

## SPECTROCHEMICAL ANALYSIS FOR NUTRIENTS AND TOXIC HEAVY METALS DETECTION IN ABUNDANTLY UTILIZED HERBAL MEDICINE (SHILAJIT) BY EMPLOYING THREE ADVANCED ANALYTICAL TECHNIQUES

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Shilajit, a Rasayana herbo-mineral substance, is a popular Ayurvedic treatment throughout the world to restore the body's energetic balance and fend off diseases like Alzheimer's and cognitive disorders. In Saudi Arabia, patients with bone fractures are treated locally with Shilajit. Due to its multiple usage elemental analysis of Shilajit to determine its nutritional value and heavy metal contamination for the patients' safety is highly significant. Using three cutting-edge analytical methods (LIBS, ICP, and EDX), the elemental composition of Shilajit was determined. The two varieties of Shilajits that are most frequently used are made in Pakistan and India were gathered for comparative studies. To hinge on Shilajit's therapeutic potential, our main focus is to draw attention to nutritional excellence and heavy metal contamination. In this study, Shilajit was analyzed both qualitatively and quantitatively using Laser-Induced Breakdown Spectroscopy (LIBS). Our LIBS analysis revealed that Shilajit samples contains several elements like Ca, S, K, Mg, Al, Na, Sr, Fe, P, Si, Mn, Ba, Zn, Ni, B, Cr, Co, Pb, Cu, As, Hg, Se and Ti. Shilajits from Pakistan and India had levels of Al, Sr, Mn, Ba, Zn, Ni, B, Cr, Pb, As, and Hg toxins that were higher than the standard permissible limit while also being highly enriched in beneficial nutrients like Ca, S, and K for human body. Even though the amounts of the majority of elements were comparable between the two Shilajits, the Indian Shilajit had higher concentrations of nutrients and toxins overall, with the exception of Hg and Ti. The self-developed calibration-free laser-induced breakdown spectroscopy (CF-LIBS) method was applied for the elemental quantification, and the LIBS results are in good agreement with the concentrations revealed using the conventional ICP OES/MS method. The presence of the aforementioned elements was confirmed by EDX spectroscopy, which was also used to validate our results from LIBS and ICP OES/MS techniques. This work is vital for raising awareness among those who are suffering from overdoses of this product and thus saving many lives worldwide.