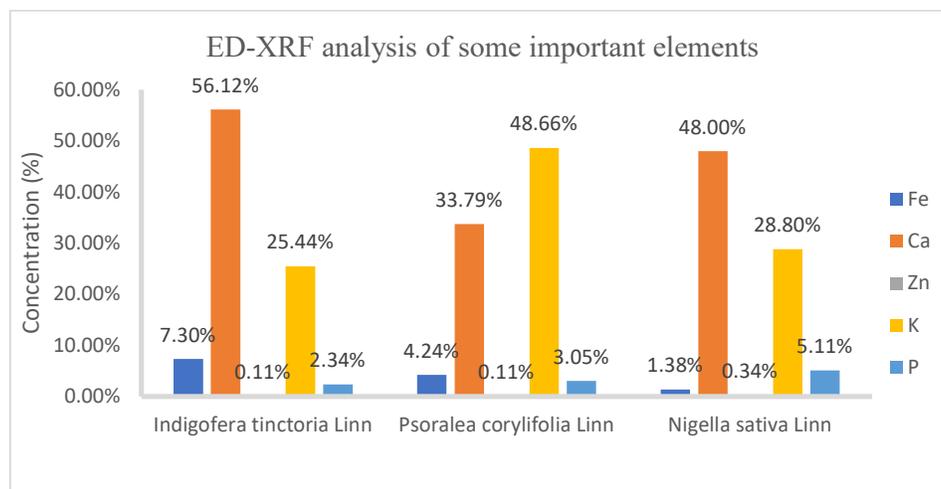


Figure 4: ED-XRF analysis of some important elements

10. RESULTS:

Elemental analysis of *Indigofera tinctoria* Linn. leaves by ED-XRF technique has been confirmed the presence of pharmaceutically active, major, minor, and trace elements. The results of elemental analysis were recorded in **Table 4**, which revealed presence of Si (0.489 %), P (2.342%), S (1.953 %), Cl (3.690 %), K (25.441 %), Ca (56.118 %), Ti (0.898 %), Mn (0.728 %), Fe (7.299 %), Ni (0.032 %), Cu (0.046 %), Zn (0.107 %), Br (0.025 %), Rb (0.028 %), Sr (0.194 %). Hazardous metals such as Be, Ag, Sn, Ba, Pb, and Bi were discovered to be completely absent in *Indigofera tinctoria* Linn. leaves.

Elemental analysis of *Psoralea corylifolia* Linn seeds by ED-XRF technique has been confirmed the presence of pharmaceutically active, major, minor, and trace elements. The results of elemental analysis were recorded in **Table 4**, which revealed

presence of Si (0.118 %), P (3.046 %), S (2.903 %), Cl (4.741 %), K (48.66 %), Ca (33.786 %), Ti (0.967 %), Mn (0.520 %), Fe (4.244 %), Ni (0.035 %), Cu (0.071 %), Zn (0.108 %), Br (0.017 %), Rb (0.020 %), Sr (0.088 %). Hazardous metals such as Be, Ag, Sn, Ba, Pb, and Bi were discovered to be completely absent in *Psoralea corylifolia* Linn. seeds.

Elemental analysis of *Nigella sativa* Linn. seeds by ED-XRF technique has been confirmed the presence of pharmaceutically active, major, minor, and trace elements. The results of elemental analysis were recorded in **Table 4**, which revealed presence of Si (0.183%), P (5.109 %), S (4.522 %), Cl (9.212 %), K (48.796 %), Ca (47.998 %), Ti (0.494 %), Mn (0.594 %), Fe (1.384 %), Ni (0.045 %), Cu (0.106 %), Zn (0.335 %), Br (0.012 %), Rb (0.052 %), Sr (0.101 %). Hazardous metals such as Be, Ag, Sn, Ba, Pb, and Bi were discovered to

be completely absent in *Nigella sativa* Linn. seeds.

11. DISCUSSION:

In comparison to other trace elements found, analysis of the current data showed that Fe was present in all of the medicinal plants examined at a sufficient concentration. Of the examined medicinal herbs, *Indigofera tinctoria* Linn. had the highest Fe concentration.

The formation of haemoglobin and the oxygenation of red blood cells both depend on the trace element Fe. Along with energy generation, it is required for a strong immune system.

Since Fe has a significant impact on immunological function, the traditional medical system may base its use of medicinal plants to treat skin conditions on the levels of Fe found in the plants.

Furthermore, Mn is an essential trace element in the immune system for controlling the body's immunological reactions as a result of the digestion of amino acids, the creation of energy, and the consumption of food.

Moreover, Mn is an important factor of the mitochondrial antioxidant defence system and the metalloenzyme manganese superoxide dismutase, which protects against free radicals that are produced by damaged cells and are bad for the skin.

For the body's metabolic reactions to take place and be properly metabolized, Zn is a

crucial ingredient. By regulating enzymes involved in cell renewal in our bodies, it is a component of both plant and mammal tissue and is crucial in keeping good epidermis. *Nigella sativa* Linn, with a Zn content of 0.335%, had the greatest level of any of the medicinal plants under study. So, it is clear how these medicinal plants might be used in the conventional medical system to address skin conditions.

Cu is well known for boosting immune function to fend off illness, helping to restore damaged tissues, and accelerating the recovery process. Cu also contributes to the cross-linking of collagen and elastic, which are necessary for the development of connective structures. Due to the fact that Cu effects our immunity and has anti-infectant qualities, all of the plant samples examined contained the highest concentration of Cu, supporting their use in the treatment of skin disorders by conventional medical practitioners. Additionally, the V protein has a specific purpose that is crucial to the management of diabetes, namely the defence of tissues from harm.

In the current research, Cu was discovered to be present in different amounts in all of the samples of medicinal plants, ranging from 0.046% to 0.106%, with the *Nigella sativa* once again having the greatest content of Cu.

In this research, the elemental makeup of all the chosen plants was traced using the ED-

XRF method. It is obvious that the components found in the plant samples contributed directly or indirectly to the prevention and therapy of skin problems and diseases. The current study's findings point to the conventional medical system's use of therapeutic plants for treating skin conditions because those plants were found to contain sufficient amounts of Fe, Zn, Cu, and Mn.

12. CONCLUSION:

The goal of the study is to use an ED-XRF spectrometer to examine trace elements found in specific medicinal plants and determine their elemental concentrations.

The medicinal plants chosen for this research contain trace elements in varying amounts in all three plants. According to popular belief, the different trace elements found in plants are crucial in the treatment of skin conditions and other illnesses. The variation in the amounts of these compounds is primarily due to the changes in structure, as well as type of the soil, age of the plant, environmental variables, and watering facilities given to the plants.

On the other hand, medicinal plant preparations have a therapeutic effectiveness comparable to that of standard treatments for dermal illness without any of the adverse effects.

To fully comprehend the connection between skin illnesses and trace elements, more study is necessary. The study's final

finding was that the material will be very helpful for the scholar who wishes to pursue research in the field of herbal remedies. Additionally, it has been discovered that certain therapeutic plants do not contain excessive amounts of poisonous substances and are therefore safe for human consumption.

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AUTHOR'S CONTRIBUTIONS:

The ED-XRF analytical results were analysed and explained by Dr. Yelmate A.A. Writing the manuscript and performing the study were significant contributions made by Kadam K.B., Sabne A.A and Eklinge S.S. The final manuscript was reviewed and authorised by all authors.

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PLANT AUTHENTICATION:

The plant parts were identified by Dr. C.S. Swami, Department of Botany, Dayanand science college, Latur. Deposition numbers for the herbarium of these samples were not given so it is not available.

ABBREVIATIONS:

ED-XRF -Energy Dispersive X-ray Fluorescence

Si – Silicon, P – Phosphorus, S – Sulfur, Cl – Chlorine, K – Potassium, Ca – Calcium, Ti

– Titanium, Mn – Manganese, Fe – Iron, Ni
– Nickel, Cu – Copper, Zn – Zinc, Br –
Bromine, Rb – Rubidium, Sr - Strontium

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