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Elemental Characterization between Single Origin Arabica and Peaberry Robusta from Vietnam

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Abstract

Coffea arabica and *coffea canephora* (robusta) are the two most common species of coffee. With the rising price and rising global demand for coffee there is an increasing incentive for distributors to pass cheap coffee as more expensive coffee creating a need to verify the authenticity of coffee. This research was conducted to perform elemental characterization of Nguyen brand arabica and robusta coffee grown in Vietnam. The coffee beans were ground and digested by acid. The samples were run using an ICP-AES instrument and compared with prepared standards containing Calcium, Iron, Rubidium and Manganese (***Ca***, ***Fe***, ***Rb Mn)***. Standard calibration for each element was created from which the samples were determined. The elemental ratio between ***Mn*** *and* ***Ca*** *in* arabica, was approximately double the ratio between ***Mn*** and ***Ca*** robusta. The elemental ratio between ***Fe*** and ***Mn*** in arabica was approximately half the ratio in robusta. The elemental ratio between ***Rb*** and ***Mn*** in arabica was also approximately half the ratio in robusta. The elemental ratios were compared to confirm that the two species of coffee grown in Vietnam were different. The results showed that the robusta absorbs more ***Fe*** than arabica when standardized with ***Fe***.

Introduction

From previous work, the location coffee was grown can be determined by ICP-AES using element ratios. Different species of plants absorb elements from their soil at different rates. Given this information, can we distinguish between two different species of coffee beans grown in the same location using ICP-AES? This type of analysis has yet to be done on coffee beans, we are breaking new ground here!

Two different species of coffee (Robust and Arabica) from Vietnam were analyzed by ICP. The metals tested included: Iron, Manganese, Calcium, and Rubidium.

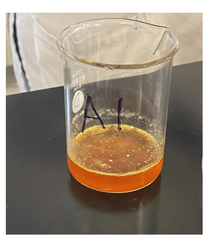
Nguyen Coffee Supply

Experimental

Sampling and Digestion: We created our samples from the species of Arabica and Robusta taking 30 beans from each and powdering them in separate mortar and pestles to avoid cross contamination. Each sample was then digested in concentrated Nitric Acid for 5 minutes before being filtered out. A 1:10 dilution was performed on each solution before passing it through the ICP-AES instrument.

ICP-AES: Our method of the analysis was based on *Anderson, 2002.* The emission wavelengths for each metal were Mn: 257.610 Fe: 259.940 Ca: 317.933 Rb: 780 023 (nm) respectively. An RF power of 1,100 W was used with a pump flow of 1.0 ml/min and an integration time of 0.25 seconds.

Analysis: Each solution was run 3 times, along with our standards to achieve a proper distribution of data. The sample solutions were run another 3 times with a 1:10 dilution as Calcium was outside our linear range in the first tests. A calibration curve was created for each metal based on our standards which were serially diluted and the concentrations of the metals within the beans were determined from that calibration.



Results

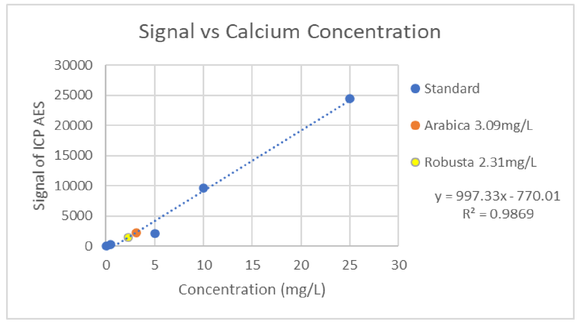
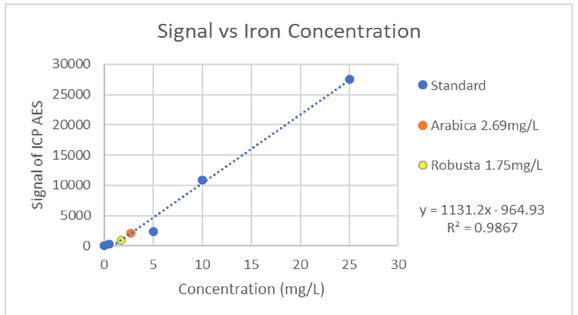


Figure 1: The calibration curve (signal vs. concentration) with a Ca standard. Arabica and Robusta are represented in orange and yellow, respectively.

Figure 2: Signal vs. concentration for Fe standard. Arabica and Robusta signal are colored differently.



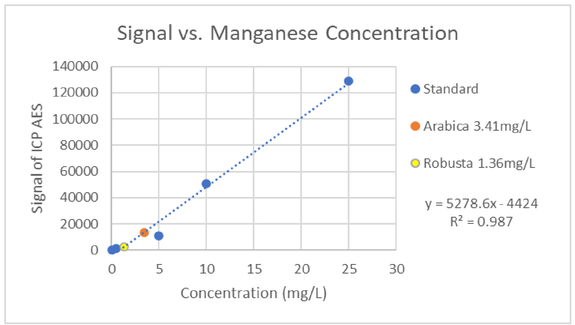
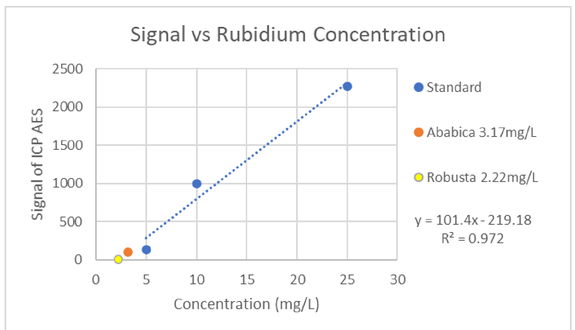
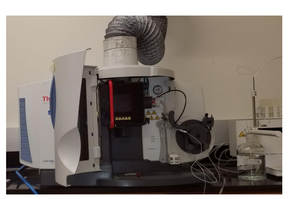
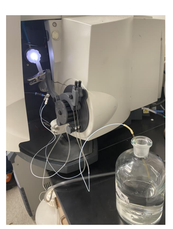


Figure 3: Signal vs. concentration for Mn standard. Arabica and Robusta signal are colored differently.

Figure 4: Signal vs. concentration for Rb standard. Arabica and Robusta signal are colored differently.







Results (cont.)

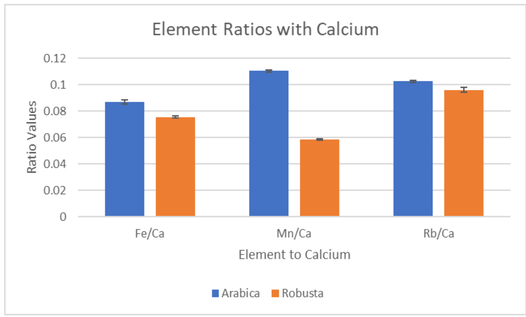
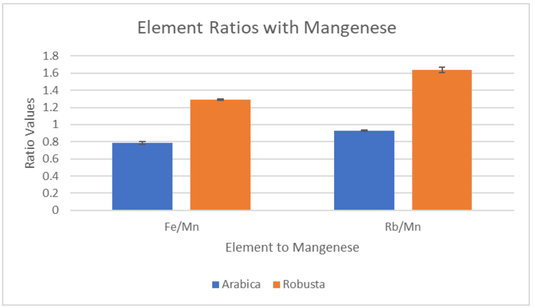


Figure 5: Compares the difference between concentrations of the metals Fe, Rb, and Mn to Ca in Arabica and Robusta beans.

Figure 6: Compares the difference between concentrations of the metals Fe and Rb to Mn in Arabica and Robusta beans.



Conclusions

To compare the element ratios between Arabica and Robusta coffee, T-Tests were performed to establish the significance of the data. Every comparison in figures 5 and 6 had a p-value of less than 0.0005. From the T-Tests the Mn/Ca and Fe/Mn were determined to be the most significant ratios for distinguishing the Arabica versus Robusta. This indicates incredibly significant data with supporting the hypothesis that Arabica and Robusta can be distinguished through ICP analysis.

Future Work

- Analyze the elemental concentrations of Arabica versus Robusta from countries other than Vietnam
- Analyze the elemental concentrations of less common coffee species such as Charrier and compare it to the Arabica and Robusta species from the same country

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