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Qualitative elemental analysis of some selected antidiabetic medicinal plants of Assam using X-ray Fluorescence (XRF) technique

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ABSTRACT

A large number of medicinal plants are reported to have antidiabetic properties. Trace elements present in those plants are some of the contributing factors of their antidiabetic activities. The present study was conducted to identify the trace and macro-elements in some selected antidiabetic medicinal plants collected from Assam using X-ray Fluorescence (XRF) technique. The data shows the presence of Fe, Zn, Pb, Mg, Cr, Cu, Ni, Mn, Mo, Sr in Aegle marmelos, MussaParadisica, Catharanthusroseus, *Garcinia pedunculataandOcimum sanctum. The results of the study provide justification for the usage of these medicinal plants in the treatment of diabetes, since they are found to contain the elements P, Ca, K and Mg which play a significant role in the management of diabetes.*

Key words: diabetes mellitus, XRF spectra, pancreatic β-cells, insulin, trace element.

INTRODUCTION

It has been found that different metals are very important for the proper functioning of human body. Deficiency of these metal ions causes many ailments.Diabetes mellitushas been found to be associated with abnormalities in the metabolism of some of the elements such as Cu, Zn, Fe, Se, Mg, Cr, V, Ca and K [1,2].

Medicinal plants have played a significant role in the management of diabetes mellitus especially in developing countries. A large amount of nutrients are required for diabetic patients to enhance their biological metabolism in a proper way. Some traditional medicinal herbs available in this region are known to have many essential and nutritional elements. Many important mineral elements remain chelated with organic ligands and thus make them bioavailable to the body systems. The various elements present in these antidiabetic medicinal plants have either direct or indirect role in the control and management of diabetes mellitus, since diabetes is associated with marked alterations in the concentrations of trace elements. Thus deficiency of mineral elements can be overcome by supplementation through consuming antidiabetic medicinal plants [3].

Aegle marmelos (Bael tree) is a medium sized, aromatic tree of Rutaceae family. *Aegle marmelos*has been used in Ayurvedic system of medicine for the treatment of various diseases. The leaves of *A.marmelos*are used in diabetes mellitus [4]. *Musa paradisiaca* (Banana or Kela tree) is a perennial tree like herb of Musaceae family. This tree is cultivated in all parts of India. The green unripe fruit of *Musa paradisiaca* has been reported to have antidiabetic effect [5]. *Catharanthusroseus*of Apocyanaceae family is an evergreen sub shrub or herbaceous plant. The leaf of *Catharanthus roseus* has been used in herbal medicine against Diabetes mellitus [6].*Garcinia pedunculata*is an evergreen tree of Clusiaceae family. Ripe fruit of *Garcinia pedunculata*is traditionally used for treating diabetes and

related symptoms [7].*Ocimum sanctum* (Tulsi) is a medicinal herb commonly grown in India. The leaves of *Ocimum sanctum*is traditionally used in the treatment of Diabetes [8].

The study was designed to characterize the elements in five medicinal plant species traditionally used in the management of diabetes mellitus in Assam namely: *Aegle marmelos, Mussa Paradisica, Catharanthus roseus, Garcinia pedunculata* and *Ocimum sanctum.* X-ray Fluorescence (XRF) has been employed to analyze the elements of these anti-diabetic medicinal plants. Different plant species contain different elements in various concentrations. The variation in elemental concentration is mainly due to the differences in agronomic parameters, as well as in the mineral composition of the soil where the plants are cultivated or naturally grown. Studies on elemental analysis of these plant species grown in this region of Assam has not yet been done systematically. Therefore, we have selected these plant species to study the elemental composition qualitatively.

MATERIALS AND METHODS

Plant materials

For the present study five plant species were selected. Leaves of *Aegle marmelos,* unripefruit of *MussaParadisica,* leaves of*Catharanthusroseus*, ripefruit of *Garcinia pedunculata*and leaves of *Ocimum sanctum* were used for detection of element. These medicinal plants are extensively used as traditional medicine for treatment of *Diabetes mellitus*, by local physicians in the area from where these plants were collected.

Sampling area

The fresh plant materials were collected from local village area of Nalbari district, Assam, located in between 26°N and 27°N latitude and 91°E and 91°47′E longitude during the month of July and November. Preliminary identification and authentication of the plants were done from the Department of Botany, Gauhati University.

Initial preparation of plant materials

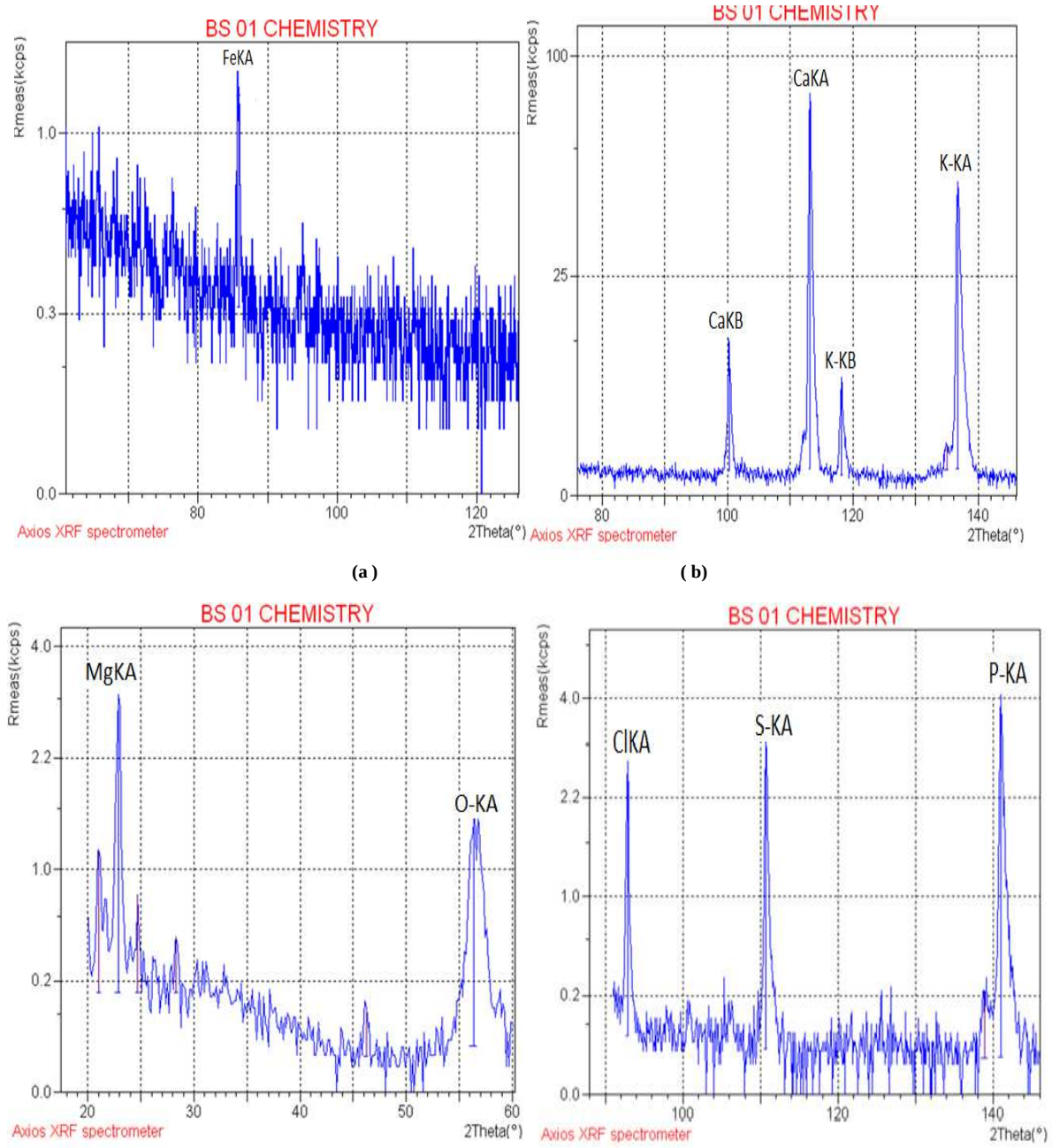
Plant parts collected were fruits and leaves. The leaves as well asmature green unripe fruits of *MussaParadisica*and ripefruit of*Garcinia pedunculata*werecollected. The plant parts were separated and washed thoroughly in running water in order to remove soil, foreign particles and all other surface contamination.The fruits were peeled off. The fruits were cut into small pieces. Then the pieces of the fruits were air dried under shade in the laboratory followed by oven drying at 40^{o}C before grinding. The pieces were mechanically crushed and ground into powder. The leaves were also separately air dried under shade and then ground into powder. The powdered plant materials were kept at room temperature away from direct sunlight in closed dry plastic bags for further analysis.

X-Ray Fluorescence (XRF) analysis

The differentelements present in the selected plants were investigated qualitatively by using X-ray Fluorescence (XRF) technique.XRF is a very useful analytical technique to investigate the chemical composition of different materials. It is also one of the most common methods for qualitative and quantitative determination of elemental composition of all kind of materials. In XRF analysis, the sample is irradiated with an X-ray produced by a source in the instrument. XRF technique was carried out at Department of instrumentation & USIC, Gauhati University. Analysis was done using the instrument computerized sequential X-ray Fluorescence Spectrometer of AXIOS model equipped with X-ray tube of Rh and Flow proportional counter & scintillation as a Detector. Elemental range of the instrument is from Oxygen to Uranium and software used by the instrument is the SuperQ software for qualitative and quantitative analysis and Pro Trace Software for trace element analysis. Analysis methods of the instrument are Pressed Pallet Method and Fused Bead Method.Analysing crystals are LiF200, LiF220,GE,PE andPX1. Standard reference materials are Silicate Rocks and Limestone.

RESULTS AND DISCUSSION

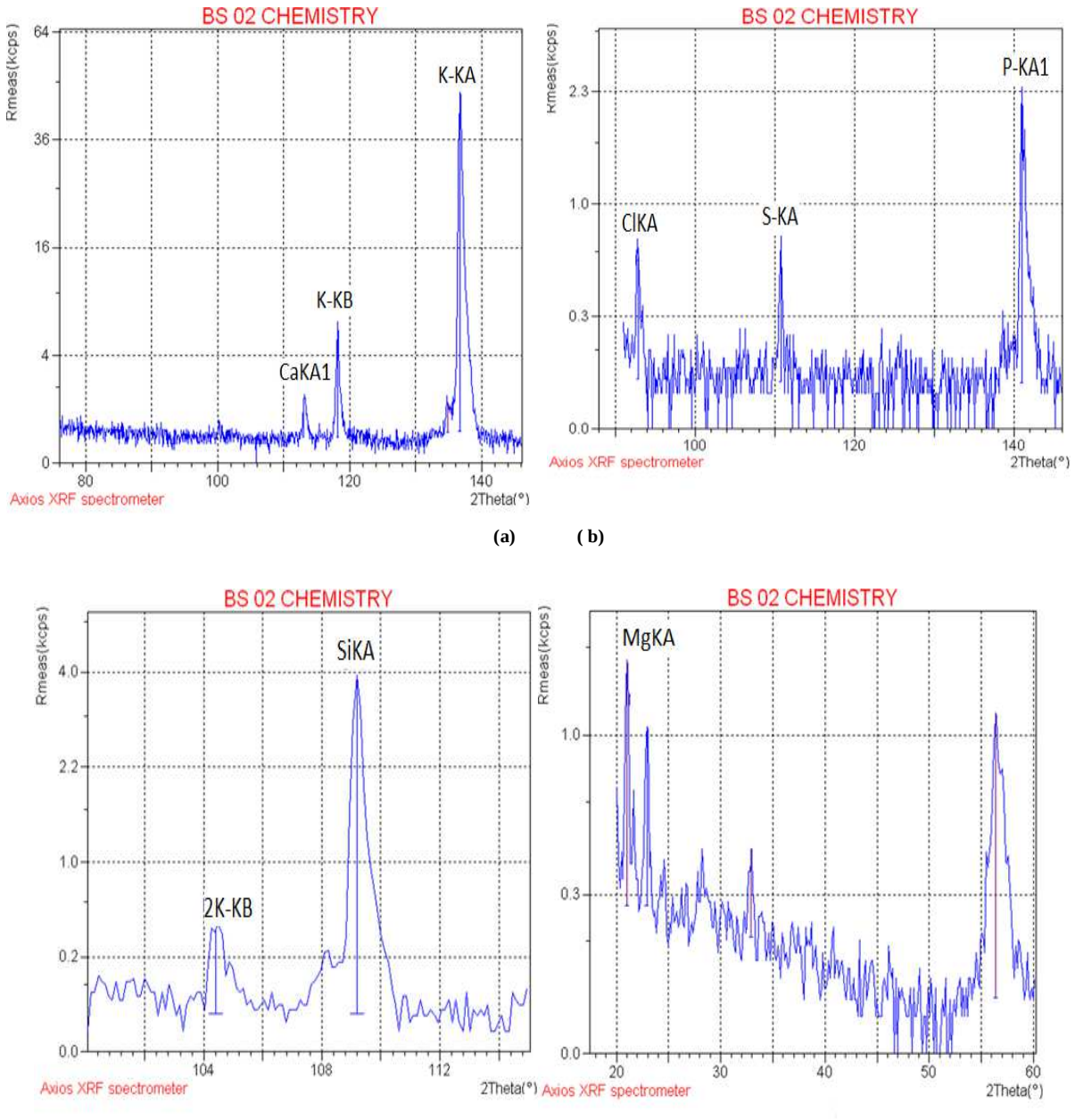
Qualitative elemental analysis of five selected antidiabetic medicinal plants have been done by X-ray Fluorescence (XRF) technique using LiF200, LiF220, GE, PE and PX1 as analysing crystals. The XRF spectras of the studied plants in different analysing crystals are as follows:



(a) **(b)**

(c) **(d)**

Fig1 : XRF spectras of *Aegle marmelos* leaves [(a):UsingLiF220 as analysing crystal, (b):LiF200 as analysing crystal, (c): PX1 as analysing crystal, (d): Ge as analysing crystal.]



(a) **(b)**

(c) **(d)**

Fig2 : XRF spectras of *Mussa Paradisica* unripe fruit [(a): Using LiF200 as analysing crystal, (b): Ge as analysing crystal, (c): PE as analysing crystal, (d): PX1 as analysing crystal.]

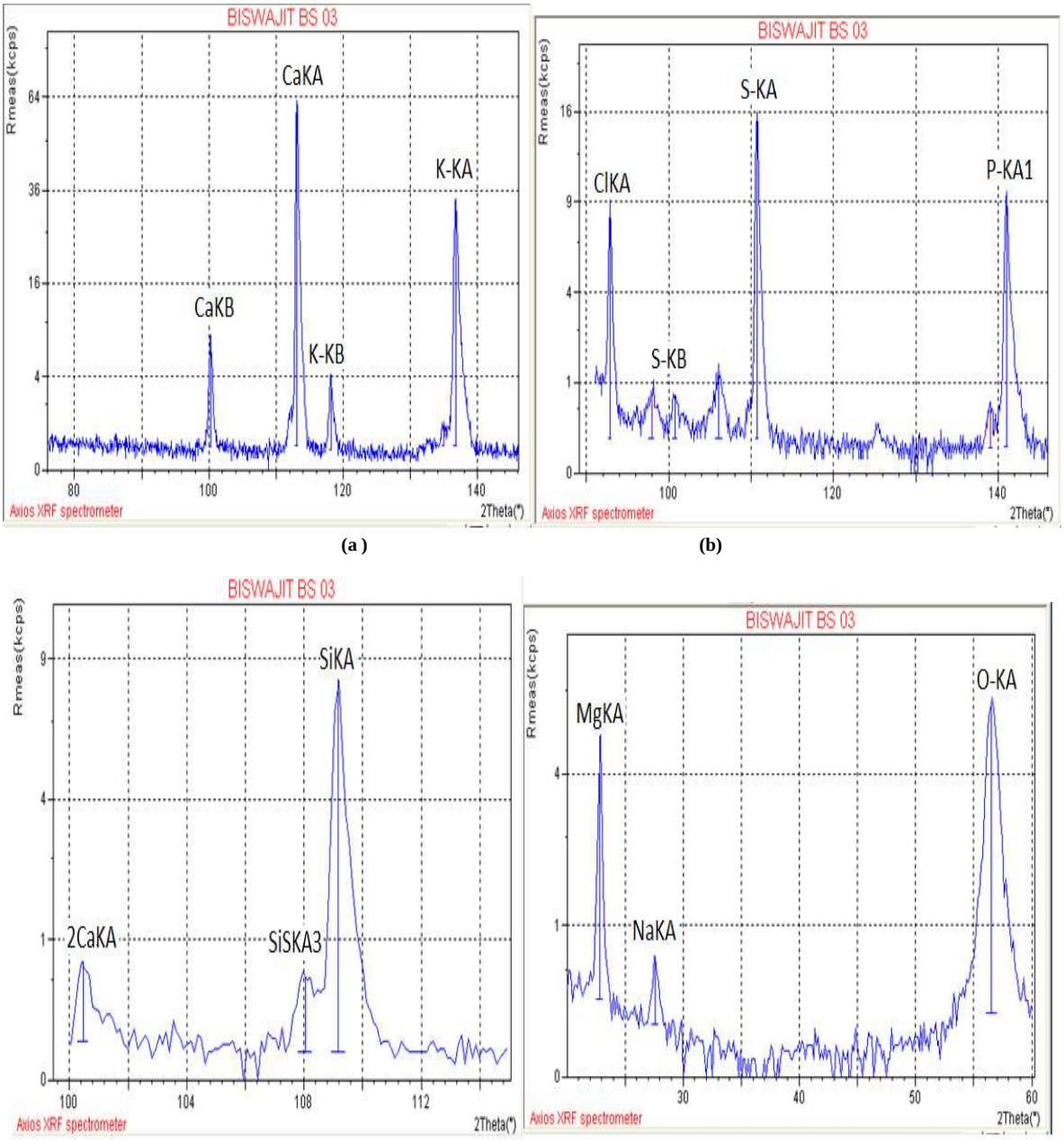


Fig3 : XRF spectras of *Catharanthus roseus* leaves [(a) : Using LiF200 as analysing crystal, (b) :Ge as analysingcrystal, (c) : PE as analysing crystal, (d) : PX1 as analysing crystal.]

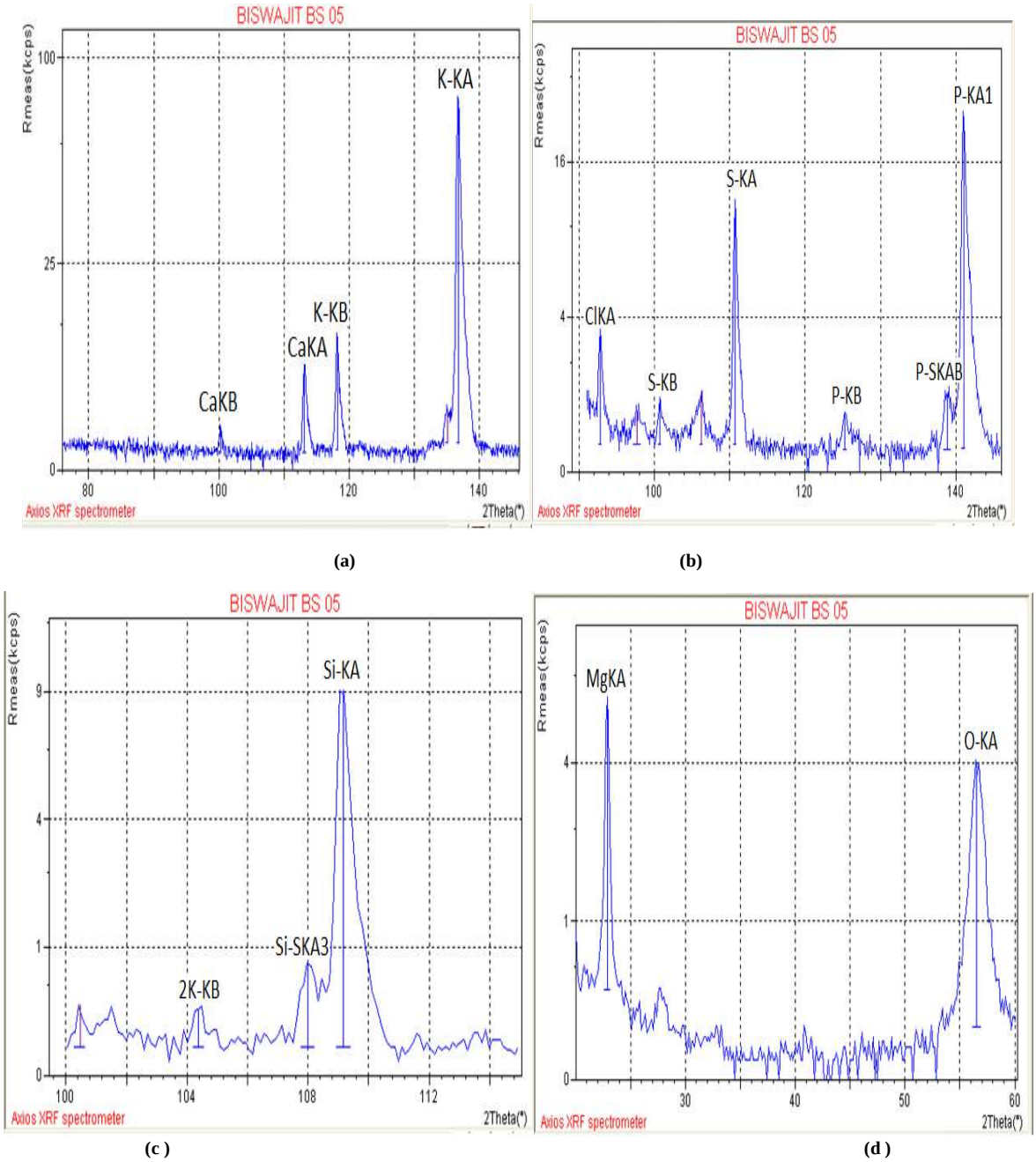


Fig 4 : XRF spectras of *Garcinia pedunculata* ripe fruit [(a) :Using LiF200 as analysing crystal, (b) :Ge as analysing crystal, (c):PE as analysing crystal, (d): PX1 as analysing crystal.]

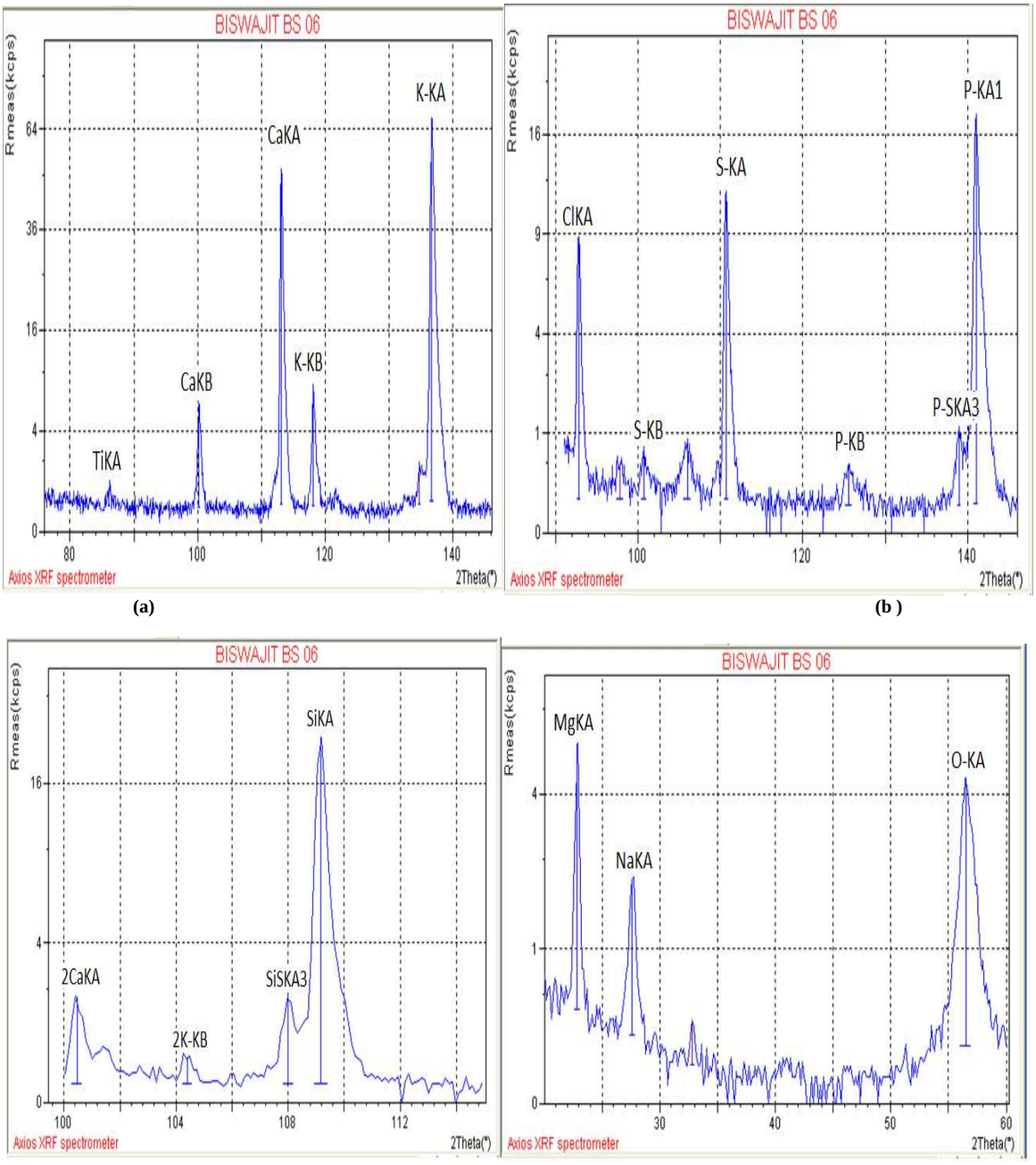


Fig 5: XRF spectras of *Ocimum sanctum* leaves [(a) :Using LiF200 as analysing crystal, (b) :Ge as analysing crystal, (c):PE as analysing crystal, (d) :PX1 as analysing crystal.]

Table 1: Detected elements from XRF analysis

Name of plant	Element detected
Aegle marmelos (leaves)	Iron, calcium, potassium, chlorine, sulphur, phosphorus, oxygen, magnesium.
MussaParadisica (fruit)	Calcium, potassium, chlorine, magnesium, phosphorus, sulphur, silicon.
Catharanthusroseus (leaves)	Oxygen, magnesium, silicon, sodium, chlorine, calcium, potassium, phosphorus, sulphur.
Garcinia pedunculata (fruit)	Silicon, phosphorus, calcium, oxygen, potassium, chlorine, sulphur and magnesium.

Ocimum sanctum (leaves)	Titanium, chlorine, potassium, calcium, magnesium, oxygen, silicon, phosphorus, sulphur, sodium.

Medicinal plants contain trace elements in a bioavailable form and their impact on the overall pharmacological action is very much important.The elements such as Mg, P, S, K, Ca, Mn, Cr, Ni, Cu, Co, Zn and V are reported to be essential in the regulation of blood sugar level in human body and production of insulin.In the biosynthesis, storage, and secretion of insulin zinc has a vital role [9].Deficiency of zinc causes a large number of metabolic disturbances such as impaired glucose tolerance, insulin degradation, and reduced pancreatic insulin content [10].Zinc has an important role in the maintaining of structural integrity of insulin [11]. It has been found that treatment of manganese significantly reduce the blood glucose level of streptozotocininduced diabetic rat [12]. Chromium acts like a cofactor in the action of insulin and it accelerates the action of insulin [13,14].

In the study, a total of eleven elements comprising iron, calcium, potassium, titanium, chlorine, sulphur, phosphorus, oxygen, magnesium, sodium and silicon were detected in the powdered medicinal plant samples by using XRF. Among the various elements detected in different medicinal plants some of them are useful in the treatment of diabetes mellitus.

Sodium (Na) involves in the production of energy, trans-port of amino acids and glucose into the body cells. Recent studies have shown that the low potassium concentration is a possible risk factor for diabetes [15].Calcium is an essential component of intracellular processes that occur within insulin responsive tissues like skeletal muscle and adipose tissue. A low level of calcium concentration is required for optimal insulin mediated functioning. Many research works have shown that calcium supplementation might reduce the risk for type II diabetes.

In human body, phosphorus exists mainly as phosphate. Phosphate depletion impairs insulin secretion by the β-pancreatic cells of the body and is associated with resistance to the peripheral action of insulin and with glucose intolerance [16]. Magnesium play an important role in improving insulin sensitivity. Mg has a great role in the activities of various enzymes which are involved in carbohydrate metabolism and glucose oxidation; it may play a significant role in the release of insulin and the maintenance of the pancreatic β-cells [17,18].Deficiency of Mg has been implicated in insulin resistance, carbohydrate intolerance, dislipidaemiaand complications of diabetes [19].

The results obtained from the elemental analysis of the selected antidiabetic medicinal plants are presented in the above Figures as well as in the table-1. The results indicate that *Aegle marmelos*leaves contain Fe, Ca, K, Cl, S, P, Mg and O. *MussaParadisica*unripefruit pulp contain Ca, K, Cl, S, P, Mg and Si. Total elements detected in *Catharanthusroseus* leaves are Ca, K, Cl, S, P, Mg, Si, Na and O. Elements found to be present in *Garcinia pedunculata*fruit pulp are K, Cl, S, Mg, Si, Ca, P and O. The elements Ti, Cl, K, Ca, Na, S, P, Si, O and Mg were detected in *Ocimumsanctum* leaves. Elemental analysis has shown that Ca, P, Mg, and K having important role in the treatment of diabetes are present in all the five studied plants.

CONCLUSION

In this study 11 elements were determined in different parts in different species of medicinal plant. The elemental results of the selected antidiabetic medicinal plants show that these plants contain some of the elements of vital importance in prevention and treatment of diabetes mellitus. The results of the present study support the usage of these medicinal plants in the treatment of diabetes.

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