Analysis of VOCs in Green Coffee Beans From Various Regions

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Introduction

Volatile organic compounds (VOCs) contribute to the aroma, taste, and health benefits of coffee beans. During roasting, one class of the VOCs emitted by green coffee beans is the aldehydes. Roasters and other workers may come in contact with these VOCs through inhalation. Excessive inhalation of these compounds can lead to airway constriction by a narrowing of the airway opening, negatively impacting breathing patterns. Aldehydes and other VOCs are chemically altered or transformed during the roasting phase of coffee production, prior to making a cup of coffee.

As a result, VOCs present in green coffee beans are the starting compounds for secondary metabolites, or other products detected in the resulting cup of coffee. A majority of studies involving coffee aroma and taste analysis involve understanding the chemical compounds present post -roasting or brewing. These studies use solid-phase microextraction (SPME) for headspace extractions in order to isolate the VOCs present. In this study, making streamlining coffee grinding was attempted by reducing the volume of the beans required to grind 4 different types of coffee beans in a single cycle.

Using four grinding chambers at once, the coffee beans were not sufficiently ground, only one coffee type could be ground per cycle. Green coffee beans from various regions and varieties were then examined using GCxGC for variations in the identities and amounts of VOCs.

Methods

Green Coffee Beans
9.0 grams per sample

Grinding by cryomill to
- retain VOCs with the nitrogen gas
- Break down coffee beans easier to create a homogenous powder

Produces a coffee powder

GCxGC Analysis
- Used solid-phase micro extraction (SPME) for headspace extractions
- Non-target comprehensive two-dimensional gas chromatography to evaluate the sample and produce a chemical fingerprint

Results

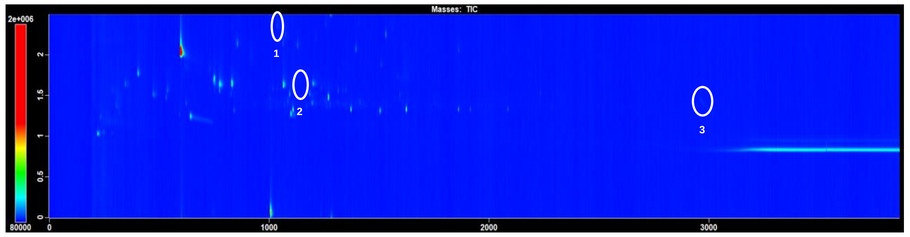

Figure 1. Chromatogram of the chemical fingerprint of **Mexican Santiago Atitlan** green beans. X axis contains retention time in minutes, Y axis contains retention time in seconds. Labelled peaks: 1) Benzaldehyde, 2) Hexanoic acid, 3) Caffeine

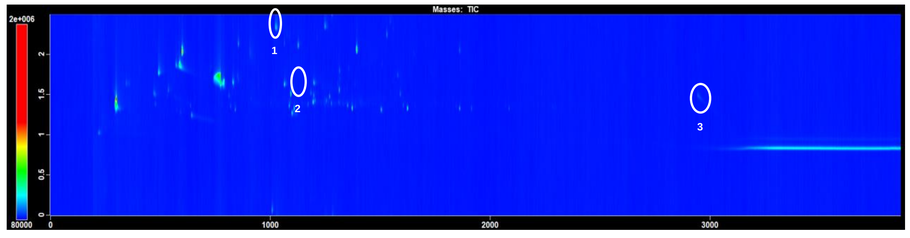

Figure 3. Chromatogram of the chemical fingerprint of **Costa Rican Mario Salazar** green beans without cryogen. X axis contains retention time in minutes, Y axis contains retention time in seconds. Labelled peaks: 1) Benzaldehyde, 2) Hexanoic acid, 3) Caffeine

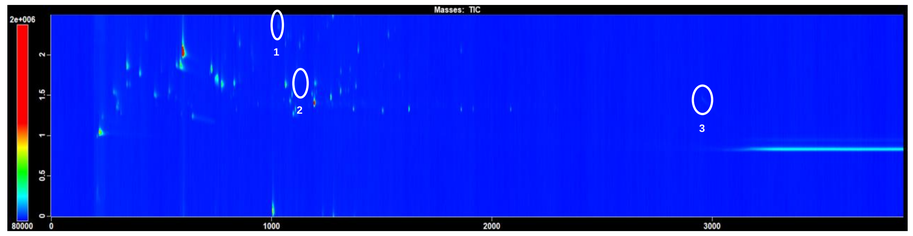

Figure 2. Chromatogram of the chemical fingerprint **of Ethiopian Hambela Natural** green beans. X axis contains retention time in minutes, Y axis contains retention time in seconds. Labelled peaks: 1) Benzaldehyde, 2) Hexanoic acid, 3) Caffeine

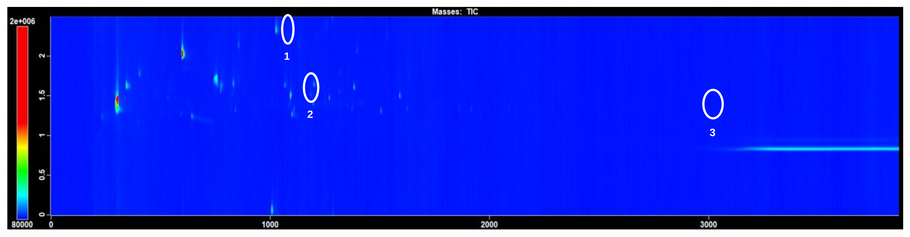

Figure 4. Chromatogram of the chemical fingerprint of **Guatemala Transcend Decaf** green beans. X axis contains retention time in minutes, Y axis contains retention time in seconds. Labelled peaks: 1) Benzaldehyde, 2) Hexanoic acid, 3) Caffeine

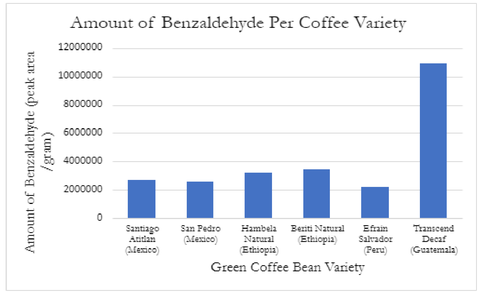

Figure 5. Bar graph of the amount of Benzaldehyde in different varieties of coffee green beans measured by the peak area per gram.

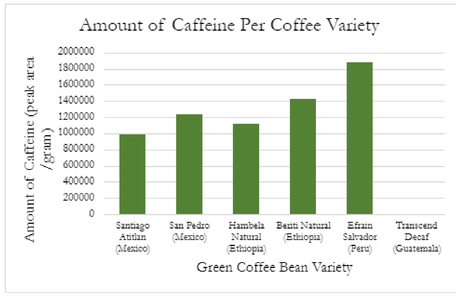

Figure 6. Bar graph of the amount of Caffeine in different varieties of coffee green beans measured by the peak area per gram.

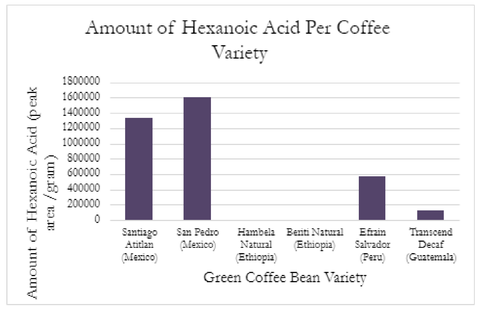

Figure 7. Bar graph of the amount of Hexanoic Acid in different varieties of coffee green beans measured by the peak area per gram.

Conclusions

- As evident from the chemical fingerprint of the Costa Rican Mario Salzar, cryogen is needed to sufficiently break down the coffee beans, as well as to prevent loss of VOCs due to the high temperatures during the process of grinding.
- In regards to the VOCs present in the various green coffee beans, caffeine is present in the highest amounts in the Efrain Salvador variety from Peru, and not present at all in the decaf variety. Alternatively, Transcend Decaf from Guatemala contains significantly higher levels of Benzaldehyde than the opposing varieties. Hexanoic Acid is seen in higher amounts in the coffee varieties from Mexico, whereas those originating from Ethiopia contain relatively none.
- The difference in VOCs between the varieties may be attributed to a range of reasons. The amounts of VOCs present in Decaf coffee may be attributed to the excessive washing that took place. The climate, soil, level of precipitation etc. could be a contributing factor to the differences in the coffee beans from distinct regions, while the differences between coffee beans originating from the same region may be attributed to the chemical compositions of the subspecies.
- Future investigations could evaluate how the lack or presence of a chemical compound reflects the environment of the region from which the coffee beans are grown in in order to gain a better understanding about the impact of the environment on food chemistry.

References

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