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Research Article

Analytical Study of Elemental Composition and Heavy Metal analysis in *Muthuchippi parpam* during Various Stages of Preparation

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ABSTRACT

Background: *Muthuchippi Parpam*, a traditional Siddha calcined preparation, is known for its therapeutic properties in strengthening bones and treating musculoskeletal diseases. **Objectives:** This study employs ICP-OES analysis to understand its elemental composition, ensuring safety and efficacy. **Materials and Methods:** The use of Siddha formulations in clinical practice holds great promise for addressing non-communicable diseases, with investigations often focusing on reverse pharmacology to understand their therapeutic properties. **Results:** The results show increased concentrations of essential elements like calcium, zinc, magnesium, and potassium after purification and calcination. **Conclusion:** The presence of zinc, calcium, and magnesium suggests potential benefits for treating musculoskeletal diseases like osteoporosis and arthritis. This study highlights the importance of scientific validation of traditional Siddha formulations, promoting evidence-based practice and integration into modern medicine.

Keywords: *Muthuchippi Parpam*, ICP-OES, Purification, Siddha Medicine, Calcium carbonate.

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INTRODUCTION

Muthuchippi Parpam, a traditional calcined preparation commonly used in Siddha medicine, is derived from oyster shells (Muthuchippi) through processes of purification and calcination.[1] This formulation is known for its therapeutic properties, such as Osteodensification, Calcium fortification, and treating conditions like osteoporosis and joint pain.[2,3] Due to its mineral-rich composition, understanding its elemental makeup is crucial for ensuring its efficacy and safety.[4] Although Siddha medicines have been effective for centuries, the lack of standardization and refinement hinders their widespread acceptance and integration into modern medicine.[5]

ICP-OES has become a leading analytical technique, prized for its exceptional performance and versatility, and has been extensively employed for the analysis of diverse chemical elements, driving progress in various academic and research endeavors.[6] It has emerged as a premier analytical technique, distinguished by its exceptional sensitivity, precision, and versatility. Its remarkable capabilities have facilitated the analysis of a diverse array of chemical elements, yielding significant advancements in various fields of study.[7] The widespread adoption of ICP-OES in recent years underscores its utility and reliability as a powerful tool for elemental analysis. It is a powerful analytical technique used to detect and quantify trace elements and metals in various materials.[8] In the context of *Muthuchippi Parpam*, ICPOES is employed to analyze its elemental composition, identifying essential minerals such as calcium, magnesium, and trace metals, as well as monitoring heavy metals.

The analysis provides a comprehensive elemental composition in raw, purified, and calcined forms of Muthuchippi, ensuring that the final parpam is safe for therapeutic use. The investigation reveals significant variations in elemental composition across the different forms, highlighting the crucial role of purification and calcination in eliminating impurities and optimizing elemental balance. The findings underscore the importance of standardization in traditional formulations, ensuring compliance with pharmacological standards and regulatory requirements. By elucidating the bioactive elemental interactions, this research enhances our understanding pharmacological relevance, paving the way for its integration into evidence-based healthcare practices. Ultimately, this study demonstrates the critical need for rigorous quality control measures in traditional medicine,

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safeguarding the well-being of patients and validating the ancient wisdom of Siddha.

MATERIALS AND METHODS

Ingredients of *Muthuchippi parpam*

The ingredients are depicted in Table1

Muthuchippi parpam is prepared based on traditional literature[3] and ICPOES analysis was assessed in ADMRL, SCRI, Arumbakkam, Chennai with the project ID SCRI/ADMRL/2024-25/ICP-OES/09.

Preparation of Sample

Take about 50 mg of sample into the Teflon microwave digestion vessel and add 1 mL of ultrapure nitric acid to digest about 45 min using Anton Paar microwave digestion unit. After that the sample is made up to a 50 mL standard measuring flask. The calibration standard solution is prepared from 2 µg/mL to 10 µg/mL by using ultrapure nitric acid and blank also. Agilent ICP-OES 5100 VDV instrument used with the following operation conditions: a RF power 1.2 kW, a plasma gas flow rate 12 L min^{-1}, and a nebulizer gas flow rate 0.70 L min^{-1}. The samples are introduced into the plasma using nebulizer and spray chamber for the analysis.[9]

Principle

When energy from an external plasma source is applied to a sample, the atoms within the sample become excited and release energy as they return to their ground state. This energy is emitted as light rays, which are measured to identify the elements present in the sample and their respective concentrations. The process involves generating plasma by ionizing argon gas with a high-frequency electric current, creating hot, dense plasma (10,000K) that excites the sample atoms. The sample is introduced into the plasma as a fine aerosol through a narrow tube. The equipment used for this process, called ICP-OES optical emission spectrometry, consists of a plasma source, a spectrophotometer, a detector, and a data processing unit, with varying configurations depending on the specific spectrophotometer and detector used.[9]

RESULTS

The elemental composition and heavy metal content of *Muthuchippi Parpam* at various stages of processing were analyzed and documented. Table 2 presents the elemental analysis results at different phases, illustrating the transformation in elemental composition due to Siddha purification and calcination methods. Heavy metal concentrations were assessed and are summarized in Table 3, confirming the safety profile of the final formulation within permissible limits. Figures 1 and 2 depict the linearity and overlaid graphs of standard solutions, respectively, establishing the calibration accuracy of the ICP-OES method. Figures 3 to 5 show the ICP-OES spectra obtained from the raw, purified, and final *Muthuchippi Parpam*, highlighting the progressive reduction in toxic elements and enhancement in bioavailable minerals. These analytical results collectively validate the efficacy of traditional purification steps in standardizing the Parpam and ensuring its safety for therapeutic use.

DISCUSSION

From the analysis, it was found that some constituents have an increasing nature from formulation and ingredient. The final end product was assessed for heavy metal analysis. The calcium content in raw Muthuchippi was 34.96% which increases to 38.07% after purification and remains as 38.64% in *Muthuchippi Parpam*. This indicates that calcium is a major component in all forms of the material and is preserved during the preparation process. Calcium is vital for bone health and prevention of osteoporosis. It is crucial for bone mineralization, muscle contraction and nerve function.[10,11] Zinc content in raw Muthuchippi was 60.99 ppm which increases significantly to 269.18 ppm after purification but slightly decreases to 237.95 ppm in *Muthuchippi Parpam*. The purification process effectively concentrates zinc, but some may be lost or stabilized during the parpam preparation. Zinc plays a

Table 1: Ingredients of *Muthuchippi parpam*.

Sl. No.	The vernacular name of the ingredients	Botanical name/Chemical name
1.	Muthuchippi	*Pinctada margaritifera*
2.	Kattralai	*Aloe barbadensis*, Mill.
3.	Ponnangkani	*Alternanthera sessilis*. Linn

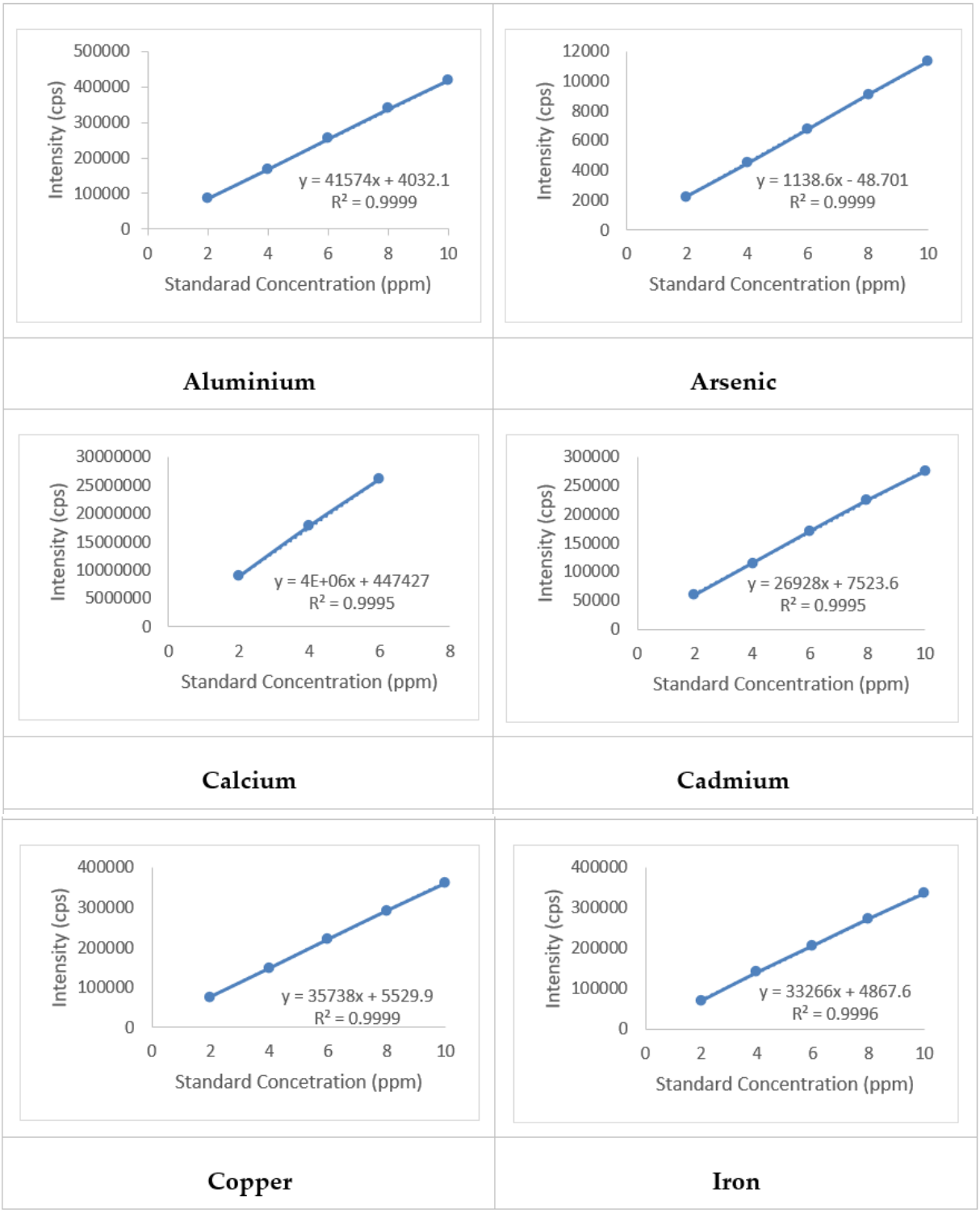
Table 2: Elemental analysis of *Muthuchippi Parpam* at Various stages of processing.

Elements	Raw Muthuchiipi	Purified Muthuchippi	*Muthuchippi parpam*
Al	187.11 ppm	137.75 ppm	480.27 ppm
Na	2.42%	1.81%	2.28%
Ca	34.96%	38.07%	38.64%
Zn	60.99 ppm	269.18 ppm	237.95 ppm
Fe	521.84 ppm	0.35%	0.2%
Mg	0.84%	1.56%	1.45%
K	BDL	270.66 ppm	0.11%

Figure 3: Heavy metal analysis of *Muthuchippi Parpam*.

Heavy metals	*Muthuchippi parpam*	AYUSH Permissible Limit
Hg	BDL	1 ppm
As	BDL	3 ppm
Pb	BDL	10 ppm
Cd	BDL	0.3 ppm

vital role in bone formation and cartilage health. It is a cofactor in collagen synthesis and bone mineralization. Also, it helps in osteoblast activity by inhibiting osteoclast activity. Zinc has anti-inflammatory properties which help to alleviate arthritis.[12] The magnesium content in raw Muthuchippi was 0.84% which nearly doubles to 1.56% after purification but decreases slightly to 1.45% in *Muthuchippi Parpam*. Magnesium plays a key role in bone structure and is involved in over 300 enzymatic



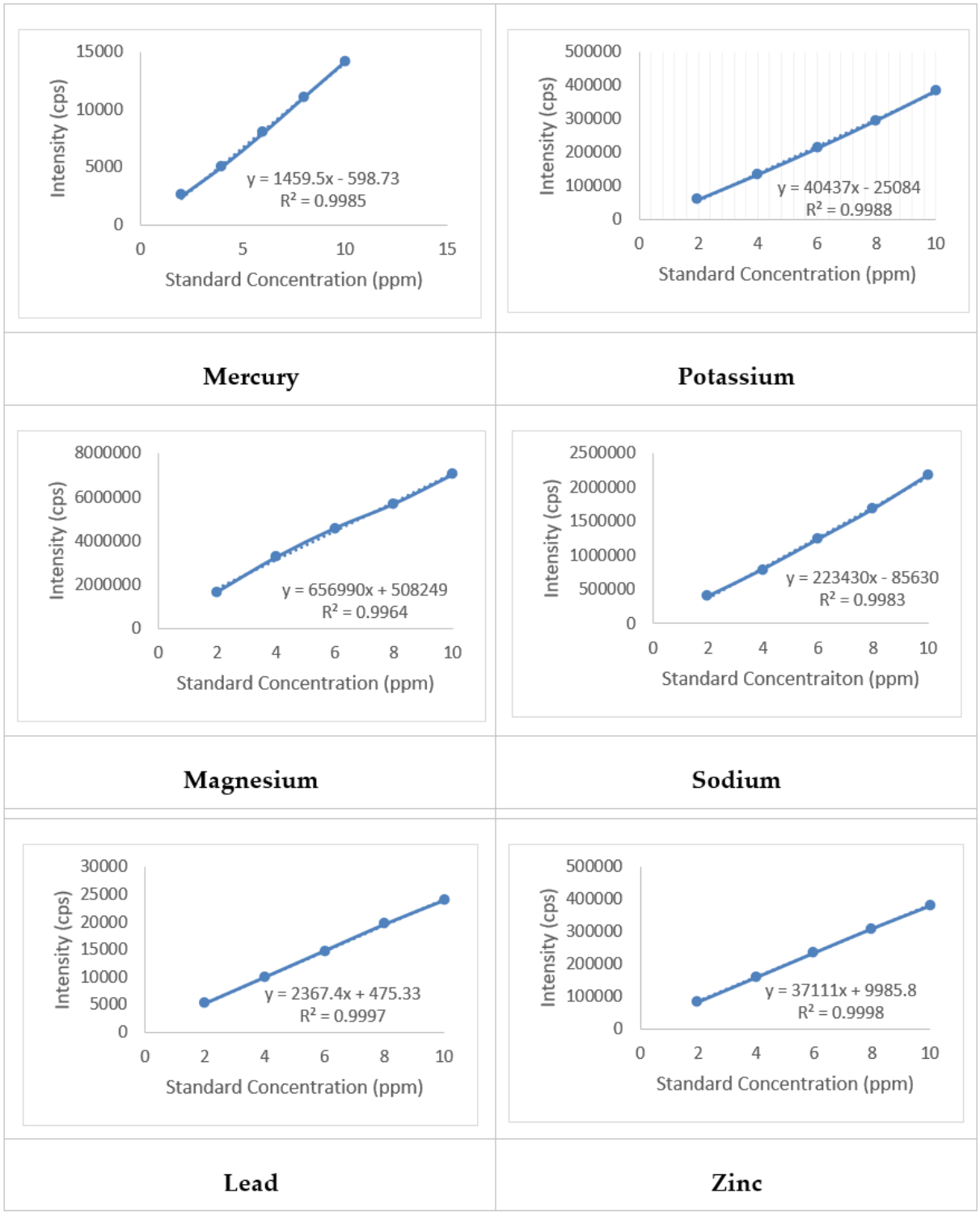
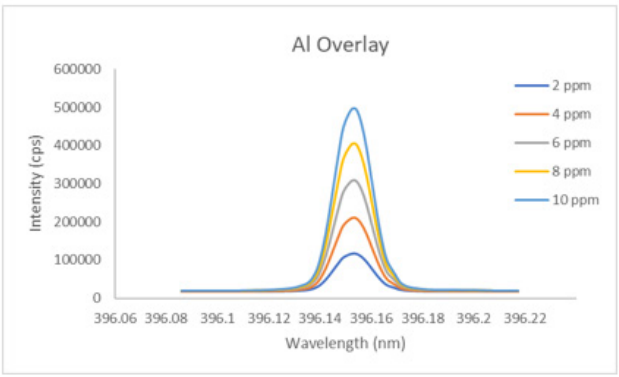
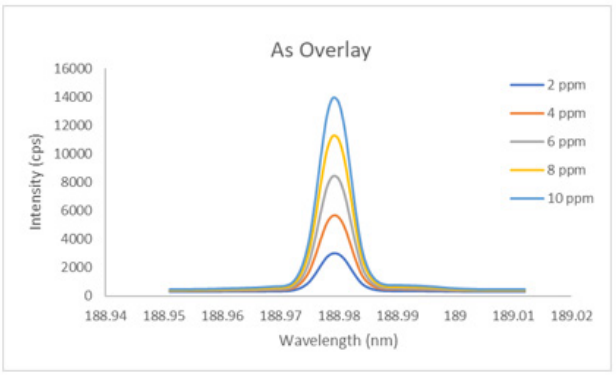


Figure 1: Representing the Linearity Graphs of Standard solutions.

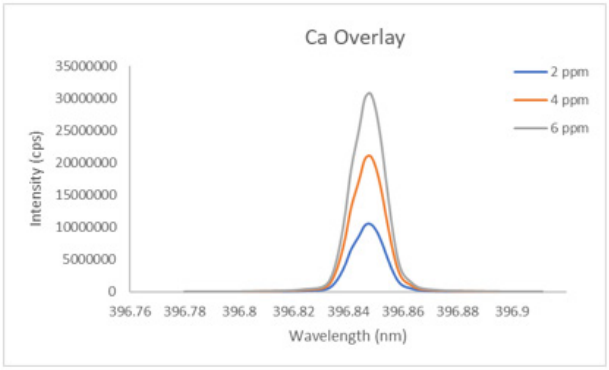
reactions in the body. It supports the calcium metabolism and bone mineralization aiding in osteoporosis and osteoarthritis. Also, magnesium reduces stomach ulcer and promotes ulcer healing.[13] The sodium content in raw Muthuchippi was 2.42% which decreases to 1.81% after purification but is almost restored to its original level of 2.28% in the *Muthuchippi Parpam*. Sodium plays an important role in rehydration, regulating blood pressure, acts as an antacid and antiseptic. Potassium is not detectable in the raw sample but found to be 270.66 ppm after purification and is further increased to 0.11% in *Muthuchippi Parpam*. Sodium and potassium play a vital role in fluid balance, nerve function and muscle contraction. Potassium promotes calcium retention aiding higher bone density.[14,15] The aluminum content in raw Muthuchippi was 187.11 ppm which decreases to 137.75 ppm



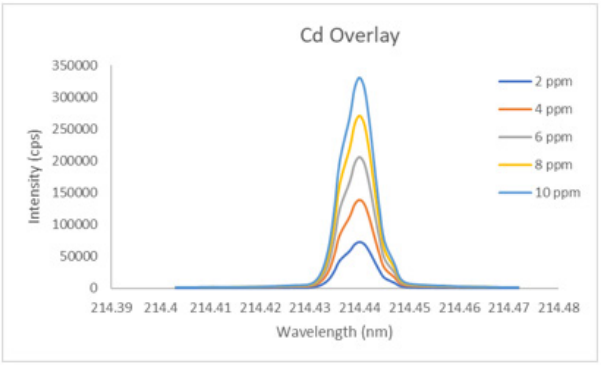
Aluminium



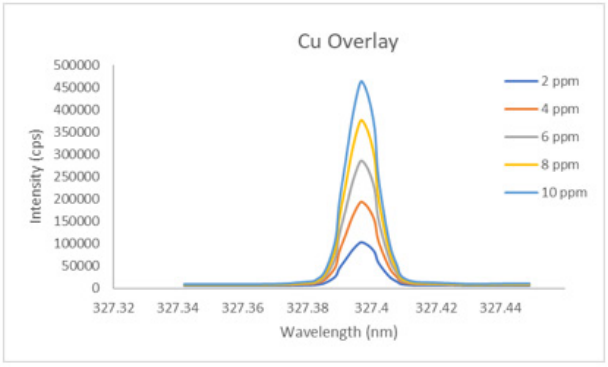
Arsenic



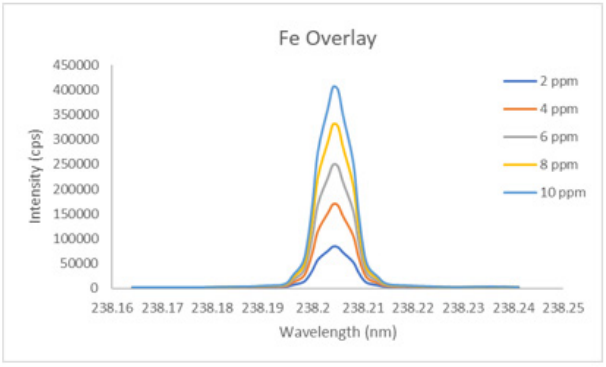
Calcium



Cadmium



Copper



Iron

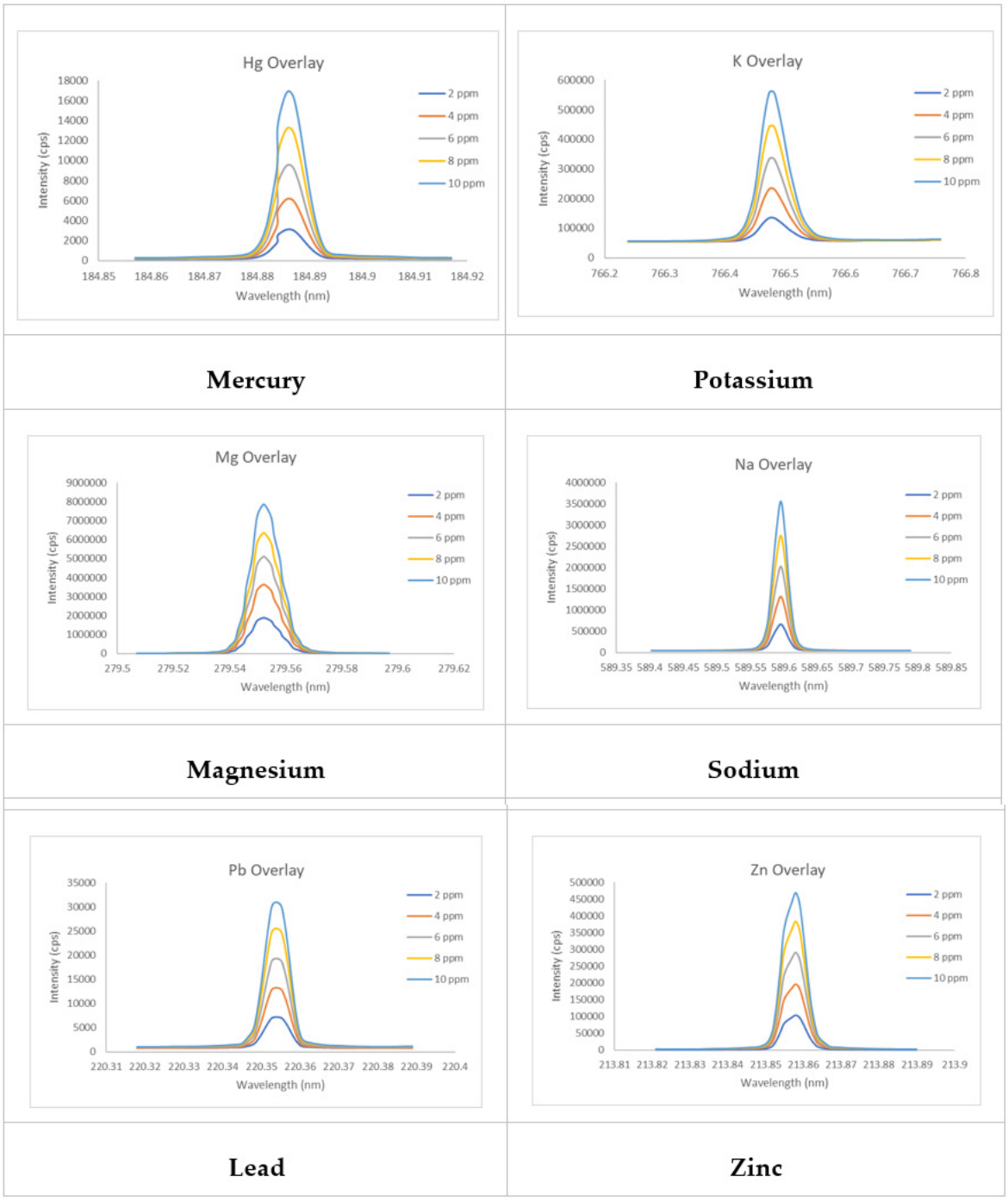


Figure 2: Representing the Overlaid Graphs of Standard solutions.

during purification but significantly increases to 480.27 ppm in the preparation of *Muthuchippi Parpam*, this could be due to the herbal juices and ingredients added while preparation. Aluminium is used as antacid, phosphate binder in renal diseases, anti-perspirents and topically applied in ulcer.[16] The iron content in raw Muthuchippi was 521.84 ppm which increased to 0.35% in purified but decreases slightly to 0.2% in *Muthuchippi Parpam*. Iron supports the wound healing potential by transporting oxygen.[17] The purification process generally increases the concentration of most elements (except for sodium), suggesting a concentration or introduction of elements like zinc and potassium. The parpam preparation further modifies the elemental composition, with noticeable increases in aluminum and potassium, while other elements like iron decrease compared to purified Muthuchippi.

The safety assessment revealed that the levels of toxic heavy metals, including arsenic, lead, mercury, and cadmium, was undetectable, confirming the safety of the study drug for consumption. *Muthuchippi parpam* is a widely used medicine effectively used for the treatment of bronchitis, asthma, and

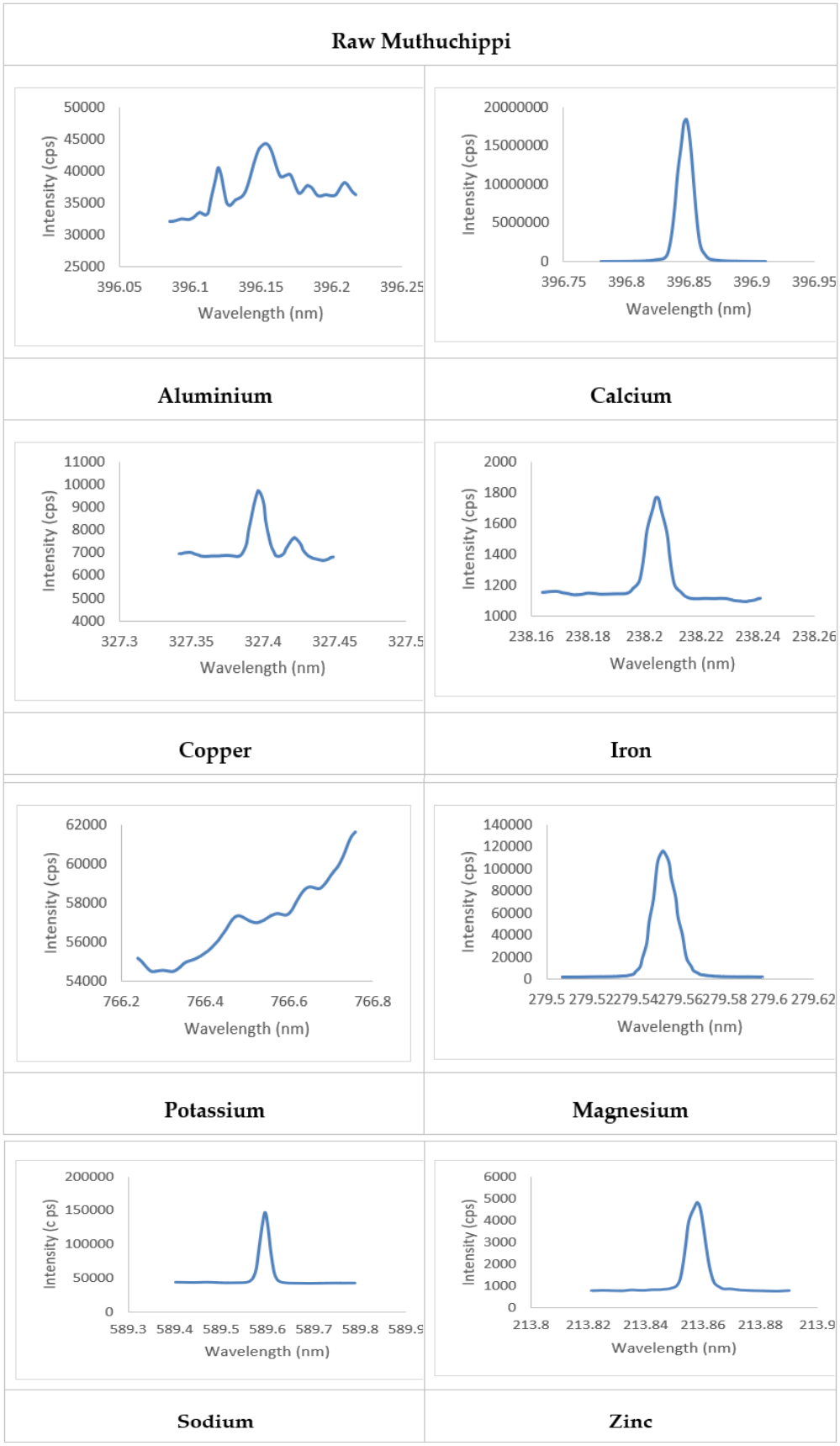


Figure 3: Representing the Graphs obtained in ICP-OES analysis of raw Muthuchippi.

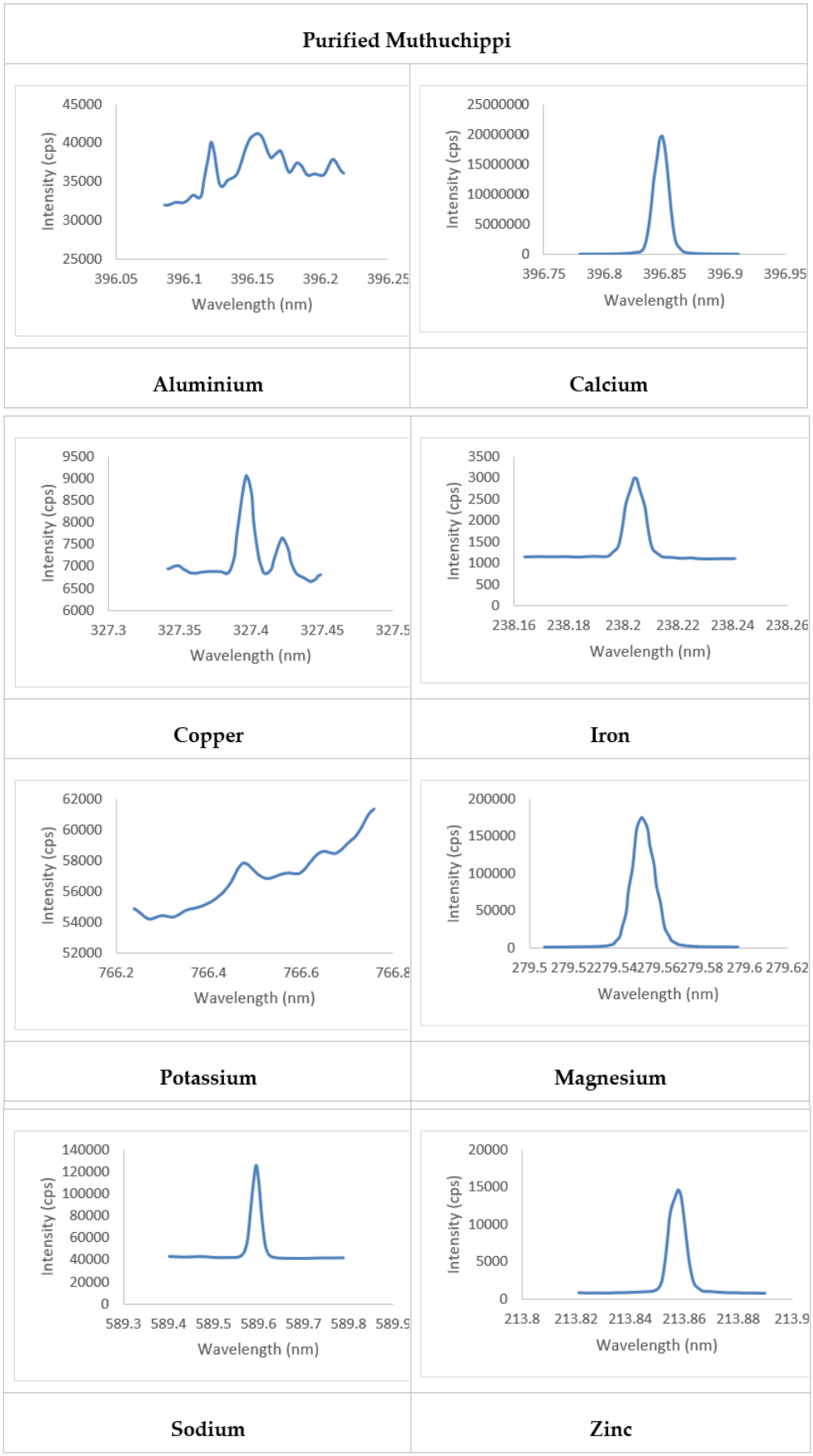
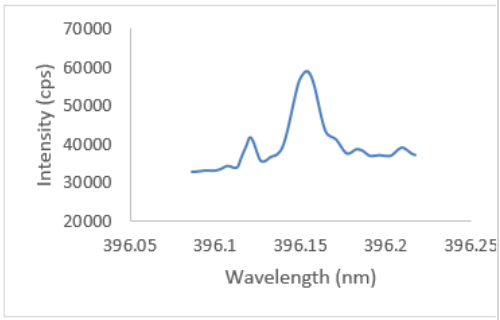
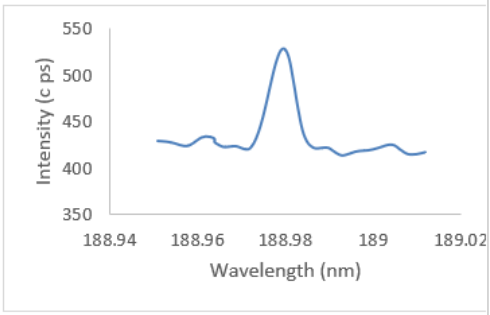


Figure 4: Representing the Graphs obtained in ICP-OES analysis of Purified Muthuchippi.

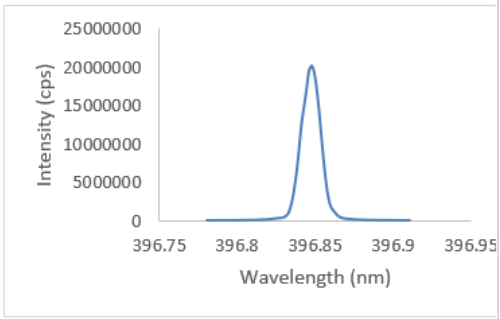
Muthuchippi Parpam



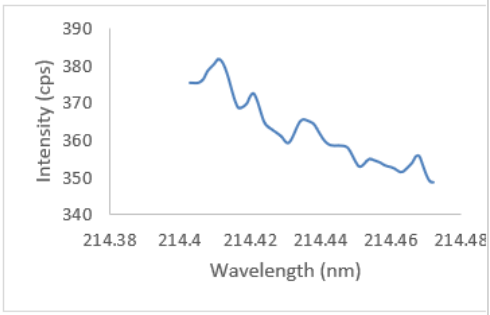
Aluminium



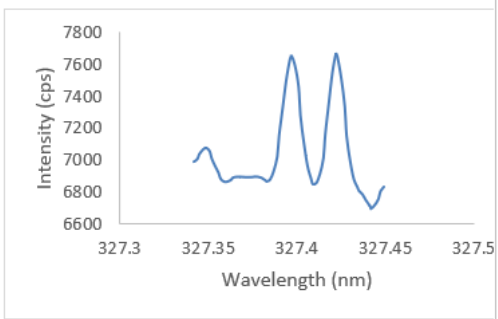
Arsenic



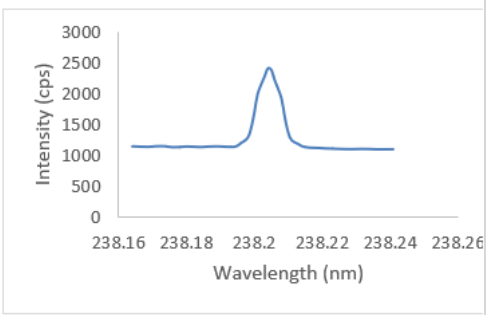
Calcium



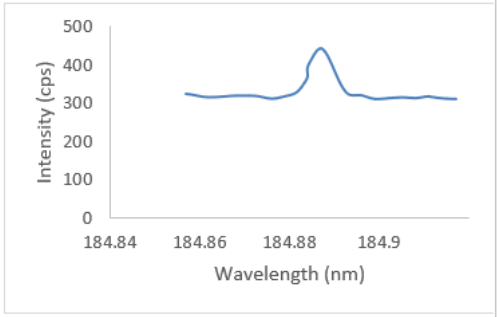
Cadmium



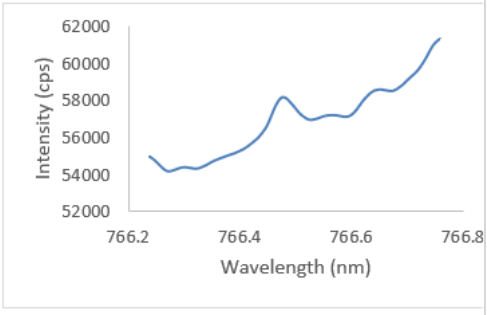
Copper



Iron



Mercury



Potassium

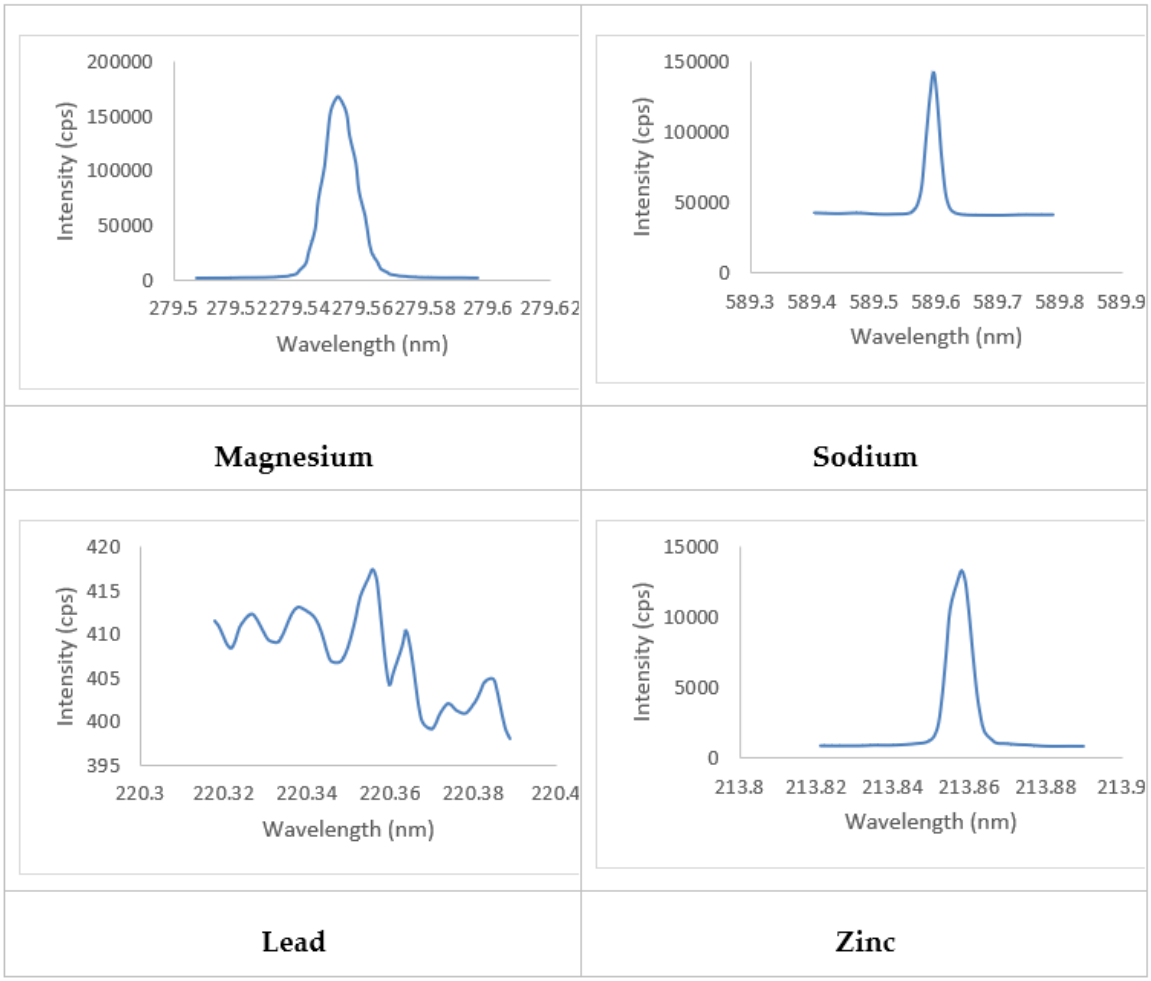


Figure 5: Representing the Graphs obtained in ICP-OES analysis of raw Muthuchippi.

degenerative disorders in regular practice. From the above study due to the presence of zinc, calcium, magnesium it will be helpful in the treatment of musculoskeletal diseases.

CONCLUSION

Employing scientific techniques and instruments is vital to verify the traditional assertions and properties of Siddha formulations, promoting evidence-based practice. The final product, *Muthuchippi Parpam*, retains these elements, with some variations. The presence of zinc, calcium, and magnesium suggests that this formulation may be beneficial for treating musculoskeletal diseases, such as osteoporosis and arthritis, due to their roles in bone health, mineralization, and inflammation reduction.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

ADMRL: Animal & Mineral Origin Drug Research Laboratory; **mg:** MilliGram; **µg:** MicroGram; **ICP-OES:** Inductively Coupled Plasma-Optical Emission Spectrometer; **kW:** Kilo Watt; **L:** Liters; **ppm:** Parts Per Million; **BDL:** Below the Detection Limit; **Ca:** Calcium; **Na:** Sodium; **Al:** Aluminium; **Zn:** Zinc; **Fe:** Iron; **Mg:** Magnesium; **Hg:** Mercury; **Cd:** Cadmium; **Pb:** Lead; **K:** Potassium; **As:** Arsenic.

AUTHOR CONTRIBUTION

Conceptualization: AB; Data collection and compilation: AB; Manuscript Writing: AB, SR, RM and KR; Proofreading and editing: AB, SR, RM and KR.

SUMMARY

Muthuchippi Parpam, a Siddha medicine derived from oyster shells, undergoes purification and calcination, increasing the concentrations of essential minerals like calcium, zinc, and magnesium, which support bone health, inflammation reduction, and muscle function, while maintaining undetectable levels of toxic heavy metals, thereby confirming its safety and therapeutic potential for musculoskeletal and respiratory conditions.

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