

# Rwanda Antestia-Potato Taste Research Group



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## ***WHERE IS THE ISOPROPYL METHOXYPIRAZINE (IMP) IN GREEN COFFEE AFFECTED BY POTATO TASTE?***

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Rwanda Collaboration  
Colloquium Sponsored by:



# Outline

- Background: What is potato taste defect?
- Results of previous research on IMP
- Our research questions
- Experiment: SPME GC-MS on sort fractions of a donated PTD sample
- Results: location of IMP in the sample
- Conclusions
- Tentative implications for PTD
- Acknowledgements

# Background

- In 2001, producing specialty coffee became part of a strategy to develop the Rwandan economy
- Washing stations were implemented to support specialty coffee: specialty production rose from 1% in 2002 to 27% in 2012
- Potato Taste Defect (PTD) threatens this plan.<sup>1</sup>



<sup>1</sup>Government of Rwanda, *Strategic Plan for Agricultural Transformation in Rwanda* (Ministry of Agriculture and Animal Resources, Kigali, 2004).

# What is PTD?

- **Potato Taste Defect (PTD)** leads to roasted coffee that smells and tastes like **potato skins**
- **PTD is not detectable** in green coffee beans by smell or appearance
- **PTD is detected in the cup** of coffee
- **PTD is detected in roasting** just before the first crack
- **PTD affects:**
  - 400,000 smallholder farmers, 86% of whom are women<sup>1</sup>
  - 25% of Rwandan coffee crops in 2008<sup>2</sup>
  - 51% of Cup of Excellence entries affected by PTD in 2013

<sup>1</sup>World Bank 2011

<sup>2</sup>Ngabitsinze, J. C., A. Mukashema, M. Ikirezi and F. Niyitanga. (October 2011). Planning and costing adaptation of perennial crop systems to climate change: Coffee and banana in Rwanda. Case study report. <http://pubs.iied.org/pdfs/G03174.pdf#page18> .



# **TO PREVENT PTD: ALL INSECT DAMAGED BEANS ARE SORTED OUT**



# Sorting is not 100% effective

- Sometimes PTD is detected during coffee cupping, or tasting, before coffee buyer makes a purchase
- Beans may also manifest the defect during export away from Rwanda and be noticed upon arrival
  - Buyers decline to purchase lots with PTD
  - One PTD cup in 40 or fewer will result in the coffee being rejected



# Previous Research on PTD

- Studies of PTD occurred mostly in 1980's and 1990's
- **Most common hypothesis is that PTD originates from feeding damage by the antestia bug followed by infection by a bacterium that produces a malodorous metabolite adhering to the beans**



Antestia bug on coffee cherry



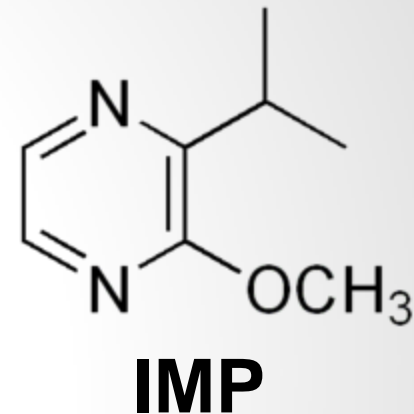
Coffee cherries that survived attack by the antestia bug.



Decaying coffee cherry after antestia bug attack

# 3-isopropyl -2 methoxypyrazine

- Intensely odiferous potato skin smelling molecule
- Detectable by human nose as low as 2 parts per trillion
- Associated with PTD in 1980s<sup>3</sup>
  - Sourced from ground green beans by solvent extraction and chromatography
  - Found by GC/MS in both good and PTD coffees; 30 times higher in PTD coffee
  - Not detected by nose in whole green coffee, but is sensed in ground green coffee and roasted coffee



<sup>3</sup>Becker, R., Döhla, B., Nitz, S., Vitzthum, O. G. (1987). Identification of the peasy off-flavour note on central african coffees. In *12th International Conference on Coffee*, Montreux, pp 203-215.



# **FROM OUR RESEARCH ON SURFACE VOLATILES OF GREEN COFFEE BEANS WE NOW KNOW...**

- I. The surface volatiles have a profile that distinguishes PTD from non-PTD coffee, but the profile does not include IMP.**
- II. The PTD surface volatile profile consists of tridecane, dodecane, hexanal – and these same volatiles are dominant in the antestia bug volatiles. It seems antestia has left its “scent” on the surface of PTD coffee.**
- III. No IMP is found on the surface of PTD or non-PTD coffee beans, even if heated to 90 °C for sampling.**

# **OUR RESEARCH QUESTIONS:**

- I. Where is the odiferous IMP found in green coffee beans?**
- II. Is IMP associated with a particular defect sort fraction, such as insect damaged, fluorescent , broken or withered?**
- III. Where do we look for the proposed “few bad beans” that are responsible for potato taste?**

# Objective to find the IMP in PTD coffee

- Previously we studied the **surface volatile organic compounds (SVOCs)** in green coffee that define the chemical nature of PTD on the surface of beans
  - Surface volatiles should concentrate compounds deposited through antestia feeding activity and/or bacterial growth – **DID NOT FIND IMP HERE**
- Now, we study the **interior volatile organic compounds (IVOCs)** inside the green coffee beans
  - Interior volatiles should reflect compounds produced by the coffee bean itself in response to stress of antestia feeding activity and/or bacterial growth

# **THE SAMPLE NECESSARY FOR THIS RESEARCH PROJECT WAS DONATED BY RUTH CHURCH OF ARTISAN COFFEE IMPORTERS – THANK YOU!**

- **This sample is a high-quality specialty coffee from Burundi that “developed” a very mild potato taste after being imported to the United States**
  - **Sample was cupped and sorted by Mr. Ed Whitman and Mr. Carlos Serrano of the Rogers Family Company**
  - **It had one cup PT out of 120 cups**
  - **Excellent quality except for that one cup!**

**Can we find the PTD and the IMP in this coffee sample?**

# Method

**Starting point: a method previously applied to roasted ground coffee : heated coffee is sampled by solid phase micro-extraction (SPME)<sup>5</sup>**

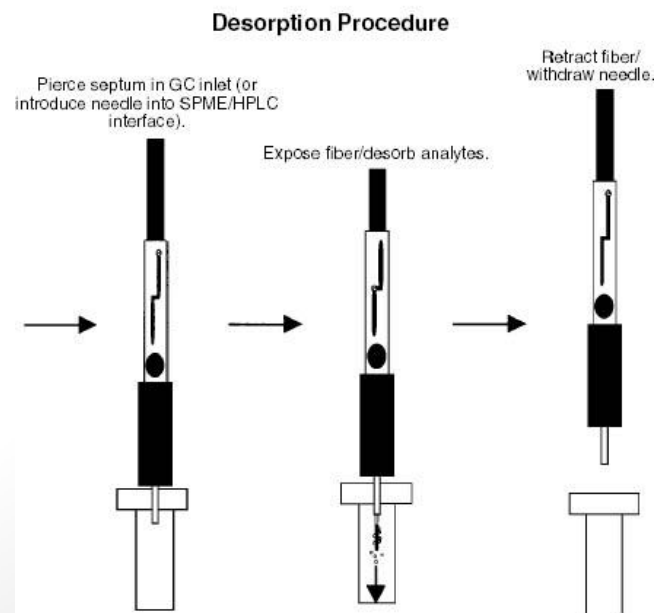
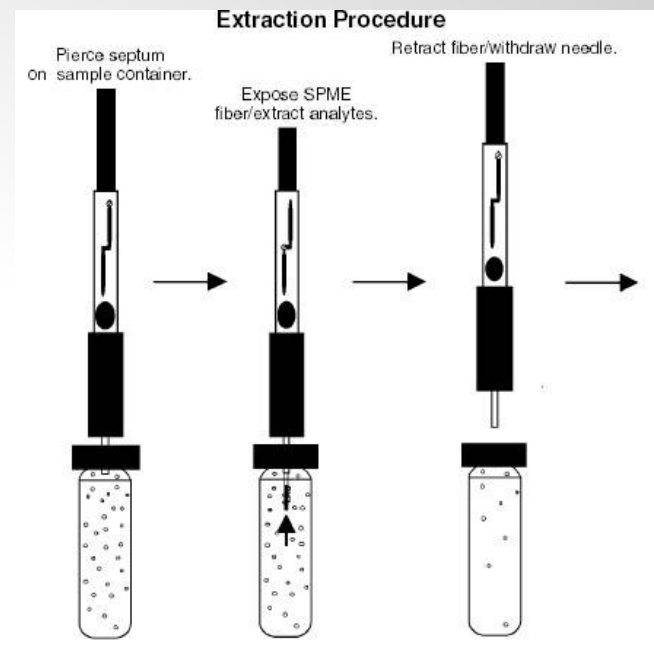
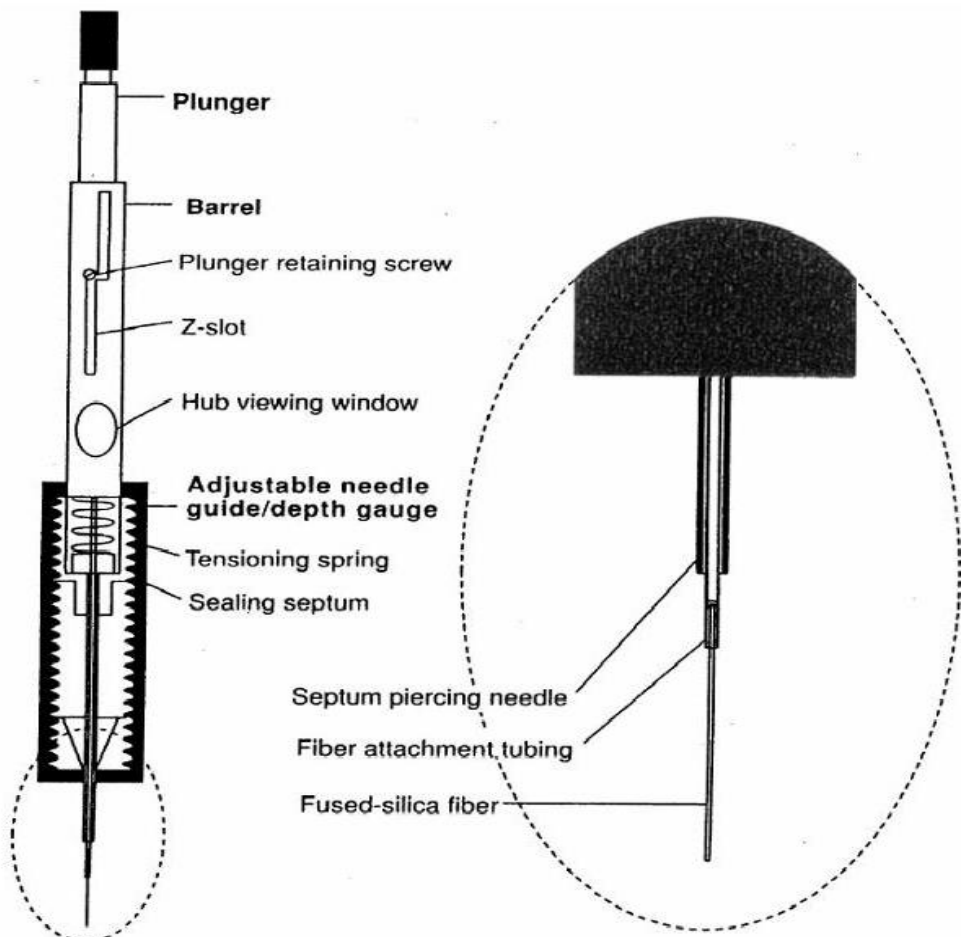
**Need to apply to ground green coffee for Interior Volatile Organic Chemical analysis :**

- **Freeze green coffee beans at -70 °C and grind, reserving fraction that passes through a 2 mm sieve**
- **Collect volatiles of ground coffee at 60 °C with SPME for one hour**
- **Separate by gas chromatography and analyze by mass spectrometry**
- **SPME has been successfully applied to volatiles, including IMP, down to nanogram level<sup>6</sup>**

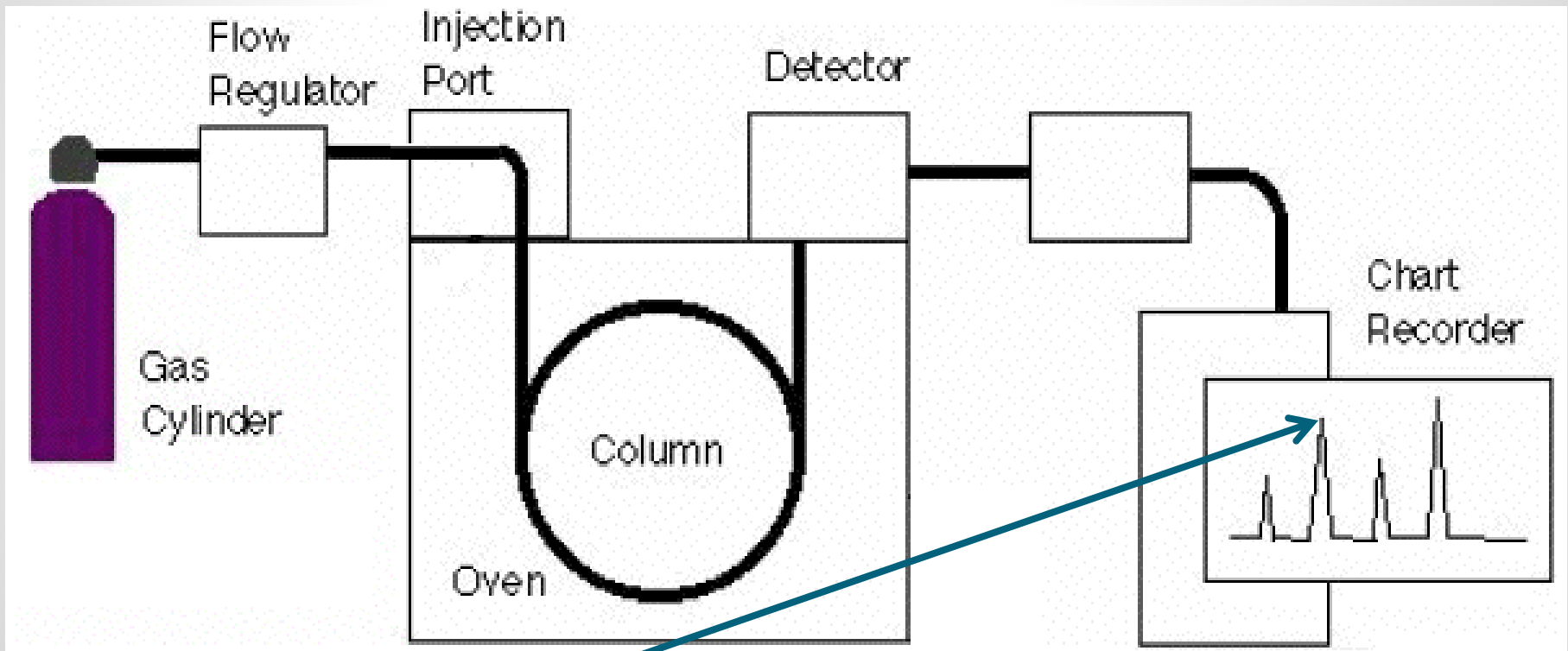
<sup>5</sup>Mondello, L., et al, (2005) Reliable characterization of coffee bean aroma profiles by headspace solid phase microextraction-gas chromatography-mass specrometry... J. Separation Science 2005, 28, 1101 – 1109.

<sup>6</sup>Sala, C, Mestres, M., Marti, M.P., Busto, O., and Guasch, J. (2002) Headspace solid phase micro-extraction analysis of 3-alkyl-2-methoxypyrazines in wines. Journal of Chromatography A, 953, 1-6.

# Solid Phase Micro-Extraction (SPME)



# Gas Chromatography- Mass Spectrometry (GC-MS)

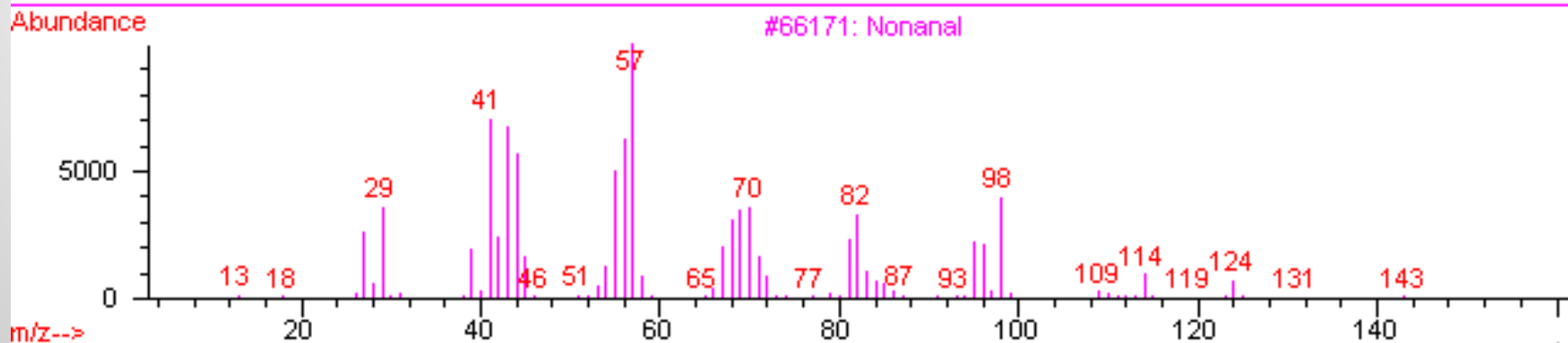
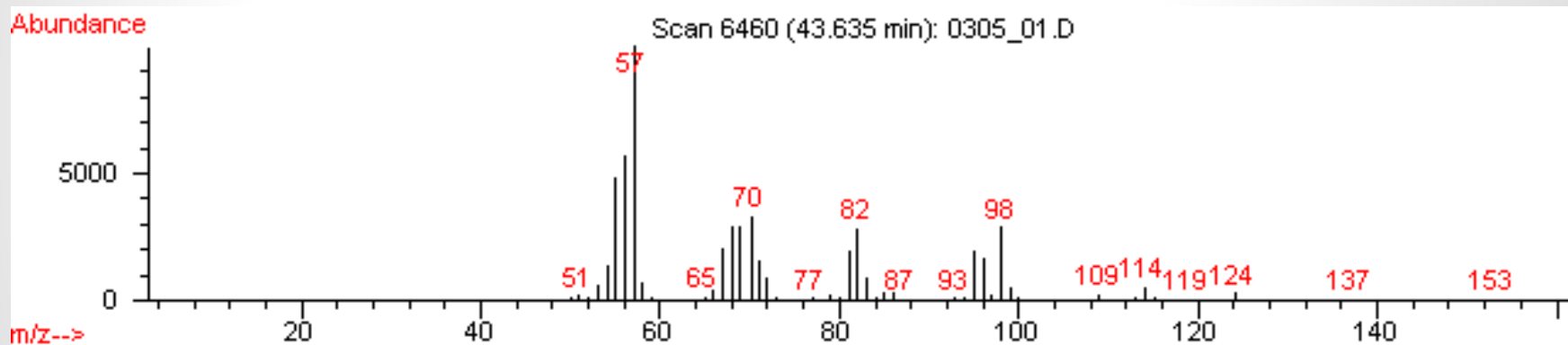


**Chromatogram with peaks and mass spectrum for each compound  
Compounds identified by 1) comparison of mass spectrum  
with NIST05 and FFNSC2 database s(>75% match) and 2) retention  
time matches with candidate compound.**

# Identifying compounds from GCMS data

With a good MS match (>75% quality), to ensure correct MS compound identification:

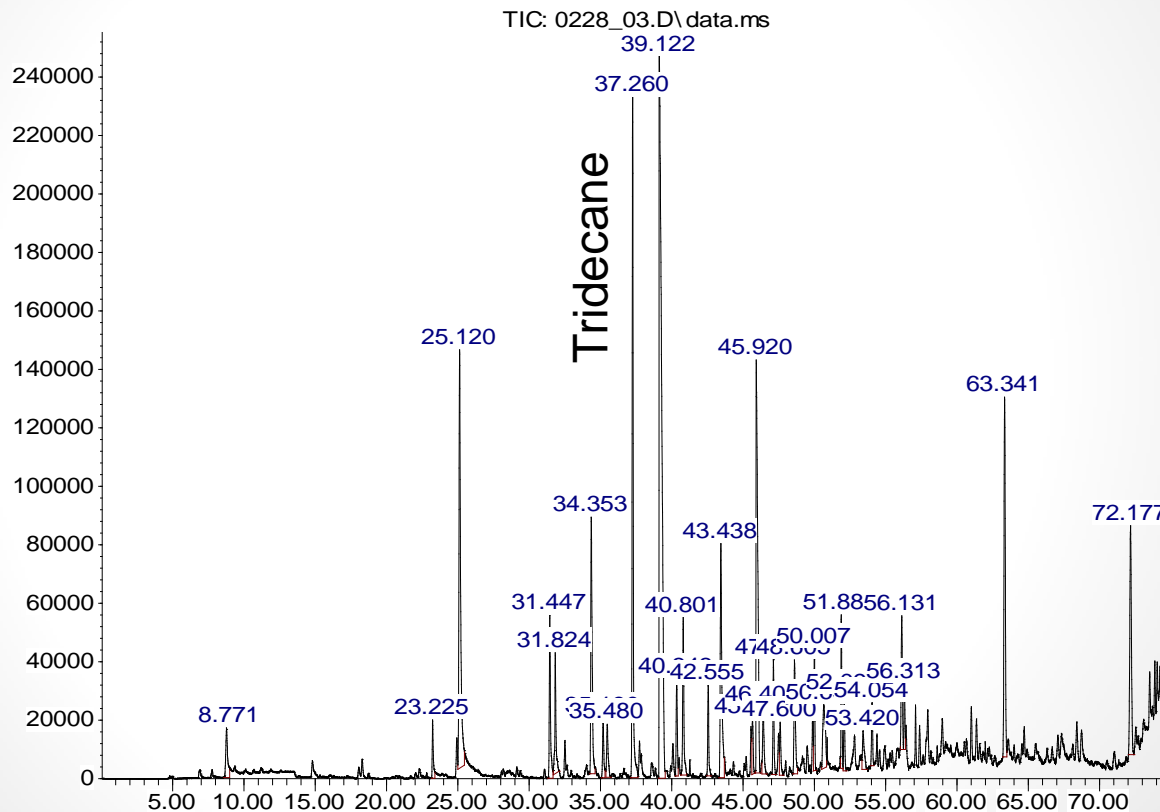
- **Check retention times** to make sure they correlate for compound and our GC settings
- **Run standards** to verify compound identification for key SVOCs





# CHROMATOGRAM OF SAMPLE, FIRST LOOKING AT WHOLE BEANS

Abundance

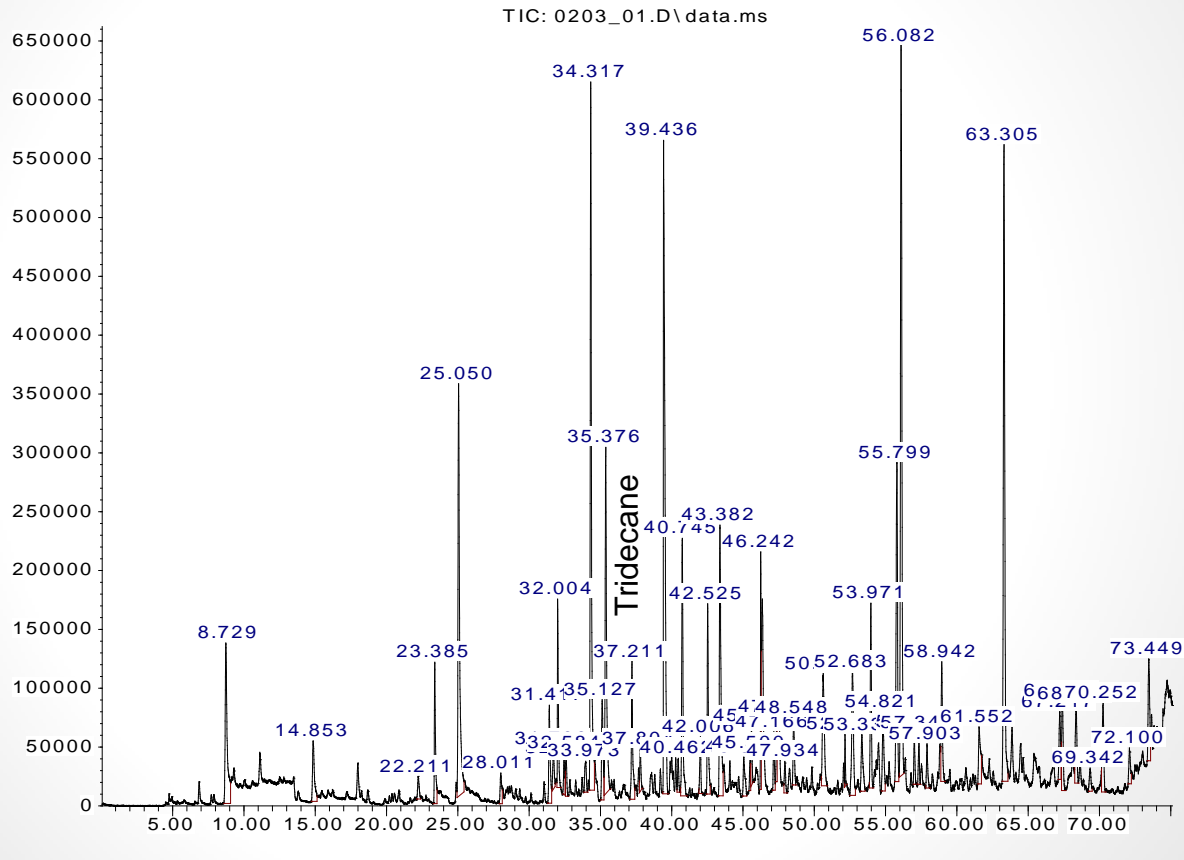


Time-->

**Note: Bulk sample does not exhibit a strong PT profile. Tridecane peak is comparable to other coffee volatiles.**

# CHROMATOGRAM OF BULK SAMPLE, GROUND BEANS

Abundance



**Note: Volatile profile is different from surface volatiles. Tridecane peak is very small, consistent with tridecane on surface but not in interior. No IMP found!**

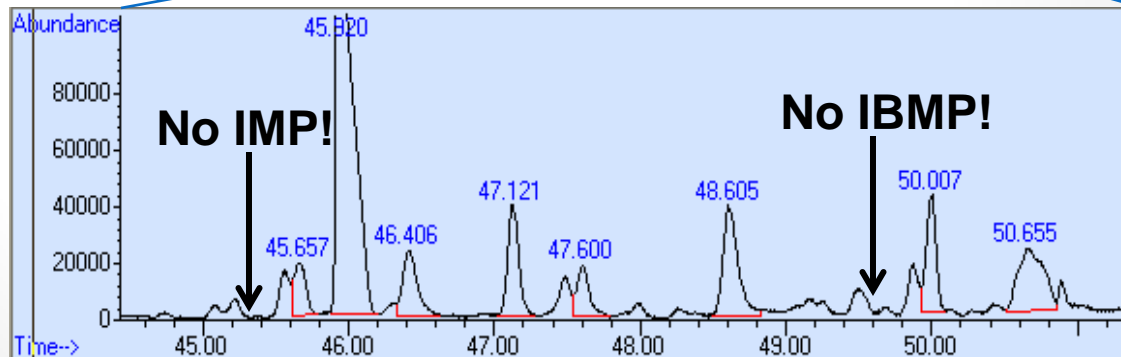
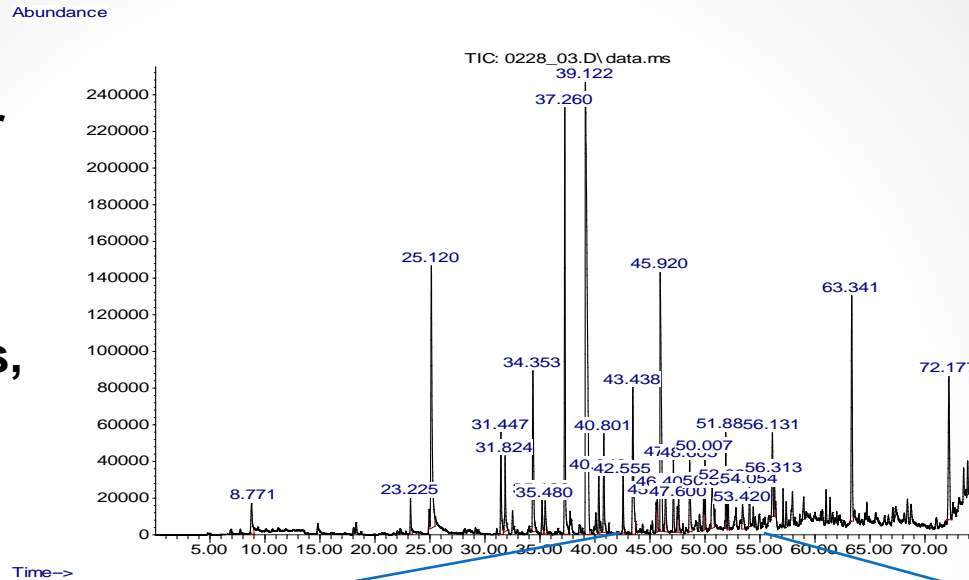
# INSECT DAMAGED FRACTION





# Results from chromatograms of fractions: insect damaged, whole beans

Since no IMP or IBMP are found on the surface of the insect damaged beans, they are inside the beans.



# Conclusions from study of fractions of Burundi sample:

- IMP is found inside the beans in the IVOCs, but NOT on the surface of the beans in the SVOCs
- IMP is most concentrated in the insect damaged sort fraction and less visible in the fluorescent and broken fractions
- Bulk sample exhibits only a mild SVOC PTD profile and no IMP visible in SVOC or IVOC

# IMP AND FLUORESCENCE AS MARKERS FOR PTD COFFEE

IMP is found in the sort fractions associated with insect activity or damage: insect damaged, fluorescent, broken



Blue fluorescence often occurs on spots that have slight discoloration.

# **TENTATIVELY,**

**IMP found in the interior of the beans in fractions with insect or other damage supports the connection of PTD and antestia activity.**

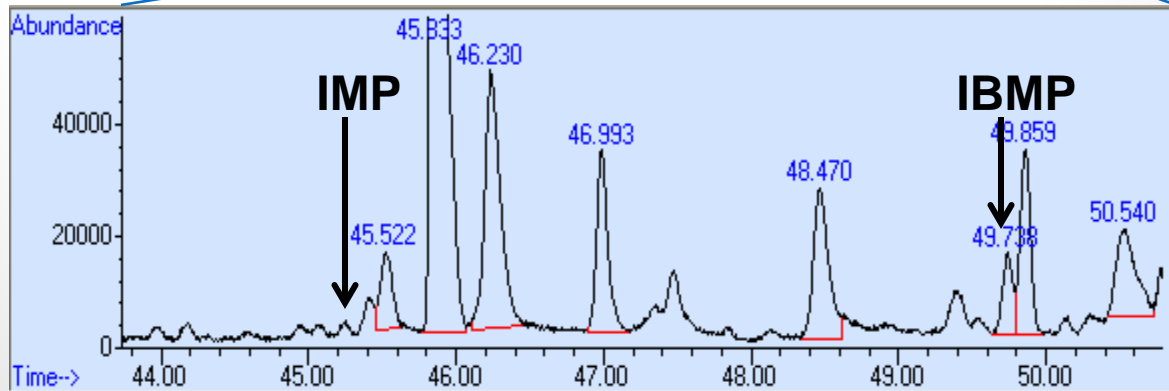
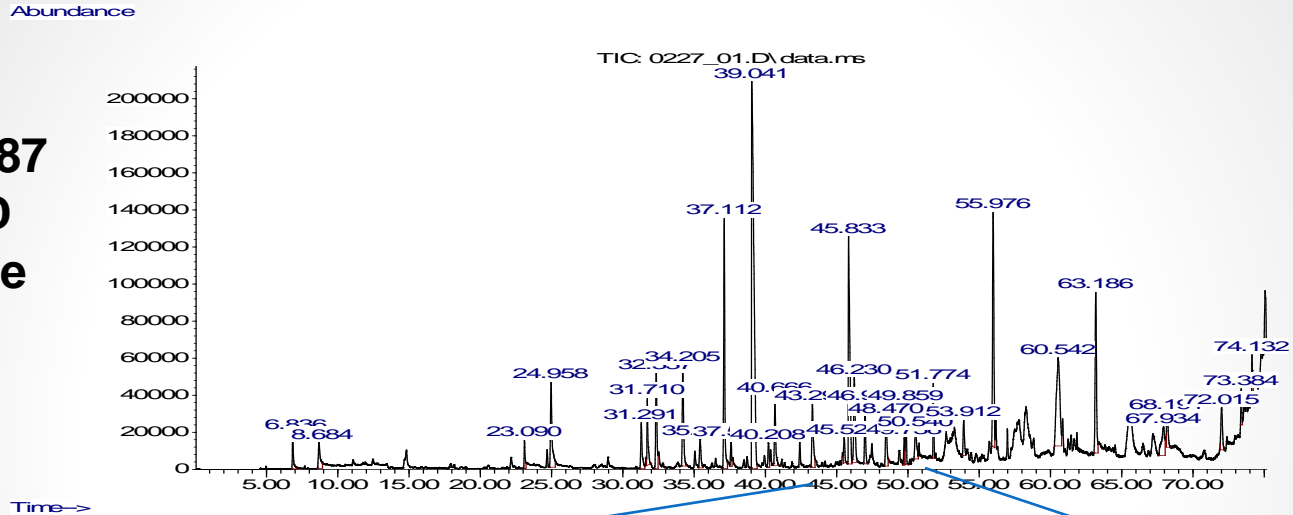
**But, IMP in the interior of the beans raises the possibility that the bean itself produces IMP in response to stress of antestia or environmental effects!**

**IMP concentrated in the insect damaged fraction gives a clue about where to look for the “bad beans.”**



# QUESTION: DO THE RWANDAN PTD SAMPLES ALSO HAVE IMP INSIDE THE BEANS? YES

SG-3387  
A PTD  
Sample



# **FUTURE WORK**

- **Collaborate with RFC and Rwandan farmers to continue to characterize PTD in green coffee**
- **Pursue the “bad bean” in the insect damaged fraction of PTD samples**
- **Obtain some really bad insect damaged samples (primary sort on the farm) to verify that PTD has been removed**
- **Continue to study antestia volatiles (further identification and characterization) to link with PTD**

# Acknowledgements

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## Rwanda Antestia-Potato Taste Research Group



- Ruth Church of Espresso Elevado for donating the large sample
- Dr. Mario Serracin and Mr. Ed Whitman, Rogers Family Company for sample characterization
- Mr. Steve Miller, Seattle University Chemistry Department



# Questions?

