Chemical Compounds in Green Coffee and Impact on Quality

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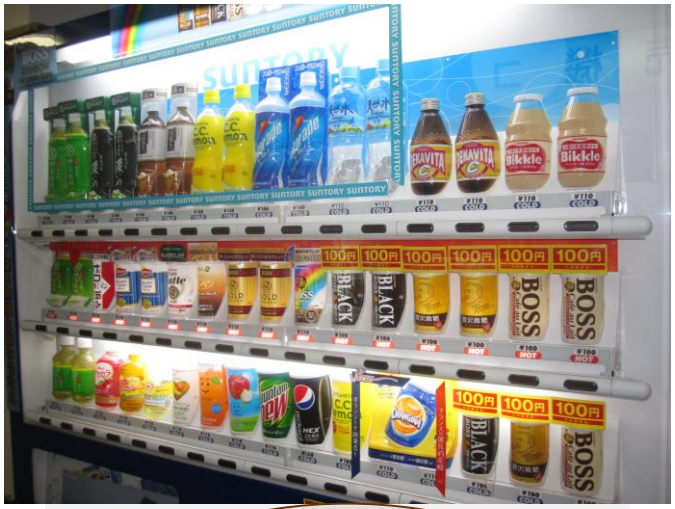
Chifumi Nagai, Keiko Iwasa, Harumichi Seta, Hiroaki Shimizu and Koichi Nakahara

SUNTORY



What determines the beverage quality of coffee ?

Green beans quality

Roasting control

Extraction control

Green bean property may have major impact on beverage quality

Understand the relationship between green beans and cupping score

Green beans quality

Cherry properties

Cultivar
Maturity
Location of the trees
Agronomic practice

Background and Need of the Project

1. No universal standard to asses the quality of coffee green beans in the coffee market

2. Grading criteria for green beans:
   - Number of defective beans
   - Screen size of beans
   - Elevation of the growing areas

4. Factors affecting green bean and cupping quality:
   - Cultivar
   - Environment (soil, temperature, sunlight, rainfall/ irrigation, fertilizer etc)
   - Bean maturity

5. Tools to evaluate green beans for cupping quality:
   - Cupping scores by qualified cuppers
   - Limited chemical analysis

Goals of the Collaborative Research

- Develop a new tool to select green beans which produce high quality coffee beverages.
- Understand the relationship between chemical components of green beans and cupping scores.

The strategy

- Green beans : Known cultivars,
  In the same field at HARC Kunia
  Harvested within 2-3 days
  Same processing method

- Chemical Analysis = **Metabolomics**
  Systematic study of metabolites.
  Metabolites are chemical products produced in living organisms

Green beans metabolites determine the beverage quality

Green beans
property

Quality of Coffee beverage

What is the key metabolites for quality?

Factors

Cultivar

Maturity level

Growing condition

Processing

Metabolite property

Green beans

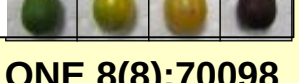
Quality

Flavor & taste

Sample collection at HARC Kunia Field, Oahu, Hawaii

Harvesting and processing coffee cherry

9 Cultivars ***4 Maturity level*** → ***Green cherry*** → ***Pink cherry*** → ***Red cherry*** → ***Dark Red cherry***

1	Catimore 5175-1	
2	Red Catuai	
3	F1 Hybrid of Catimor and Tall Mokka (5175-1 xMA2-7)	
4	Maragogipe	
5	Tall Mokka MA 2-7	
6	SL28	
7	Typica	
8	Yellow Bourbon	
9	Yellow Catuai	

*** PLoS ONE 8(8):70098**

Strategy of Metabolic profiling

HARC, Kunia

Green beans

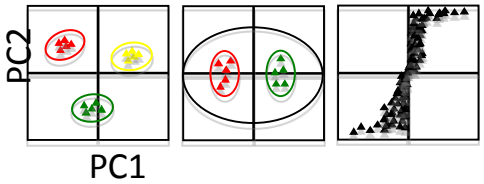
1) Grinding
2) Extraction by 70 % methanol

LCMS data of green bean extracts

Labs at Suntory

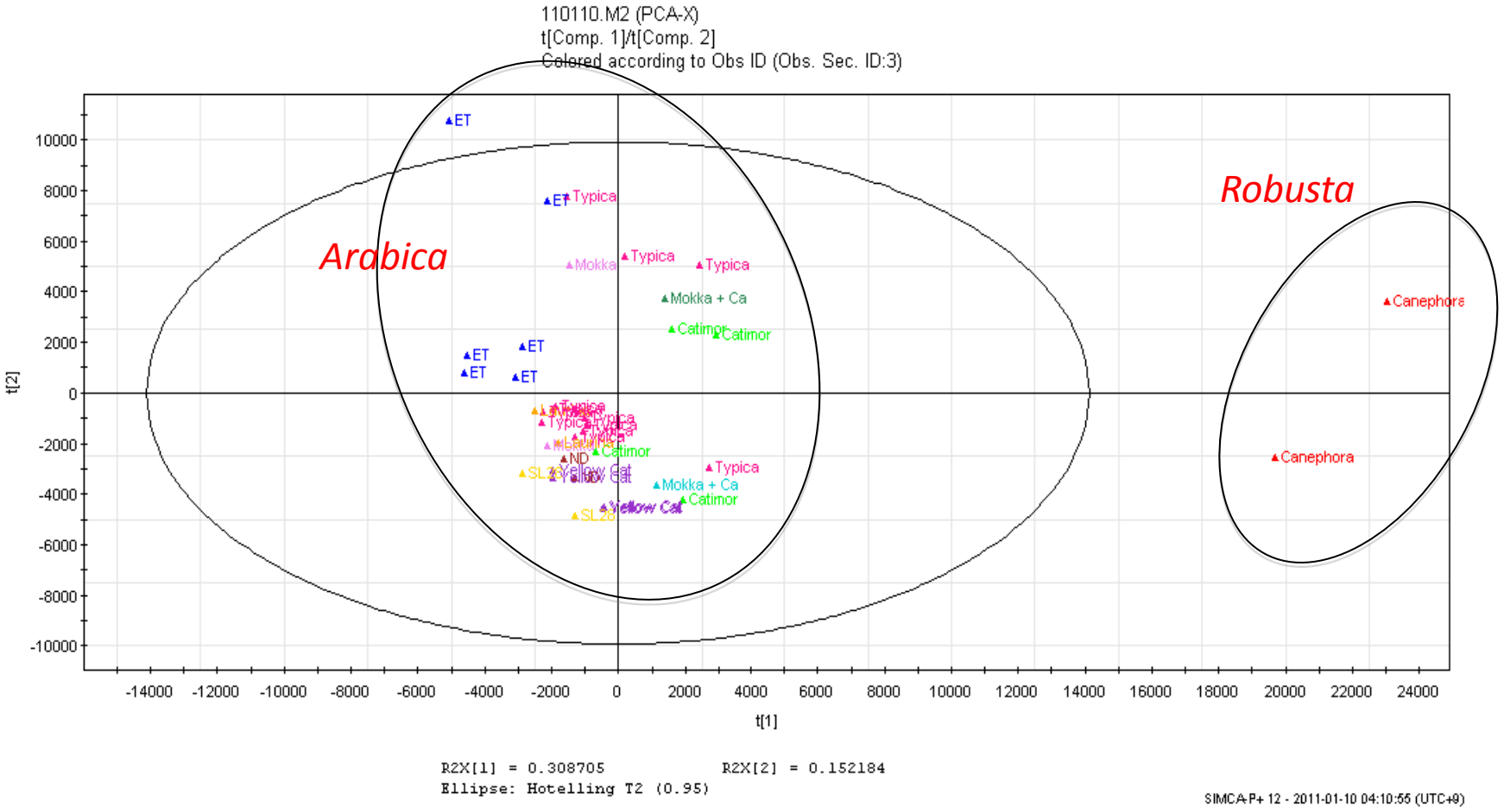
Over 3,200 chemical signals

Multivariate analysis

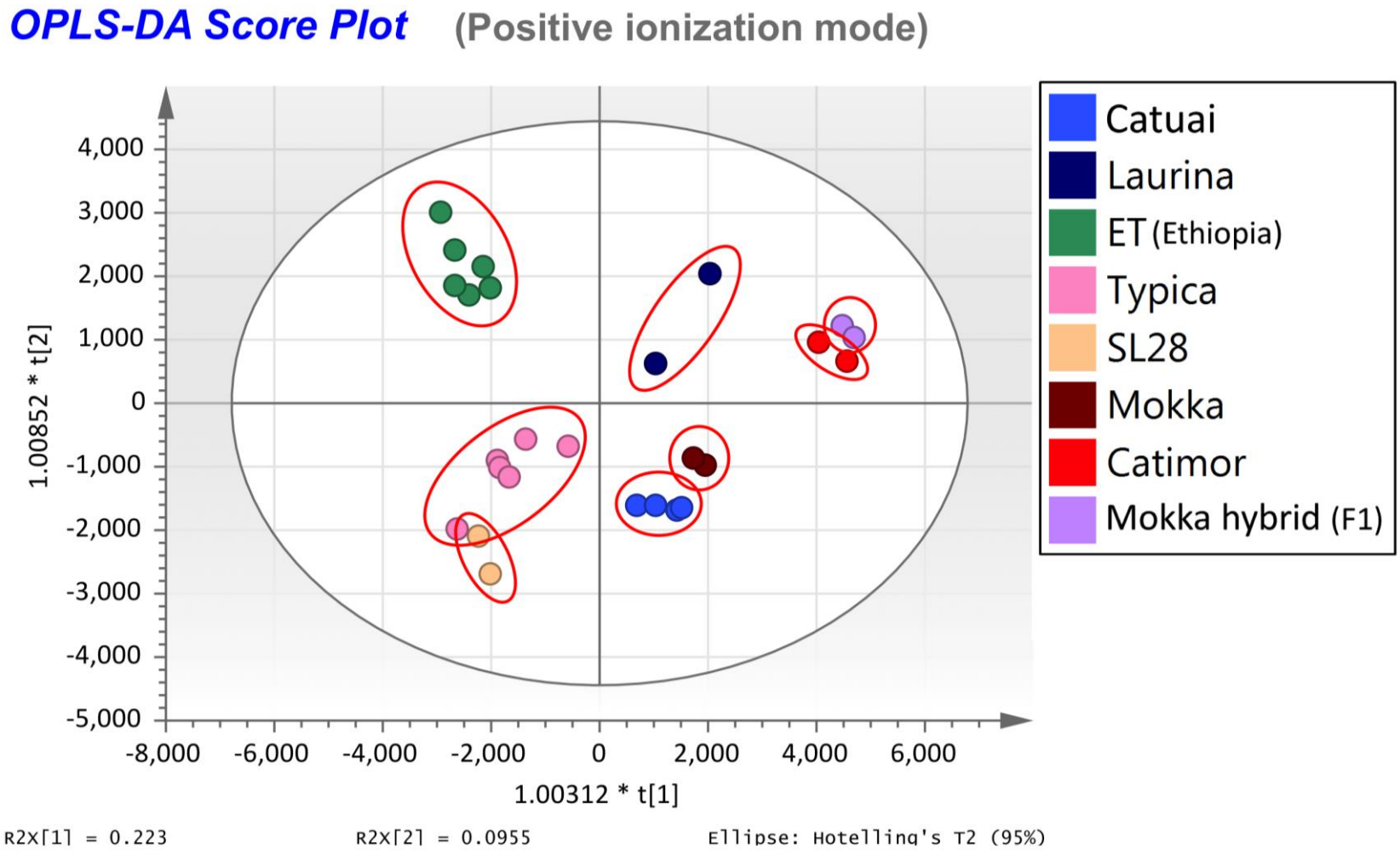


Data Processing
Multivariate analysis

Arabica vs Robusta



Arabica cultivars

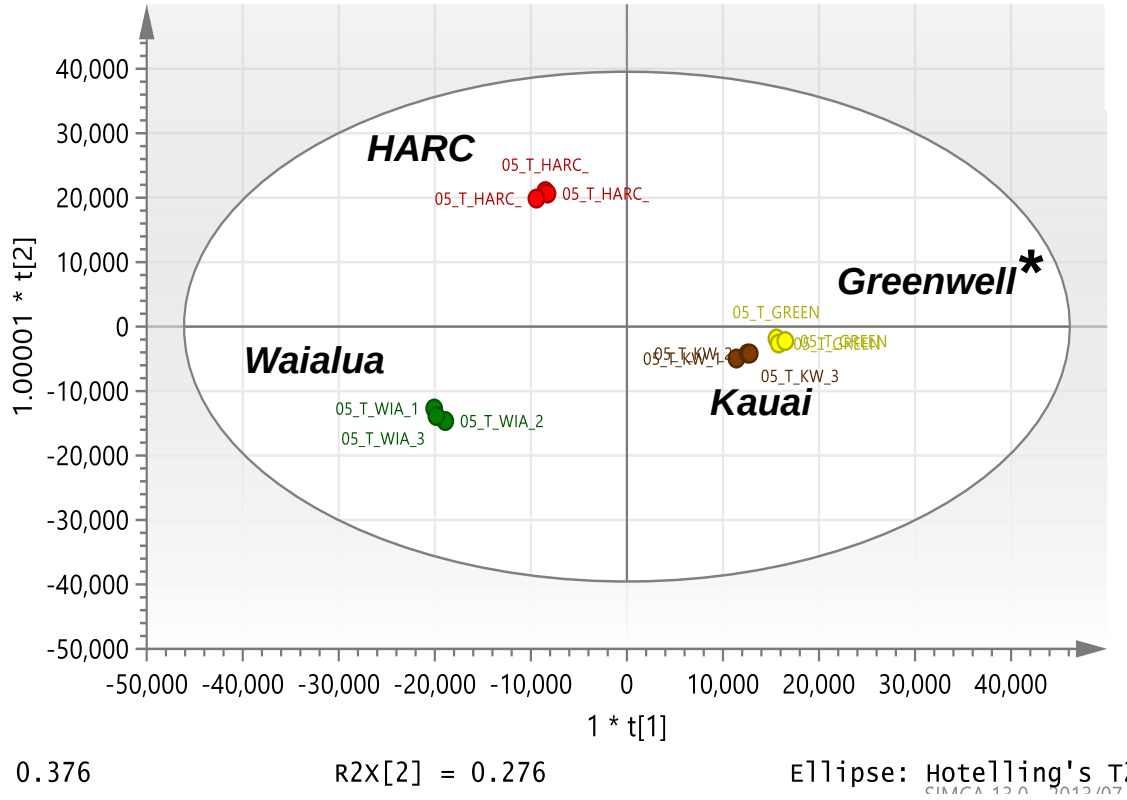


Typica from 4 growing areas on 3 islands

Location:	Fields	Harvest Dates
Waialua,	Waialua Estate Coffee& Chocolate	October 2012
Kunia,	HARC	October 2012
Kona,	Greenwell Farms	October 2012
Kauai,	Kauai Coffee	January 2013

Analysis of green beans from 4 fields - Cultivar : Typica

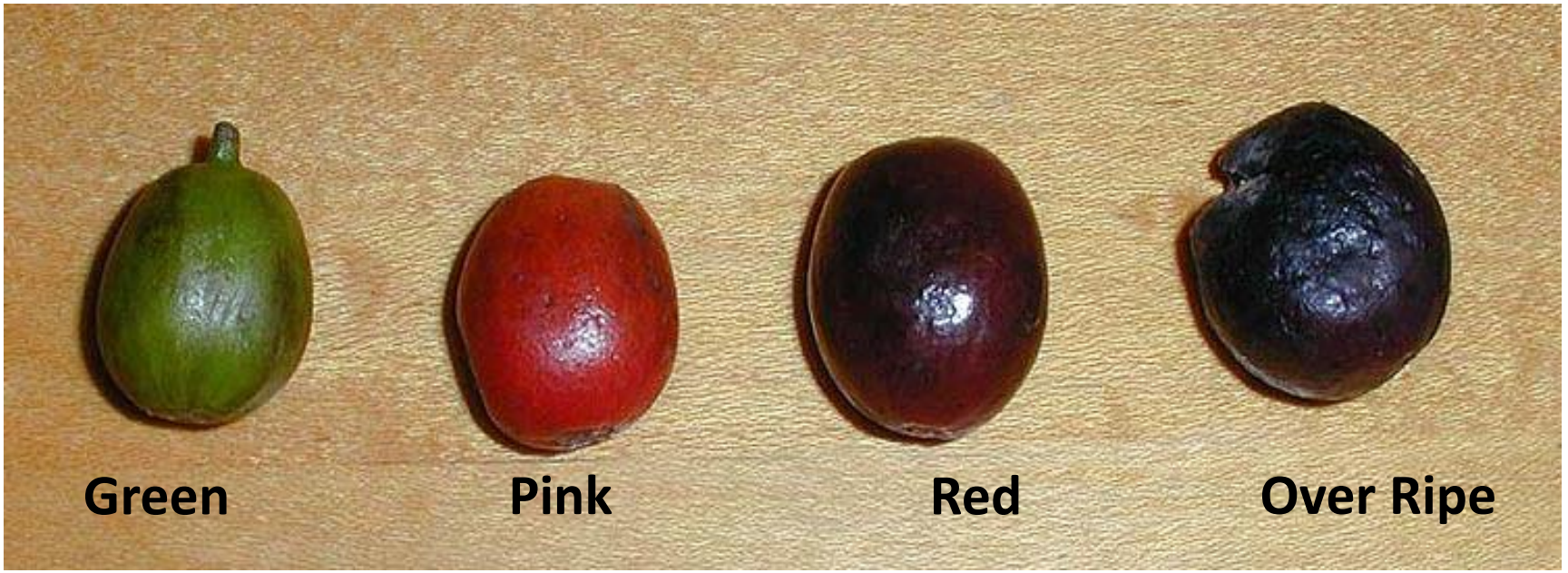
◆ ***OPLS-DA, Scatter Plot***



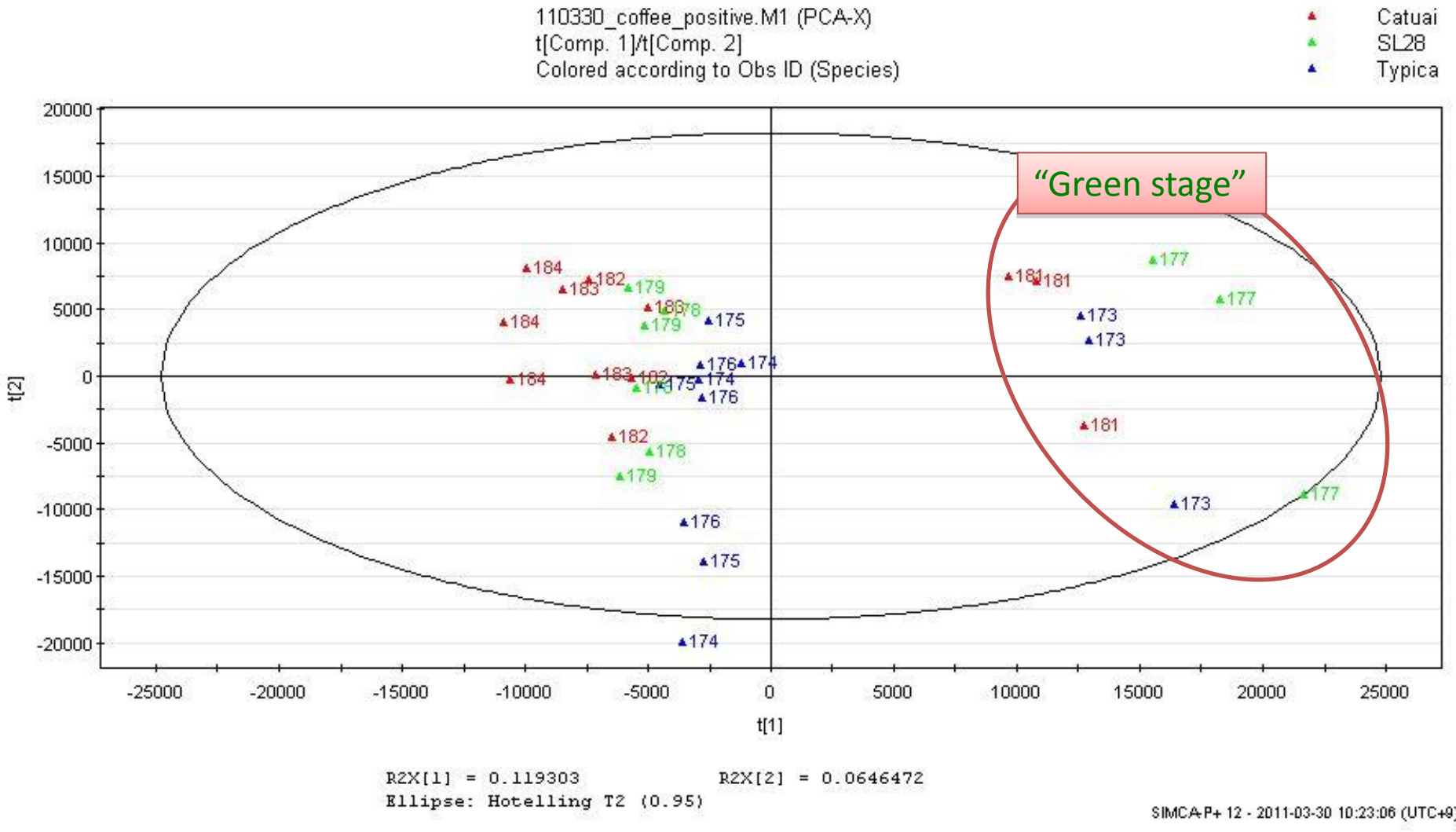
* ***Only Greenwell's beans are high density beans separated by gravity concentration. The other beans are not separated.***

From the viewpoint of chemical components, the property of Kauai is similar to the property of Greenwell.

Maturity Levels of Cherries



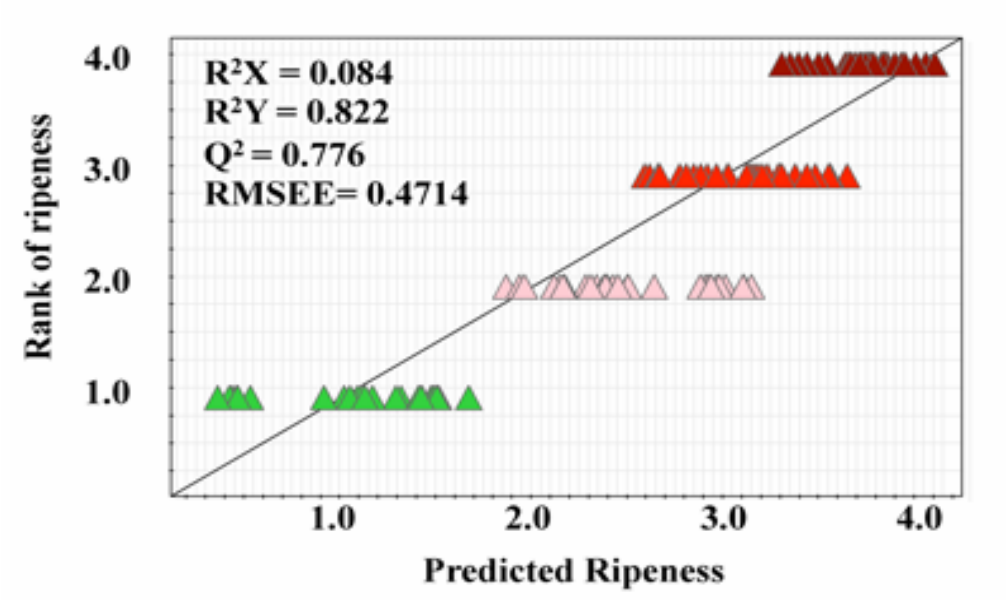
PCA for Maturity Levels of 3 cultivars



Prediction of Ripeness by Chemical profiling

Searching for “key metabolite” correlating to maturity level

PLS regression model



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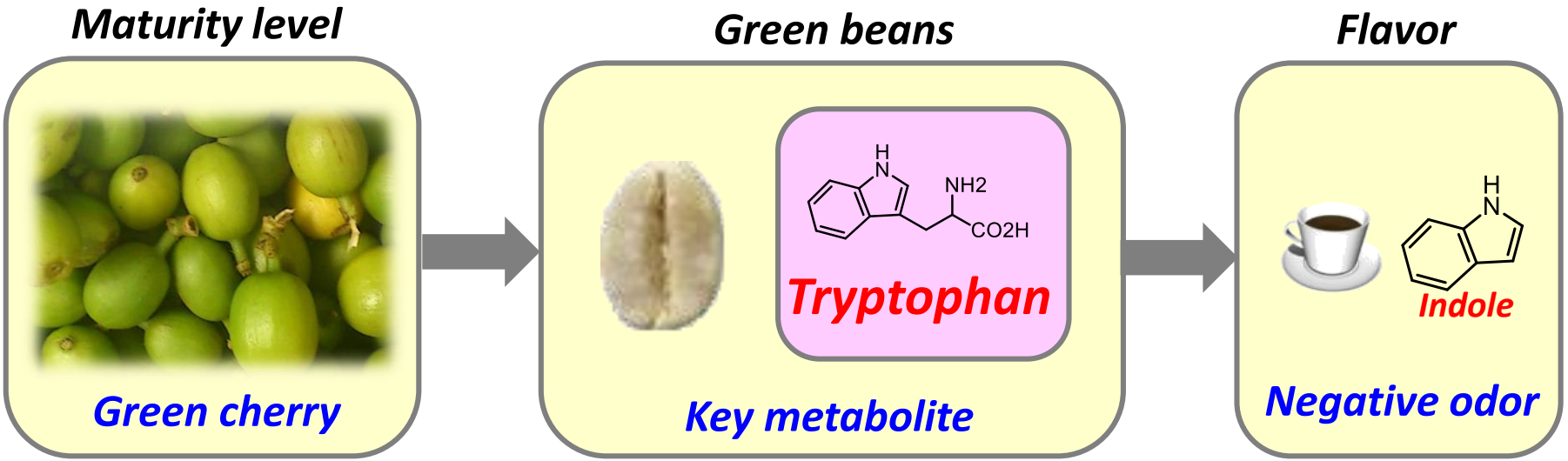
“key metabolite” correlating to maturity level



- Tryptophan is a specific marker of immature green beans.
- Tryptophan is the cause of indole and methyl indole by roasting.
- Indole and methyl indole give coffee beverage the negative odor.

http://www.suntory.com/softdrink/news/pr/d/SBF0198.html

Chemical compounds in green beans predict precisely the coffee cupping quality

Green coffee beans:
36 samples: various locations and producers in Guatemala

Roasting

Powder, Extraction

Chemical analysis by LC-MS
2,649 signals of metabolomic information

SCAA Cupping Score

SCAA cupping score (points)	
89	89.0
88	
87	
86	
85	
84	84.0, 84.0, 84.25
83	83.0, 83.0, 83.25, 83.25
82	82.0, 82.0, 82.0, 82.0, 82.0, 82.25, 82.25, 82.5, 82.75
81	81.0, 81.25, 81.25, 81.5, 81.5, 81.75, 81.75
80	80.0, 80.0, 80.75, 80.75, 80.75
79	79.0, 79.5, 79.5
78	78.25, 78.5
77	77.5
76	76.5

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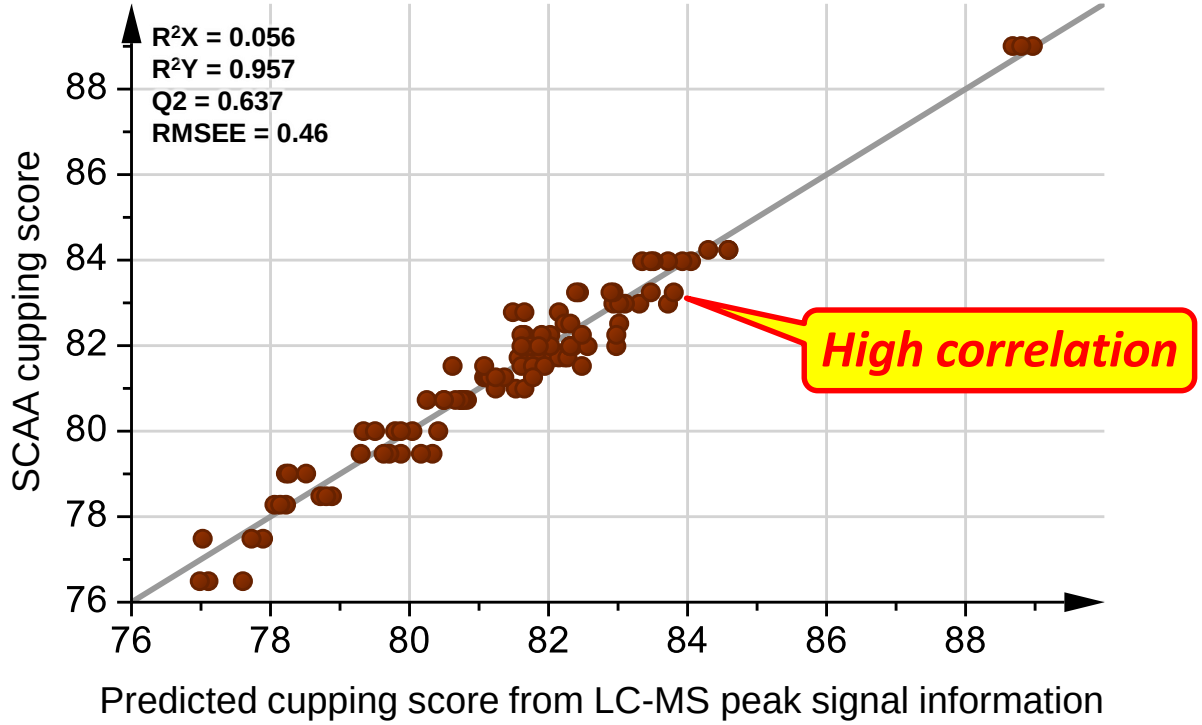
Prediction of beverage quality from green beans metabolites



Metabolomic information is a precise predictor of SCAA cupping score

Novel compounds in green beans

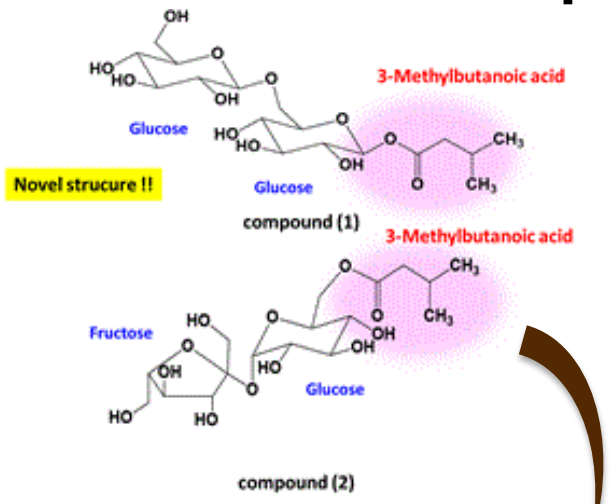
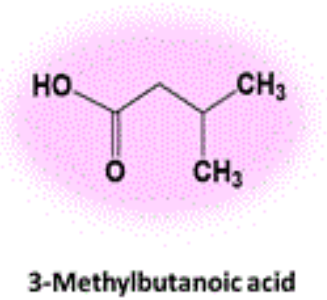


Figure 2. Two isomers of 3-methylbutanoyl glycosides in raw beans.
These compound contents are higher in the raw beans with higher cupping score.

Roasting (230◦C 10 min)

Thermal reaction product



3-Methylbutanoic acid

Figure 3. 3-Methylbutanoic acid in roasted beans
This compound are generated by the thermal reaction of 3-methylbutanoyl glycosides.

3-Methylbutanol disaccharides (3MDs) are 2 key compounds in green beans

Cupping scores

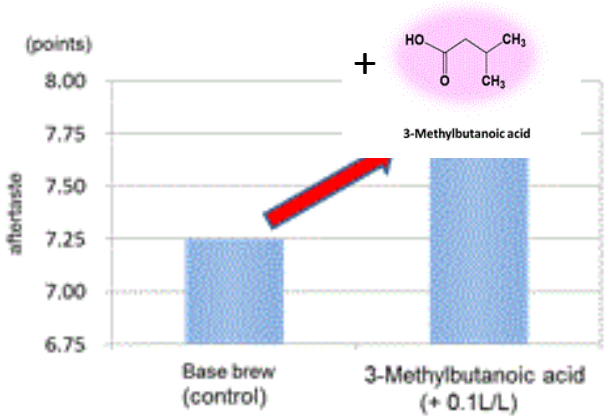


Figure 4. Sensory evaluation (cupping score of aftertaste)
The addition of 3-methylbutanoic acid improves the quality of coffee beverage.

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Conclusion

By using chemical information of green beans,
We were able to discriminate cultivars,
maturity levels and cupping scores

In future
We are going to focus on

- Agronomical practices: Irrigation/Fertilization
- Processing methods: Wet process, Natural
- Correlation between metabolites and gene expression

References

Setoyama, D., K. Iwasa, H. Seta, H. Shimizu, Y. Fujimura, D. Miura, H. Wariishi, C. Nagai and K. Nakahara. High-throughput metabolic profiling of diverse green *Coffea arabica* beans identified tryptophan as a universal discrimination factor for immature beans. 2013. PLOS ONE 8(8): e70098. doi:10.1371/journal.pone.0070098

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http://www.suntory.com/softdrink/news/pr/d/SBF0198.html

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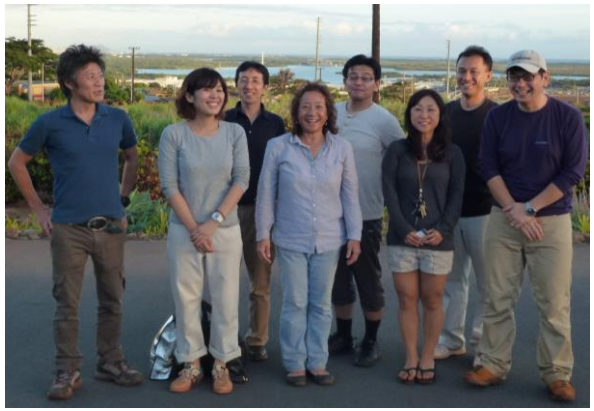
The Team

Suntory Global Innovation Center limited Kyoto, Japan

Dr. K. Nakahara
H. Shimizu
H. Seta
Dr. K. Iwasa
K. Iwaki
K. Ochiai
S. Nakamura



HARC: Kunia, HI

Dr. Chifumi Nagai
Sayaka Aoki
Becky Heinig
Lance Santo

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Dr. Mel Jackson
Derek Lanther- Waialua Coffee
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Pepe Miranda

Kyushu University
Innovation Center for Medical Redox Navigation,
Fukuoka, Japan

Drs. H. Wariishi, Y. Fujimura, D.Miura, D.Setoyama