

Characterization of Traditionally Useful Herbal Mineral from *Ficus benghalensis* Leaves for Skin Disorders

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Saravanan *et al.*: Characterization of Mineral of *Ficus benghalensis* Leaves

Ficus benghalensis is remarkable tree native to India. It is commonly known as banyan tree. It contributes to business, religious and medicinal purposes. The classical literature of Siddha system of Indian medicine depicts the use of ashes of its leaves especially yellow matured leaves to heal the various ailments like skin diseases, chronic diseases etc. The ash obtained from matured yellow leaves of *Ficus benghalensis* mixed with sesame oil is used in the treatment of skin disorders as per Siddha system of Indian medicine. Hence an attempt was made to analyse the ash of *Ficus benghalensis* in both yellow matured as well as green leaves for exploring the mineral constituents through instrumental characterization such as scanning electron microscopy energy dispersive spectrometry, X-ray fluorescence spectrometry, powder X-ray diffractometry and inductively coupled plasma-optical emission spectroscopy. In this study, the presence of various elements such as calcium and potassium as major elements, magnesium, sodium, iron, boron, zinc and copper as minor elements were detected in the ash of leaves of *Ficus benghalensis*. Ashes of both green and yellow leaves of *Ficus benghalensis* have minor variations in the contents of mineral composition.

Key words: *Ficus pubescens*, *Ficus banyana*, *Ficus contonifolia*, aalamaram, elemental analysis, eczema

From the ancient times of human existence, man adopted several plants for diverse applications like food, medication, other livelihood etc. Plants participates significant part in the development of human cultures around the whole world. There are various varieties of plants and trees with enormous medicinal properties. Indian and other ancient civilization were using these plants for curing and treating various diseases and ailments. Medicinal plants are the backbone of traditional medicine because they are rich sources of therapeutic value which can be used in drug development. India is known as medicinal garden of world. It has rich diversity of plant species in wide range of ecosystems. In India, these medicinal plants are used by both tribal communities and traditional system of medicines for healing practices. The rise of knowledge to cure diseases results generation of new plant derived drugs^[1]. India is one of the biggest 17 mega biodiversity countries in the world. It has 15 000-20 000 plants having medicinal values in 45 000 plant species^[2]. In 1996, United Nations Educational, Scientific and Cultural Organization (UNESCO) has declared that most developing

countries use medicinal plants and traditional medicines for good health maintenance. India has widely accepted traditional medicinal systems, viz., Ayurveda, Siddha, Unani, Homeopathy, Yoga and Naturopathy^[3].

Ficus benghalensis (*F. benghalensis*) Linn is commonly known as banyan, banyan fig and Indian banyan tree. It is a huge tropical, deciduous, evergreen tree and belongs to Moraceae family. *Ficus pubescens* (B. Heyne ex Roth), *Ficus banyana* Oken, *Ficus contonifolia* stokes are synonyms of *F. benghalensis*. It is commonly known as Baragad and Bad in Hindi, Peraal in Malayalam, Aalamaram in Tamil, Marri in Telugu. *F. benghalensis* is fast growing, evergreen tree found in monsoon and rain forests; grows upto 3 m, with spreading branches and many aerial roots. Leaves are stalked, ovate, cordate, 3-nerved, when young, they are downy

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on both sides. The petiole bears a large, smooth, greasy gland at the apex and is compressed and fuzzy. The fruit occurs in auxiliary pairs, each the size of a cherry, sound and downy. It grows from low altitudes to 2000 ft (600 m). It develops propagating roots, which reach the ground and become woody trunks. A very large branching tree reaching a height of 20 m or more with a stout trunk and with numerous aerial roots arising from horizontally growing branches, several of which reach the soil^[4,5]. It is native to Indian sub-continent and widely distributed in Southeast Asia and South China. The tree is considered as sacred as a symbol of peace and harmony. It is harvested from wild for timber, ornamental in roads and gardens and medicinal uses. It is planted for soil conservation and is suitable for paper pulp. The timber is utilized for well-curbs, furniture, etc.^[6]. Plants need 17 essential macronutrients and micronutrients for plant growth and metabolism. They were carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, sulfur, calcium, magnesium, boron, chlorine, copper, iron, manganese, molybdenum, nickel and zinc^[7].

All parts of FB are astringent, acrid, sweet, refrigerant, anodyne, vulnerary, depurative, anti-inflammatory, ophthalmic, styptic, anti-arthritic, diaphoretic, antidiarrheal, antiemetic and tonic^[8]. The aerial roots are useful in obstinate vomiting, leucorrhoea and osteomalacia of limbs. The bark is useful in burning sensation, hemoptysis, hemorrhages, diarrhea, dysentery, diabetes, enuresis, ulcers, skin diseases, gonorrhoea, leucorrhoea and hyperplasia. Leaves are good for ulcers, leprosy, allergic conditions of skin and applied hot as poultice for abscesses. The apical buds are useful in diarrhea and dysentery. The fruits and seeds are refrigerant and tonic. Latex is externally applied for pains, bruises and useful in rheumatism, lumbago, nasal inflammation, bleeding and inflammations of gums, hemorrhoids, gonorrhoea, inflammations, cracks of sole and skin diseases^[9].

Ash is the amorphous powder of inorganic components after the combustion of plant material. Ash is composed of many major and minor elements which plants need for growth. Most of elements are extracted from the soil and atmosphere. The ash was used mainly to produce potash for fertilizer industry. Ash consists of many inorganic minerals. Traditionally wood ash is used in fertilizers,

composts, pottery, soaps, bio-leaching and food preparation. It is necessary for the maintenance of certain physicochemical processes which are essential to life. They are required for a variety of biochemical and physiological functions such as enzyme action, nerve impulse transmission and muscle contraction.

Unlike carbohydrates, fats and proteins, minerals don't furnish energy but they influence the rate of biochemical reactions through enzymes. The minerals required in human nutrition broadly are classified into two groups as macro elements and micro elements. The macro-minerals contain calcium, phosphorus, sodium and chloride, while the micro-elements contain iron, copper, cobalt, potassium, magnesium, iodine, zinc, manganese, molybdenum, fluoride, chromium, selenium and sulphur^[10]. The macro-minerals are required in amounts >100 mg/dl and the micro-minerals are required in amounts <100 mg/dl^[11].

In addition to physiological functional uses of the minerals, some medicinally therapeutic usages are mentioned in Siddha system of Indian medicine. The ashes of matured yellow leaves of *F. benghalensis* is mentioned for the treatment of eczema^[12]. The skin is the body's largest organ which participates in sensitivity and offers protection against microorganisms, chemicals and Ultraviolet (UV) radiation. Consequently, the skin may suffer alterations such as photo-ageing, immune dysfunction and inflammation which may significantly affect human health^[13]. Eczema is an umbrella term which includes several skin disorders such as dark colored patches, rough, scaly, leathery patches, swelling, crusting and oozing. It is an itchy, inflammatory skin condition with a predilection for the skin flexures^[14]. In this communication, the authors attempted to characterize the mineral composition of the ash of matured yellow leaves of *F. benghalensis*, which is specifically mentioned to cure eczema in the Siddha system of medicine and as well as the matured green leaves.

MATERIALS AND METHODS

Plant collection and preparation of ash:

Matured green leaves and yellow leaves of *F. benghalensis* were collected from natural habitats in Arumbakkam region of Chennai in the months of December and February 2018 respectively.

They were dried at room temperature and roughly powdered. According to traditional systems of Indian medicine, earthen pots are used for burning purposes. Hence, the coarse powder of *F. benghalensis* Green Leaf (FBGL), *F. benghalensis* Yellow Leaf (FBYL) were taken in earthen pot and kept in muffle furnace maintained at 600° till ash becomes carbon free. Then they were cooled in desiccator, stored in air tight containers and labeled as FBGLA, FBYLA for further analysis and chemical characterization.

Characterization techniques:

Surface morphology and elemental composition and mapping were obtained by Field Emission Scanning Electron Microscopy (FE-SEM) attached to Energy Dispersive X-ray spectrometry (EDX). The mineral compositions were determined using X-ray Fluorescence spectrometer (XRF), Powder X-ray Diffractometer (PXRD) and Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES).

SEM:

FE-SEM (TESCAN-MIRA 3XMU, Czech Republic) was used the present study. The material was mounted directly on stubs using double-side adhesive tape and sputtered with a thin layer of gold in a fine coater. The electron micrographs were obtained at 15 kV, with an integrated digital image acquisition system.

EDX:

The elemental analyses were obtained by an Energy Dispersive Spectrometer (EDS, TESCAN-MIRA 3XMU, Czech Republic). The Instrumental parameters: Voltage was 10 kV, magnitude was 386, take off was 3 s and live time was 81.9 s, amplitude time was 3.84 s and resolution was 27.4 eV, for FBYLA sample the set magnitude was 570.

XRF:

The measurements were performed XGT-2700 X-Ray analytical microscope (Horiba, Japan) with X-Ray tube and Rh-anode. The tube voltage and current were 50 kV and 1 mA, respectively. High purity silicon detector (xerophyte) capable of detecting sodium to uranium (atomic numbers 11-92) was used. Range of Charge-Coupled Device (CCD) camera was magnification 30 and 100 approximately which can analyze varied type of samples like metal plates, powders and coatings. Instrumentation parameters were fixed. Live time

was 60 s, processing time was p3, XGT diameter is 10 μm. The X-ray tube voltage was 50 kV, current was 1.000 mA, X-ray filter and cells were nonexistence and quantification correlation was standardless.

PXRD:

Powder diffraction data was collected by Aeris analytical diffractometer with Ni-filtered copper radiation, in Bragg-Brentano (BB) geometry with the sample prepared in thin layer on a silicon zero-background holder. 1 g of each sample was taken and powdered in Agate mortar to very fine powder. PXRD patterns were scanned in the range $2\Theta=10-100^\circ$ with a step size of 0.01° and 40 s per step. The analytical high score plus software suite was used for data treatment.

ICP-OES:

In this study, the wet digestions of the samples were performed using a laboratory microwave digester with 40 closed vessels (Mars 6, CEM, United States of America (USA)). An inductively coupled plasma optical emission spectrometer (Agilent, Model 720 series, Santa Clara, California, USA) was used for the determination of elements present in the samples FBGLA and FBYLA. The gas employed was argon with 99.99 % purity. For sample preparation, the method of EPA 3050B was followed.

About 0.5 g sample was accurately weighed and taken with 10 ml con. HCl and 10 ml con. HNO_3 . Then the solution was kept on laboratory microwave oven. Further 10 ml of con. HCl added for complete digestion. Finally the solution was filtered through Whatman no.1 filter paper. The filtrate solution was made-up to 250 ml in a standard measuring flask. The solution was taken to instrumental analysis.

RESULTS AND DISCUSSION

SEM-images a sample by scanning it with a high-energy beam of electrons. The electrons interact with the atoms that frame the sample producing signals that contain information about the sample's surface topography, composition. SEM is used across a number of commercial, industrial and research applications. From cutting edge production processes to forensic applications, there's a diverse range of practical applications for the modern SEM^[15].

The morphology of FBGLA and FBYLA were observed by FE-SEM and are shown in fig. 1. The images showing non-crystalline amorphous structure present in the ash were non-uniform in the nature. From FE-SEM image it is clear that both FBGLA and FBYLA were amorphous granular in nature.

The EDX technique is non-destructive and specimens of interest can be examined *in situ* with little or no sample preparation^[16]. The technique measure qualitative, semi-quantitative, quantitative and also provide spatial distribution of elements through mapping. The EDX spectrum was

recorded to determine the chemical composition of the FBGLA and FBYLA (fig. 2). The content of carbon in FBGLA is 6.3 times greater than in FBYLA, content of oxygen in FBGLA is 1.13 times lesser than in FBYLA, content of magnesium in FBGLA is 1.1 times lesser than in FBYLA, content of aluminum in FBGLA is 1.51 times lesser than in FBYLA, content of silicon in FBGLA is 1.72 times lesser than in FBYLA, content of chlorine in FBGLA is 1.33 times greater than in FBYLA, content of potassium in FBGLA is 1.63 times greater than in FBYLA, and content of calcium in FBGLA is 1.48 times lesser than in FBYLA (fig. 2).

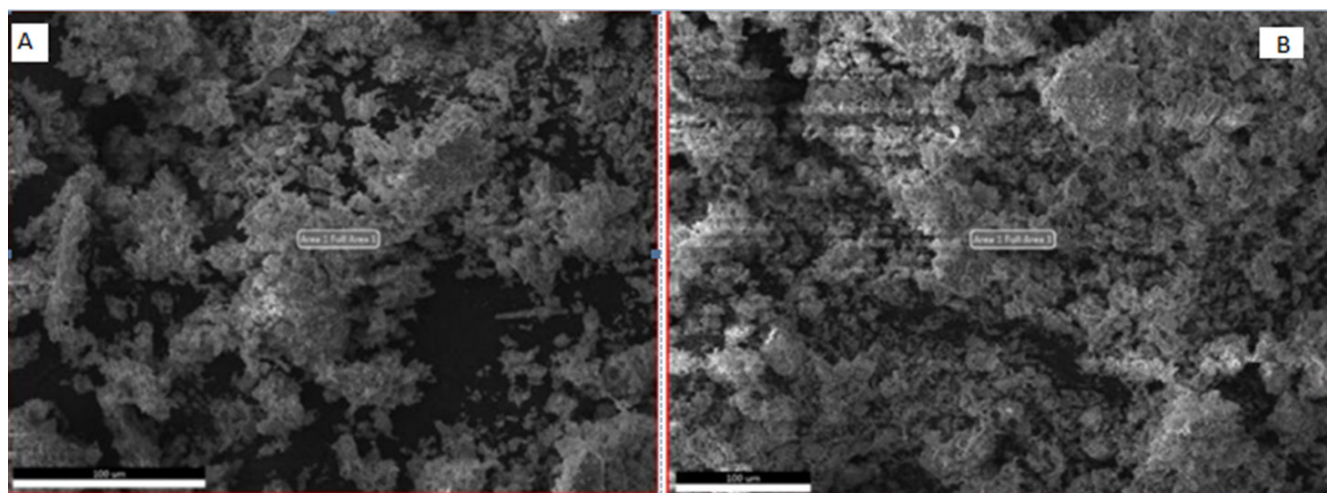


Fig. 1: SEM images-(A) FBGLA;(B) FGYLA

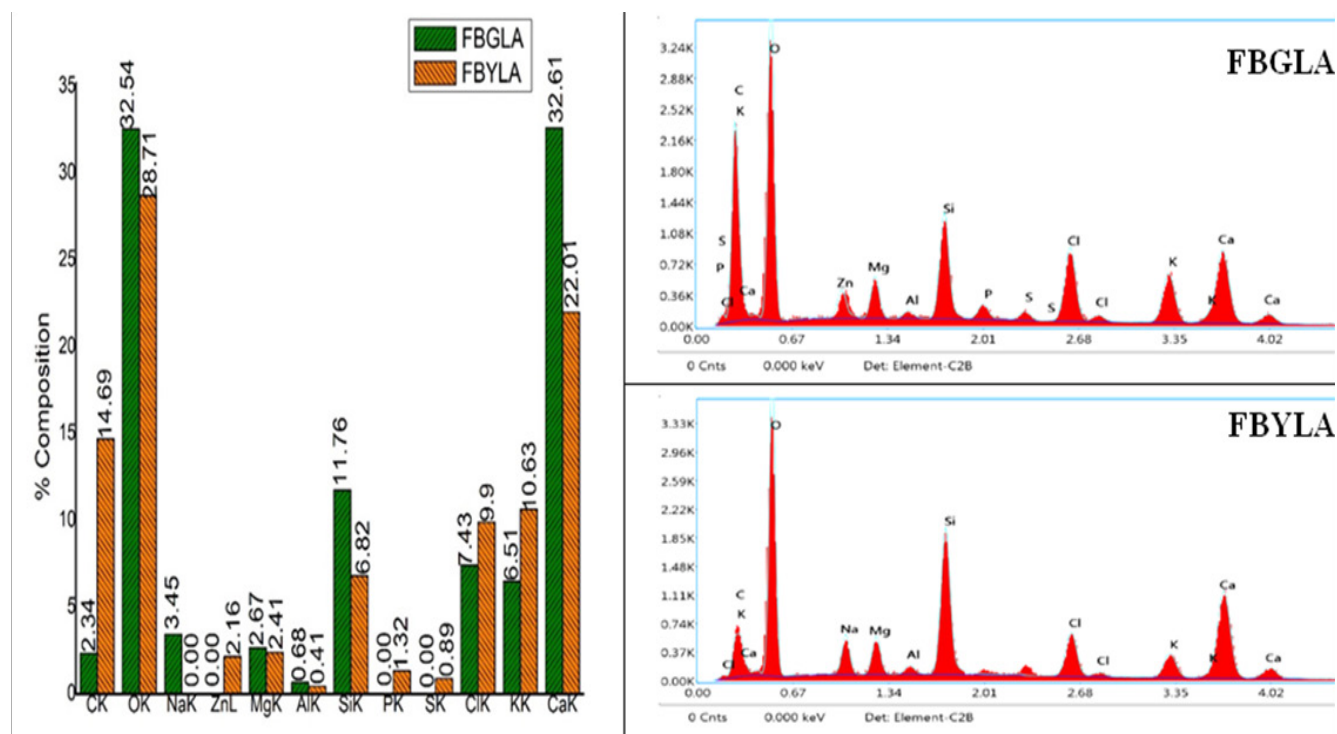


Fig. 2: Elemental composition and graph of EDX

The XRF findings revealed the presence of silicon, sulphur, potassium, calcium, iron, strontium and palladium. In this exploration, the weight percentage of calcium was found to be higher in FBYLA (77.87 %) than FBGLA (65.43 %). Similarly, the weight percentage of silicon was higher in FBYLA (4.74 %) than FBGLA (3.58 %). The content of potassium and iron in FBGLA were 26.25 % and 4.76 % which were higher than the content of potassium (12.74 %) and iron (3.40 %) in FBYLA. The content of silicon in FBGLA is less than 1.33 times in FBYLA, content of potassium in FBGLA is greater than 2.06 times in FBYLA, content of calcium in FBGLA is less than 1.21 times in FBYLA, and content of iron in FBGLA is 1.4 times greater than in FBYLA. The XRF results conclude that both samples FBGLA and FBYLA were rich in calcium and potassium. The calcium content in FBYLA was slightly higher than FBGLA, contradictorily the potassium content in FBGLA was slightly higher than FBYLA. The identified elements are presented in fig. 3.

The peaks of the FBGLA and FBYLA were matched with the standard constituents through Inorganic Crystal Structure Data (ICSD). In FBGLA, strong peaks showing high intensities at 2θ angles of 28.3090, 29.3658 and 40.4824 were recorded (fig. 4). Several intermediate and small peaks, displaying low intensities, were recorded at 2θ angles of 23.0290, 31.6408, 35.9601, 39.3986,

43.1453, 47.4681, 48.4701, 48.4701, 50.1469, 66.4042, and 73.7168. PXRD results show the presence of elements such as Ca, K, Cl, C and O in the form of calcite (CaCO_3) (98-002-0179), sylvite (KCl) (98-024-0519) and halite (NaCl) (98-024-0599). FBGLA contains CaCO_3 (50 %), KCl 45 % and halite (5 %).

In FBYLA, strong peaks screening high intensities at 2θ angles of 28.3146, 29.3589 and 31.6568 were recorded. Some intermediate and small peaks screening low intensities at 2θ angles of 23.0293, 35.9361, 39.3733, 40.4761, 43.1529, 47.4692, 48.4666, 50.1347, 56.4733, 57.3737 and 60.7018 were recorded. The major peak corresponds to CaCO_3 , KCl and NaCl and their percentages are 73 %, 15 % and 12 % respectively. The content of calcium in FBGLA is 1.46 times lesser than in FBYLA, content of potassium in FBGLA is 3 times greater than, and content of sodium in FBGLA is 2.4 times lesser than in FBYLA.

ICP-OES method has the advantages of low cost, rapid analysis, wide linear range, low detection limit and broadly used in simultaneous determination of multi-elements. In recent years, microwave digestion method has become more common international digestion methods, which has many advantages, such as fast dissolving, good dissolving effect, simple, safe, easy to control, low evaporation losses, multiple samples digestion and good reproducibility^[17](fig. 5).

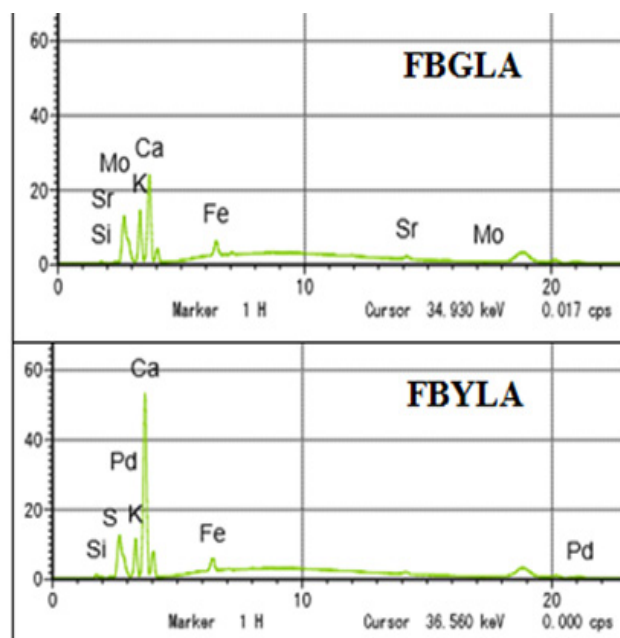
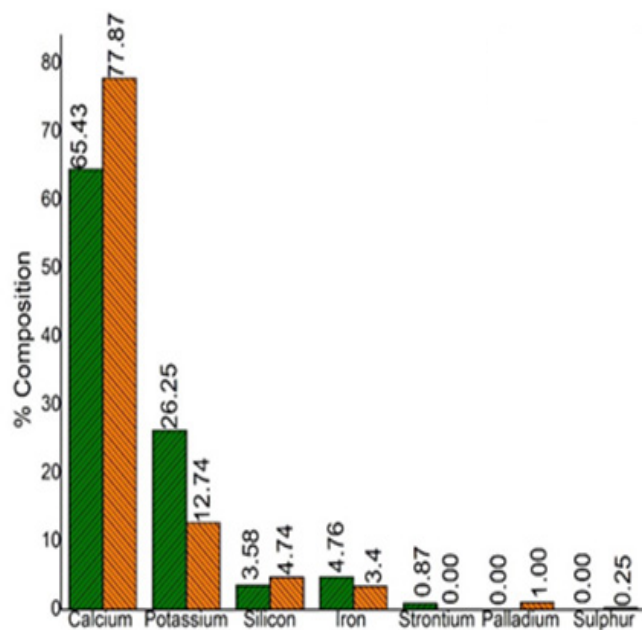


Fig. 3: Graphical representation of elemental composition by XRF
Note: (■) FBGLA and (▨) FBYLA

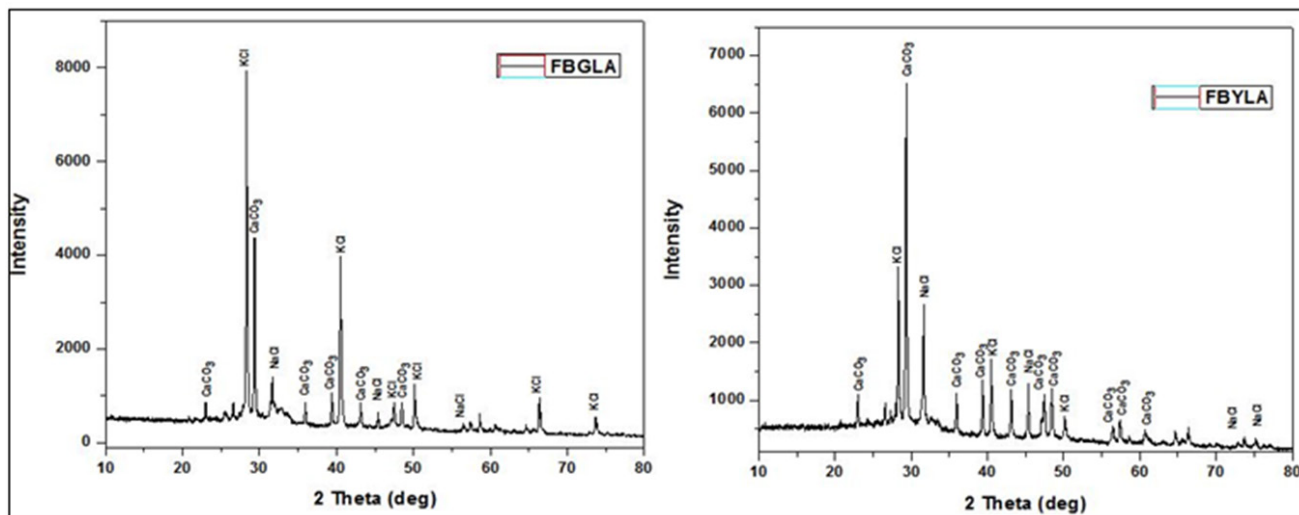


Fig. 4: PXRD pattern

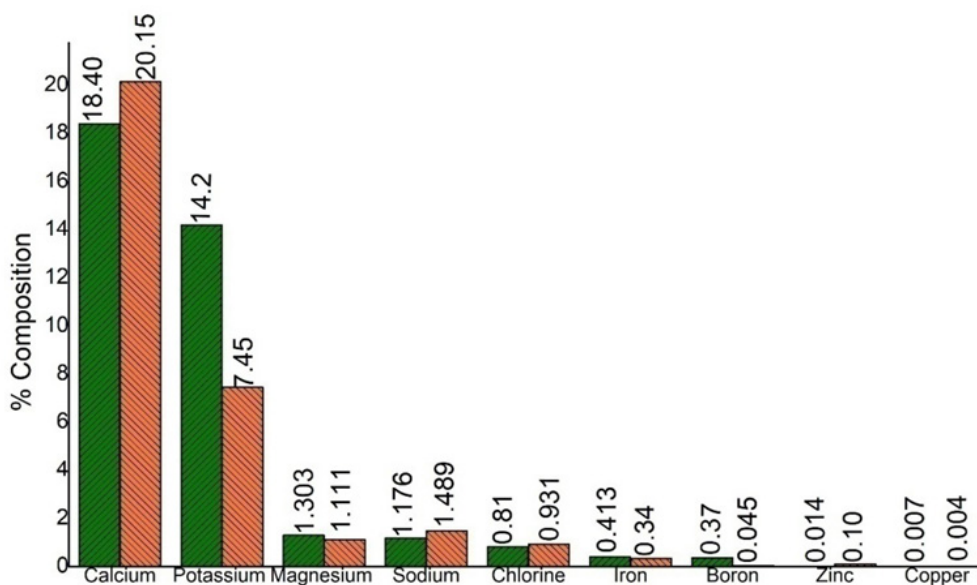


Fig. 5: Graphical representation of elements estimated by ICP-OES

Note: (■) FBGLA and (■) FBYLA

The ICP-OES results showed the presence of boron, copper, iron, calcium, magnesium, potassium, sodium, chlorine and zinc. The elements calcium, potassium, sodium and magnesium were present in major quantities than boron, copper, iron, chlorine and zinc. The content of boron in FBGLA is 1.22 times less than in FBYLA, content of copper in FBGLA is 1.75 times greater than in FBYLA, content of iron in FBGLA is 1.22 times greater than in FBYLA, content of calcium in FBGLA is 1.1 times less than in FBYLA, content of magnesium in FBGLA is 1.17 time greater than in FBYLA, content of potassium in FBGLA is 1.91 times greater than in FBYLA, content of sodium in FBGLA is 1.27 times less than in FBYLA, content of chlorine in FBGLA is 1.15 times less than in

FBYLA, and content of zinc in FBGLA is 7.14 times less than in FBYLA.

FE-SEM images showed non-crystalline amorphous structures which were non-uniform in the nature. EDX results (fig. 2) showed that main elements in the test samples were carbon, oxygen, zinc, magnesium, aluminium, silicon, phosphorous, sulphur, chlorine, potassium and calcium. Here 1.32 % of phosphorous was identified in FBYLA but not in FBGLA. Phosphorus is an essential element of biological systems. It is part of the genetic material and the phosphate ester bond is universally used for energy transfer reactions in organisms. It is the second most abundant mineral in the body. It is present in each cell of the body. Most of the phosphorus is present in the bones

and teeth. Phosphorus also helps the body to make Adenosine Triphosphate (ATP), a molecule the body uses to store energy, kidney function, muscle contractions, normal heartbeat and nerve signaling^[18].

XRF results showed that potassium and calcium were present in higher quantities and can be called as the macro nutrients and all other elements can be recorded as micro nutrients. These micro nutrients, viz., silicon, sulphur, iron, strontium also play significant roles in the maintenance of human health.

Silicon serves as bioactive valuable element. It is highly abundant in soil and occurs in all organisms including plants and humans. Bioavailability of silicon in human diet strengthens bones and improves immune response, as well as neuronal and connective tissue health^[19]. Sulphur is required for all living organisms. The most important sulfur-containing organic compounds include the amino acids (cysteine, cystine and methionine which are components of proteins), the vitamins (thiamine and biotin), the cofactors lipoic acid and coenzyme A, certain complex lipids of nerve tissues (sulfatides), components of mucopolysaccharides, the sulfated polysaccharides, various low molecular-weight compounds, such as glutathione and the hormones vasopressin and oxytocin^[20]. Potassium is necessary for the function of all living cells present in all plant and animal tissues. Potassium is the main intracellular ion for all types of cells, while having a major role in maintenance of fluid and electrolyte balance^[21]. Calcium plays diverse activities in biology such as muscle contraction, microtubule formation, hormonal responses, exocytosis, fertilization, neurotransmitter release, blood clotting, protein stabilization, intercellular communication, mineralization, cell fusion, adhesion, and growth^[22]. Iron is an essential element for approximately all living organisms as it participates in a wide variety of metabolic processes, including oxygen transport, Deoxyribonucleic Acid (DNA) synthesis and electron transport^[23]. Strontium is absorbed by the human body in the place of calcium and in case of bone growth problem due to their chemical similarity and insignificant health threat of strontium^[24]. PXRD results suggest that FBGLA and FBYLA comprise mainly CaCO₃ and KCl. Previously, similar study reported the presence of sylvine, silica, dolomite in *Solanum surrrentence*

fruit^[25], halite, sylvine, CaCO₃ and silica in *Datura metel* whole plant^[26], CaCO₃, sylvine and dolomite in *Strychnos nux-vomica* nuts^[27].

In ICP-OES exploration, the weight percentage of calcium was found to be higher in FBYLA (20.15 %) than FBGLA (18.40 %). Similarly weight percentage of sodium was higher in FBYLA (1.489 %) than FBGLA (1.176 %). The contents of potassium in FBGLA were 14.20 % which is higher than the content in FBYLA (7.445 %). Minimal amounts of sodium, magnesium, boron, copper and iron were identified. These nutrients partake applications in biological systems. Boron is an essential element for plants, human and animal health. Boron has a wide range of physiological effects on biological systems at low concentrations, whereas it is toxic too at high concentrations. It has roles in steroidal hormone metabolism, healthy bone development and cell membrane maintenance^[28]. Copper is an important mineral, human body contains 75-100 mg of copper. It present in each tissue of the body, majorly in the liver, with less amounts found in the brain, heart, kidney, and muscles^[29]. Magnesium is an essential element in biological systems. It plays essential role in biological activity of ATP and drug binding. It is present in chlorophyll, enzymes, nucleic acids, cell membrane walls and proteins. In human health, it helps to nerve conduction, hypertension, diabetes and glucose tolerance^[30]. In humans, sodium plays a key role in the regulation of blood volume, blood pressure, osmotic balance and maintains a constant pH. Sodium ions are primarily found inside the nerve cells of human. They regulate the flow of water across the membrane. They are needed for transport of sugars and amino acids into the cells^[31]. Zinc is essential for many biological functions including DNA synthesis, cell division, gene expression and the activity of many enzymes in biological systems^[31]. Skin is the primary of defense for protecting our bodies against external perturbations, including UV irradiation, mechanical/chemical stress and microbial disease. Nutrition is required for the safeguarding of skin health. An impaired nutritional status, in particular, the importance of micronutrients such as zinc and iron changes the structural integrity and biological function of skin. Skin health measured in cell culture, animal and clinical studies. These micronutrients are working as active compounds in therapeutic agents or treating certain skin diseases and as ingredients

in cosmetic products. Vitamins and minerals from all the forms *viz.*, food, supplement, skin cream, play an integral role in a healthy complexion. The minerals such as zinc, magnesium, iron, calcium promote healing of skin diseases^[32]. Zinc is an essential cofactor of numerous metallo-enzymes. Main function of zinc is to protect the skin against photo damage by absorbing UV radiation and limiting penetration of radiation into skin^[33]. Patients with atopic dermatitis also show a significant decreased level in zinc^[34]. Like vitamins E, C and zinc, peptide copper acts as an antioxidant, protects skin from the damage due to UV radiation^[35]. Copper stimulates the maturation of collagen^[36]. Selenium protects the skin from UV radiation induced oxidative stress^[37]. Selenium used in treatment of psoriasis which shows decreased glutathione peroxides levels^[38].

By comparing the data obtained from XRF, ICP-OES, XRD and EDX, it is found that the content of carbon, phosphorus, sulfur, potassium, iron, copper and strontium in FBGLA > FBYLA, The content of oxygen, zinc, sodium, aluminum, silicon, calcium, boron, and palladium in FBGLA < FBYLA, the content of magnesium in FBGLA > FBYLA according to ICP-OES, the content of magnesium in FBGLA was found to be lesser as measured by EDX. The content of chlorine in FBGLA < FBYLA according to ICP-OES, but it was found to be greater as measured by EDX.

The minerals and nutrients play vital role in skin care treatment in ancient and modern decades. Here scientific characteristic studies of non-destructive electron and X-ray methods delivers the presence of various elements in the ash of both green and yellow leaves *F. benghalensis*. FBYLA CaCO₃ (73 %), KCl 15 % and halite (12 %). FBGLA contains CaCO₃ (50 %), KCl 45 % and halite (5 %). The variations in the content of CaCO₃ and KCl are notable. Efficacy studies on the treatment of eczema is essential in both yellow matured leaves and green leaves to scientifically validate the traditional claim.

Acknowledgments:

Authors are thankful to The Director General, Central Council for Research in Siddha, The Assistant Director I/c, Siddha Central Research Institute for encouragement and support.

Funding:

Funded by Central Council for Research in Siddha under Intra Mural Research Scheme vide sanction no. 457/2016-17 dated 17.01.2017.

Conflicts of Interest

The authors declare no conflict of interest.

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