# Redefining Coffee Education: The Proven Irrelevance of Organic Acids Training

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## Acids in brewed coffees: Chemical composition and sensory threshold

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IX. *On the Problem of the most Efficient Tests of Statistical Hypotheses.*

*By* J. NEYMAN, *Nencki Institute, Soc. Sci. Lit. Varsoviensis, and Lecturer at the Central College of Agriculture, Warsaw, and* E. S. PEARSON, *Department of Applied Statistics, University College, London.*

(*Communicated by* K. PEARSON, *F.R.S.*)

(Received August 31, 1932.—Read November 10, 1932.)

CONTENTS.



INTRODUCTORY.

The problem of testing statistical hypotheses is an old one. Its origin is usually connected with the name of THOMAS BAYES, who gave the well-known theorem on



[Published February 16, 1933.

# Statistics

is

Mathematics-based constructively critical thinking!

Almost a hundred years old!!

[Published February 16, 1933.

# The essense of statistical thinking

| What is ***believed*** to be the case | What ***is*** the case in 'Rality' | |
|---|---|---|
| | True | False |
| Believed | Correct | You think it is the case but in reality it is not (**Type 1** error) |
| Not believed | You think it is not the case but in reality it is (**Type 2** error) | Correct |

# Medical tests, Covid-19

| Do I have Covid-19? | What ***is*** the case in 'Rality' | |
|---|---|---|
| | You actually **have** Covid-19 | You actually **don't have** Covid-19 |
| My **test was positive** so I think I have Covid-19 | True Positive<br>Correct | False Positive<br>You think it is the case but in reality it is not (**Type 1** error) |
| My **test was negative** so I don't thikn I have Covid-19 | False Negative<br>You think it is not the case but in reality it is (**Type 2** error) | True Negative<br>Correct |

# Baby nappy

| Do I need to change it? | What ***is*** the case in 'Rality' | |
|---|---|---|
| | There is something | There is nothing |
| Olfactions tells me there is something | True Positive<br>Needs a new | False Positive<br>Turned out it was only gas |
| Olfaction tells me there is nothing | False Negative<br>There is something but it never smelled like there was | True Negative<br>Does not need a new |

# Legal judgments

| Do we think the person is guilty | What ***is*** the case in 'Rality' | |
|---|---|---|
| | The person did it | The person never did it |
| We think the person is guilty | Correct<br>The person is correlty convicted | Judicial murder (**Type 1** error) |
| We think the person is not guilty | False Acquittal (**Type 2** error) | Correct<br>Correct Acquittal |

# Ghosts

| Do you believe in ghosts? | What ***is*** the case in 'Rality' | |
|---|---|---|
| | Ghosts exists | Ghosts don't exist |
| I believe ghosts exists | Correct<br>True believe | Superstitious (**Type 1** error) |
| I don't believe ghosts exists | Close-minded (**Type 2** error) | Correct scepticism about ghosts |

# Other cases

- Security in airport (T1E: False alarm ; T2E: Miss dangerous item)
- Spam detection (T1E: Non-spam in filter ; T2E: Spam in your inbox)
- Burglary alarm (T1E: False alarm ; T2E: Furniture gone but no alarm)
- Marriage (T1E: Jealous partner ; T2E: Affair)

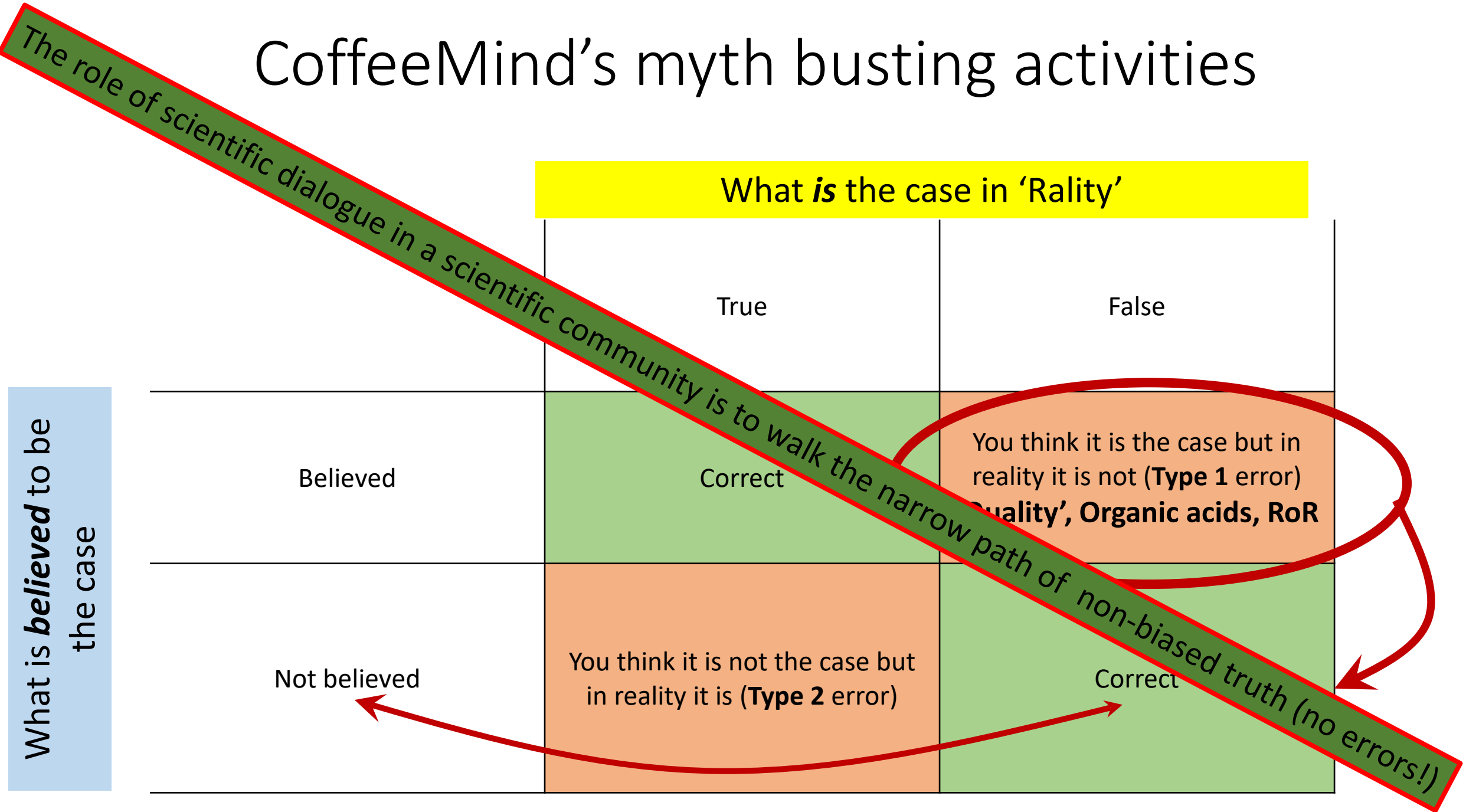
# Meditation and deep neurological implications

Morten's masters thesis: **Contemplative Experience and Science**
How Science and Tibetan Buddhism Grasp Contemplation through Phenomenology and the Theory of Science

What ***is*** the case in 'Rality'

| What is ***believed*** to be the case | True | False |
|---|---|---|
| Believed | Correct | You think it is the case but in reality it is not (**Type 1** error) |
| Not believed | You think it is not the case but in reality it is (**Type 2** error) | Correct |

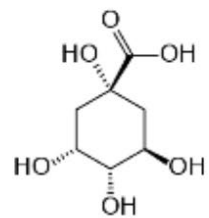
# CoffeeMind's myth busting activities

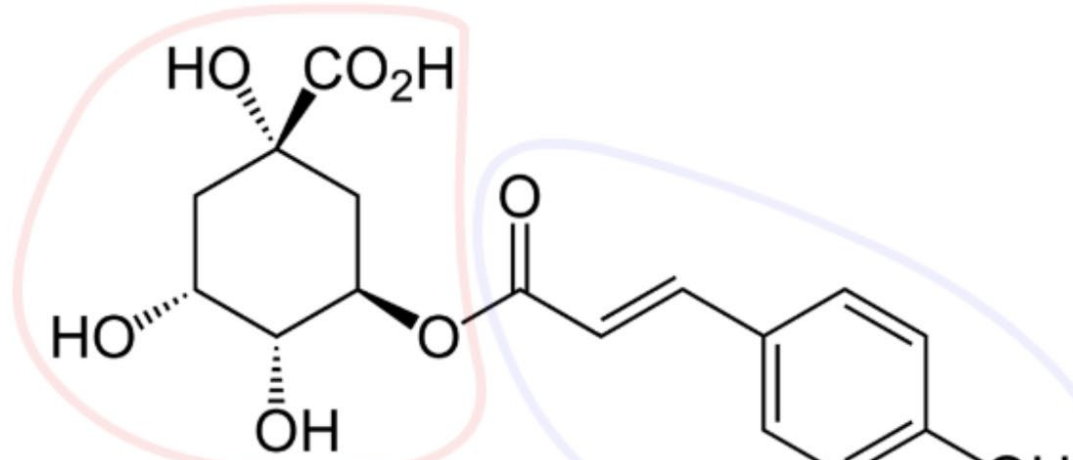


# Types of causalities / levels of reality

| Realm | Area | Types of law | Consequence |
|---|---|---|---|
| Spirit | Values/Religious | Ethical | Moral |
| Mind | Legal | Societal | Prosecution |
| Body | Physical | Scientific | Malfunction |

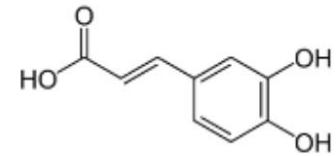
Chlorogenic Acid

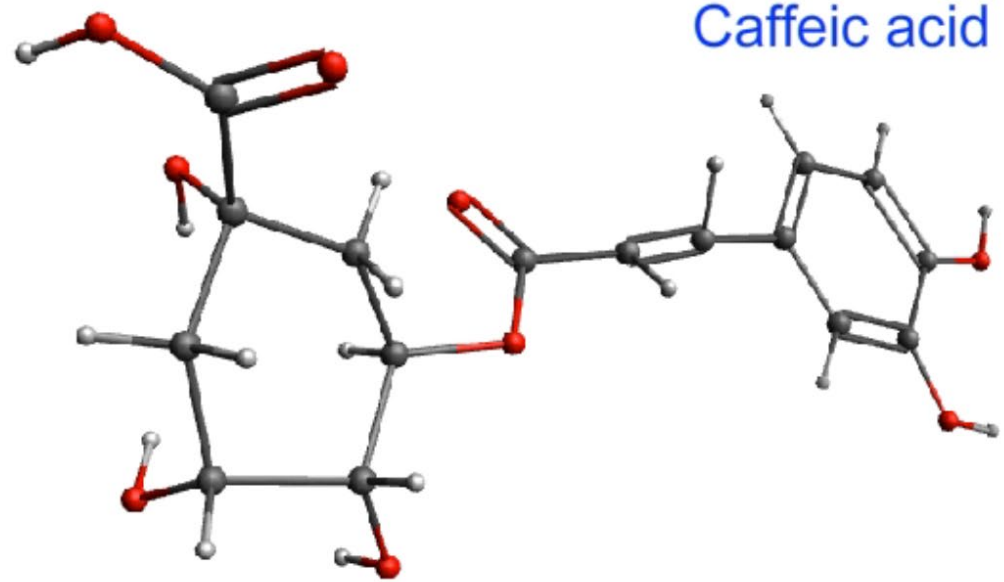




Quinic acid

Caffeic acid



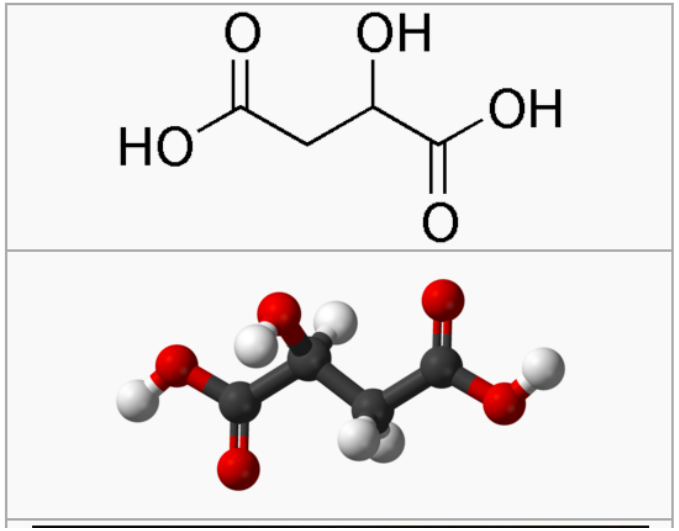


Source of bitterness

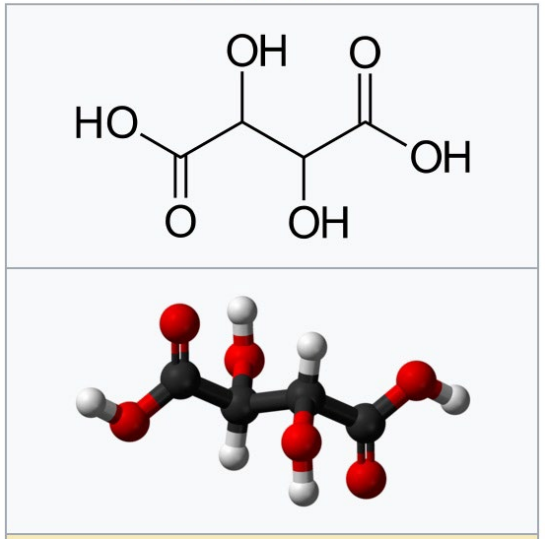
# Acids in green

Already in green coffee

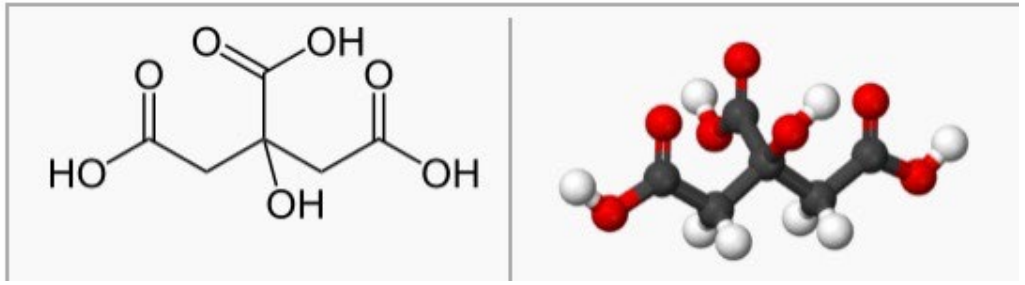
Malic acid




Tartaric acid[1]



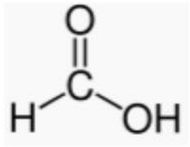

Citric acid



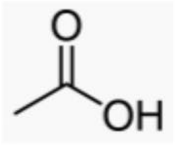
# Acids

Created during roasting and Glucose derived

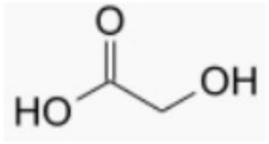
Formic

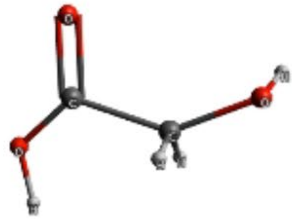



Acetic

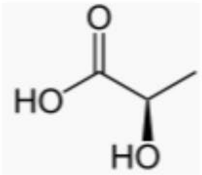


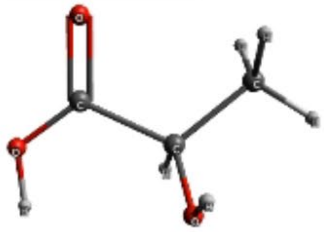

Glycolic



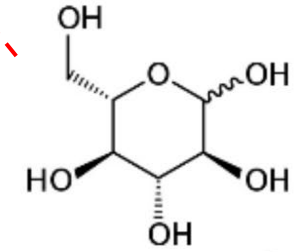



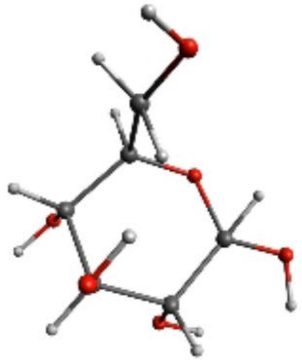
Lactic



Derived from Glucose



# Background

**What have been done previously?**

**30 scientific papers** from **1959-2020** have reported about **Organic Acids in coffee -** green, roasted, and brewed(Yeager et al., 2021)

**Only 4** scientific papers have reported firsthand data on the Organic Acids in **brewed coffee**

**Espresso** (Khamitova et al., 2020)
**Cold brew** (Ahmed et al., 2019),
**ISO standard** (Rodrigues et al., 2007)
**Different brewing conditions** (grind size, brew temperature and brew time) (ICO, 1991)

# Sensory
# Detection Threshold

## Method

Two Alternative Ascending Forced Choice (2-AFC)

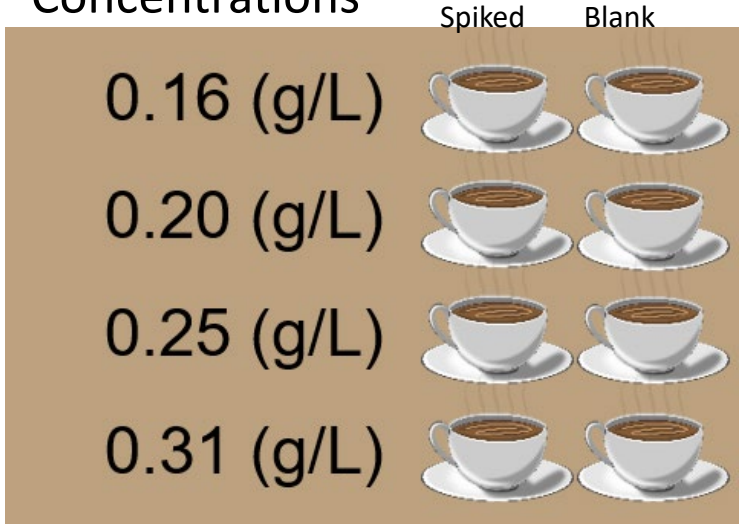
N = 24 consumers

## Acid selection

Based on Coffee Quality Institute (CQI) and
Specialty Coffee Association (SCA) training

- Citric, malic, acetic, lactic and phosphoric

Concentrations




5 test set in total

## Concentrations

0.4 (g/L) all acid

0.5 (g/L) lactic

Mean measured consentration

# Recognition test

**Method**

**N = 13 Coffee Experts**

**Training**

The experts train regularly, also with acids

30 minutes intense training prior test

**Test**

According ISO standard 3972:2011

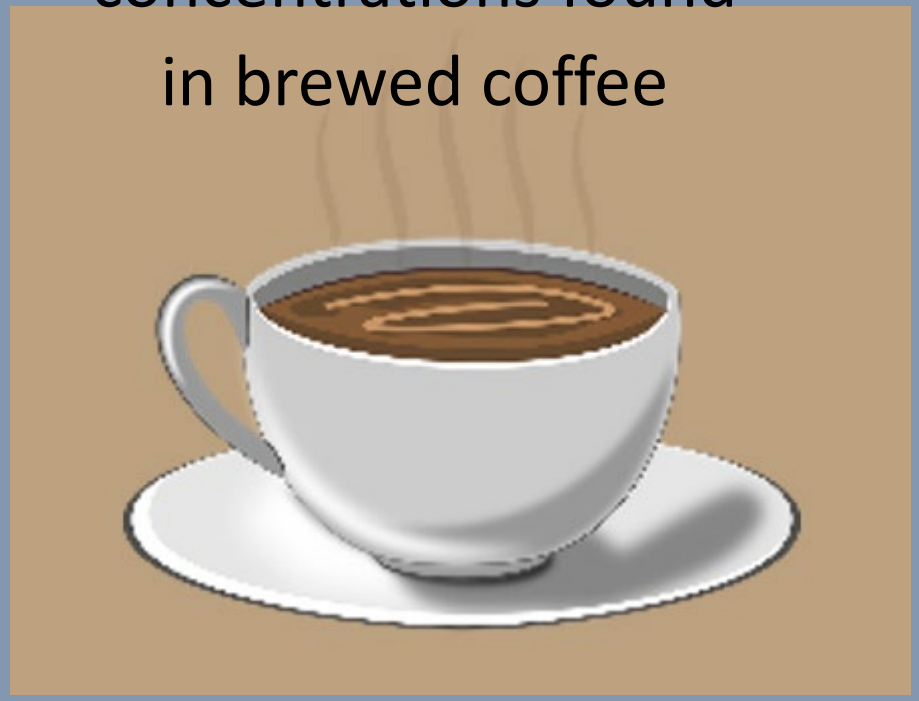
”name the acid spiked in this water/coffee”,
Suggestions were provided

# In Water

Only **acetic acid** was significantly recognized in **water,** at test concentrations (0.4-0.5 g/L)

# In Coffee

**No acid** was significantly recognized in **Coffee,** at concentrations found in brewed coffee



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REVIEW



# Acids in coffee: A review of sensory measurements and meta-analysis of chemical composition

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Looking at **green** and **roasted** coffee (not brewed) and focus mainly on Chlorogenic acids differences between Robusta and Arabica

## Conclusion:

"One overarching **conclusion** is that relatively **little research** has been performed on OAs in coffee, **despite their important role in sensory quality**. Data for the less abundant acids in coffee, such as lactic, formic, and tartaric acid, was notably sparse compared to CGAs. Our hope is that the data presented here help illustrate the need for future research to focus on acid concentrations across varying roast levels to help **understand their role in consumer appreciation of coffee**."

# ACIDITIES

| Acids | SCAE | Q-grader | SCAA Flavo Wheel |
|---|---|---|---|
| Citric | X | X | X |
| Malic | X | X | X |
| Tartaric | X | | |
| Lactic | X | | |
| Phosphoric | | X | |
| Acetic | | X | X |
| Butyric Acid | | | X |
| Isovaleric acid | | | X |

# Organic acid identification in education

“There is no evidence to support the choice of these specific acids instead of other acids in coffee, or to justify why they are added to water and coffee and why they are all tested in a concentration of 0.4 g/L except the lactic acid which is tested in a concentration of 0.5 g/L (Personal communication with Ida Steen from CoffeeMind, 2017)”

“a weak tendency of the assessors being able to differentiate citric/malic, citric/tartaric, and phosphoric/citric are seen”

“acetic acid is the only acid where all the results show that the assessors have a significant ability to differentiate the acid as all the results concerning acetic acid are significant”

“Acetic acid differs from all the other acids by being detectable by nasal inhalation in a low concentration and not only in a high concentration”

“when acetic acid is present as single acid in water, the assessors were also able to identify this acid as the only acid, but after mixing it with just one acid the assessors were not able to identify it anymore. This indicates that it will be very difficult to recognize the acids in a cup of coffee which contains many other flavors”

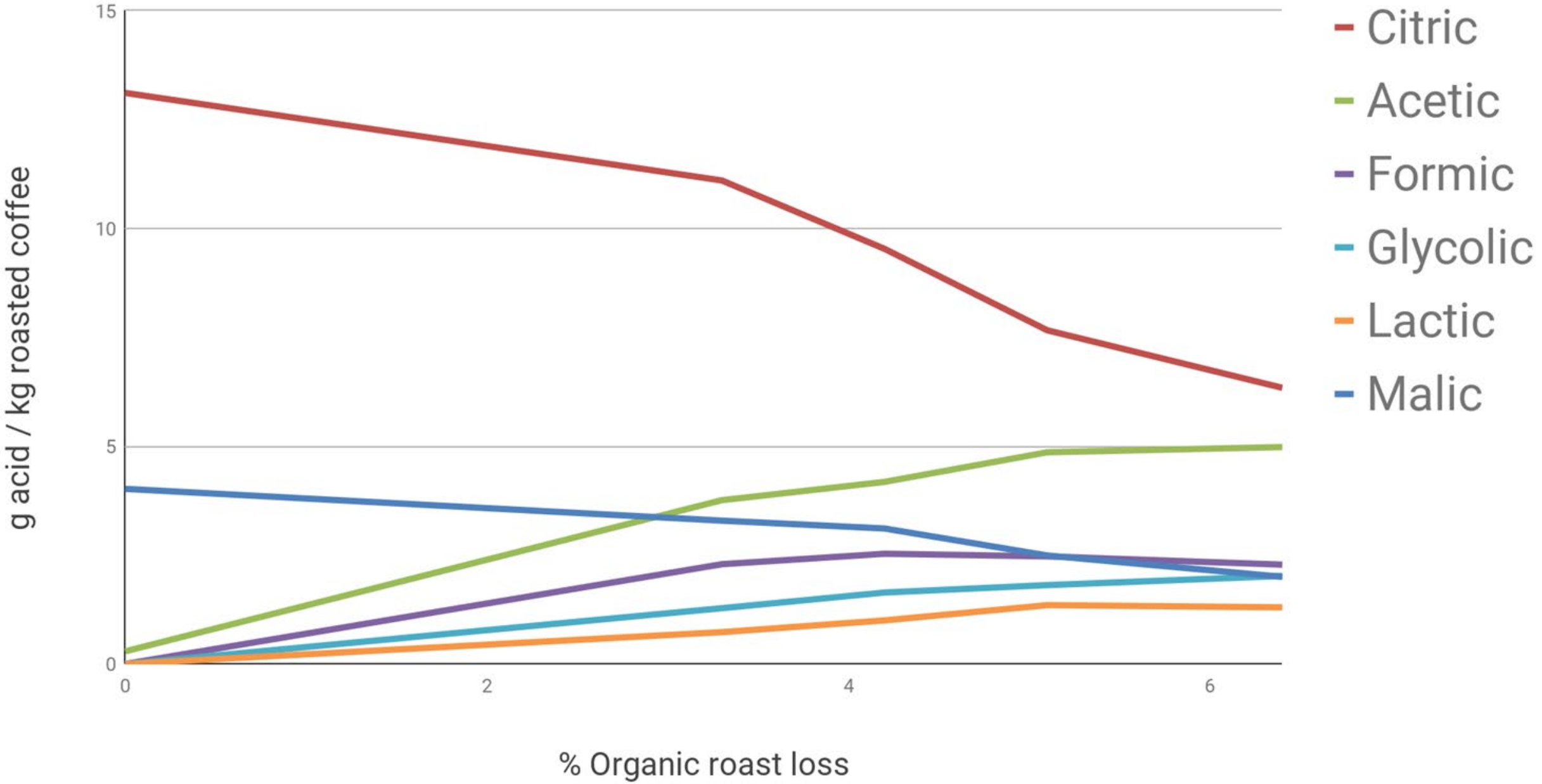
*Master thesis by **Christine Maae Bach**, August 2017*

# Organic acids in coffee from a chemical perspective

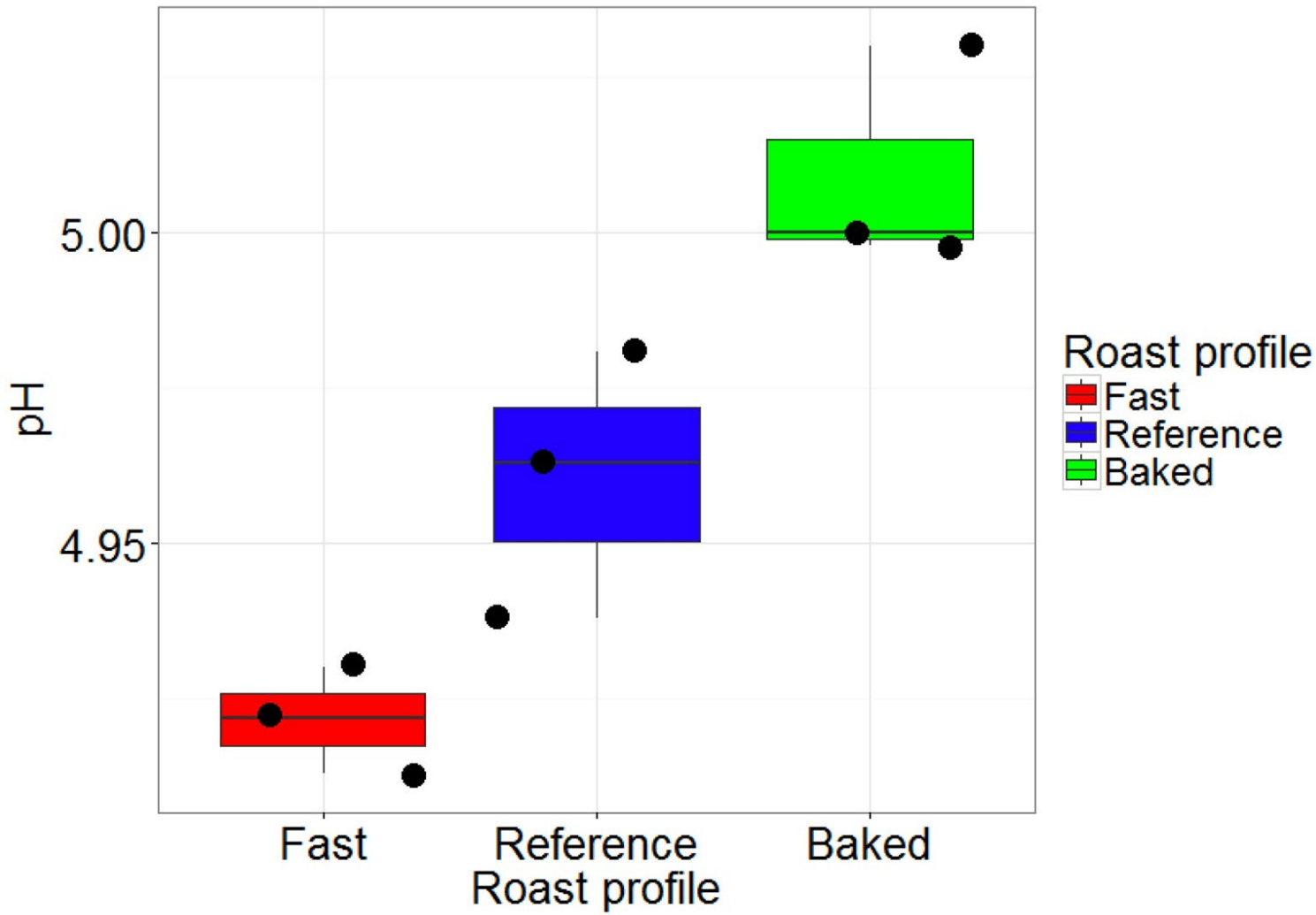
- Natural Ethiopian, Pulped Natural Brazil and Washed Kenya had same distribution (ranked concentrations):

| Type of acid | Concentration (g/L) |
|---|---|
| Citric acid | 0.4 |
| Acetic acid | 0.22 |
| Formic acid | 0.14 |
| Lactic acid | 0.12 |
| Tartaric acid | 0.10 |
| Phosphoric acid | 0.05 |

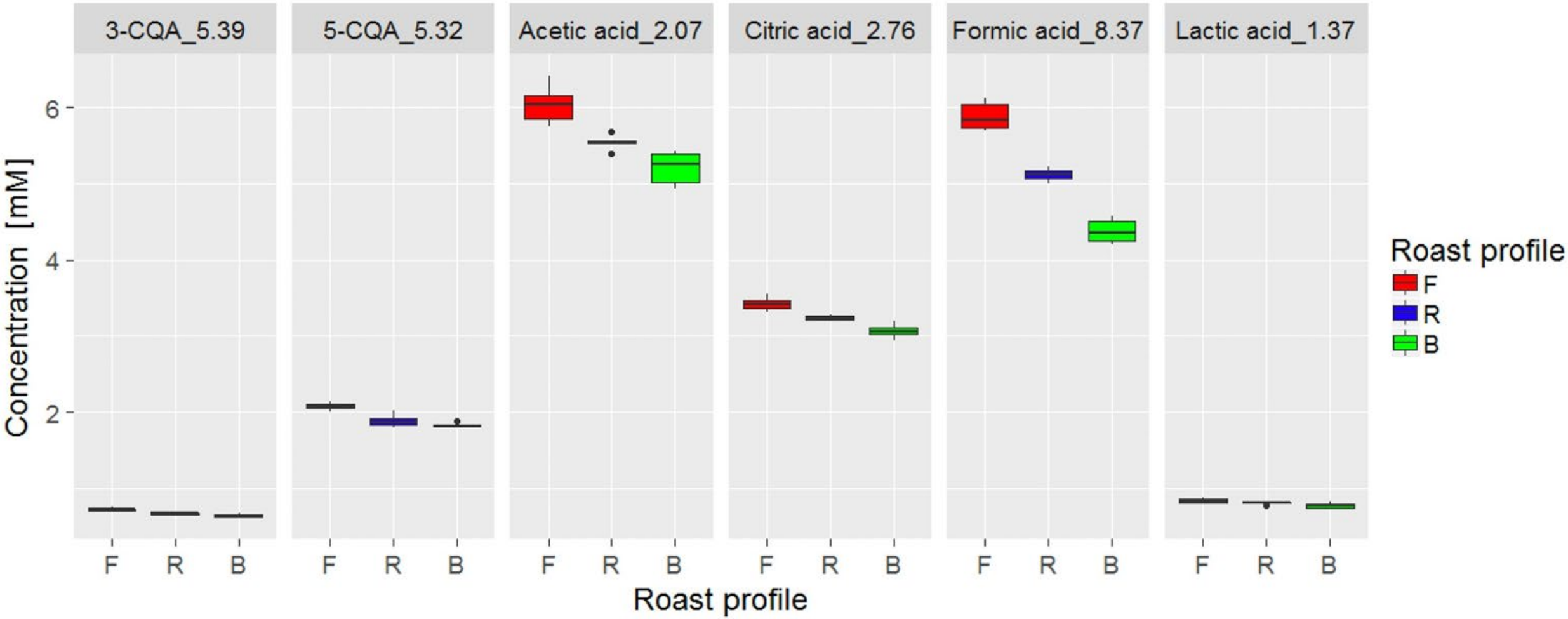
*“Coffee: Recent Developments”*
*Ronald Clarke, O. G. Vitzthum 2001*



# Organic acids in roasting



# Organic acids in roasting



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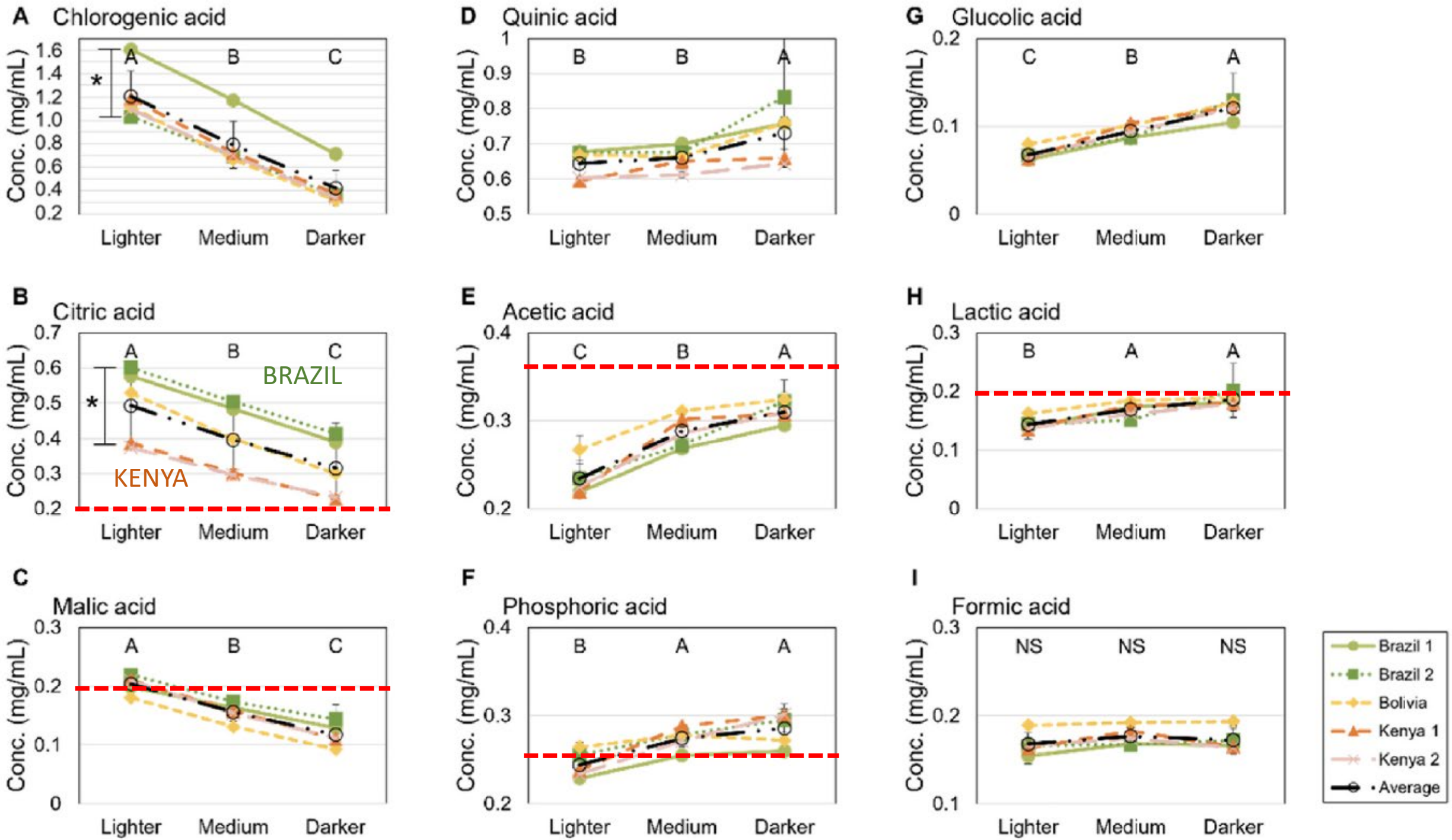
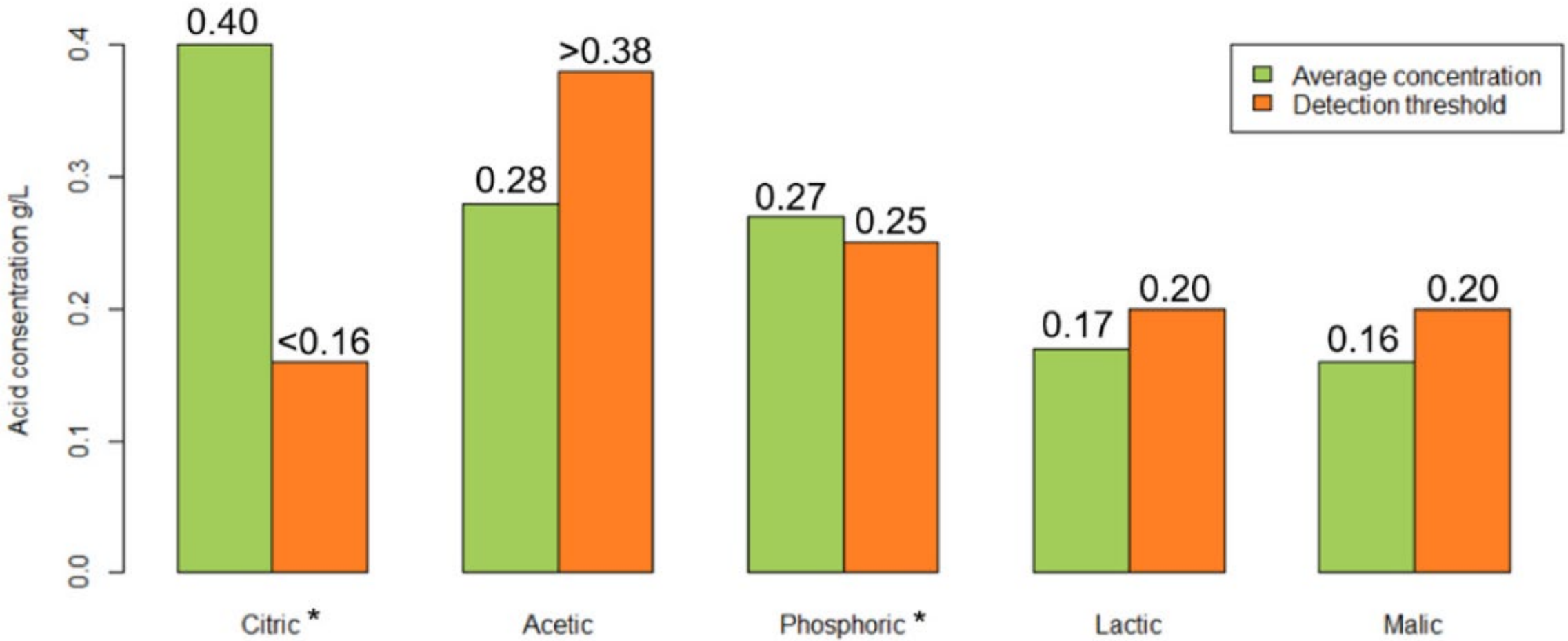
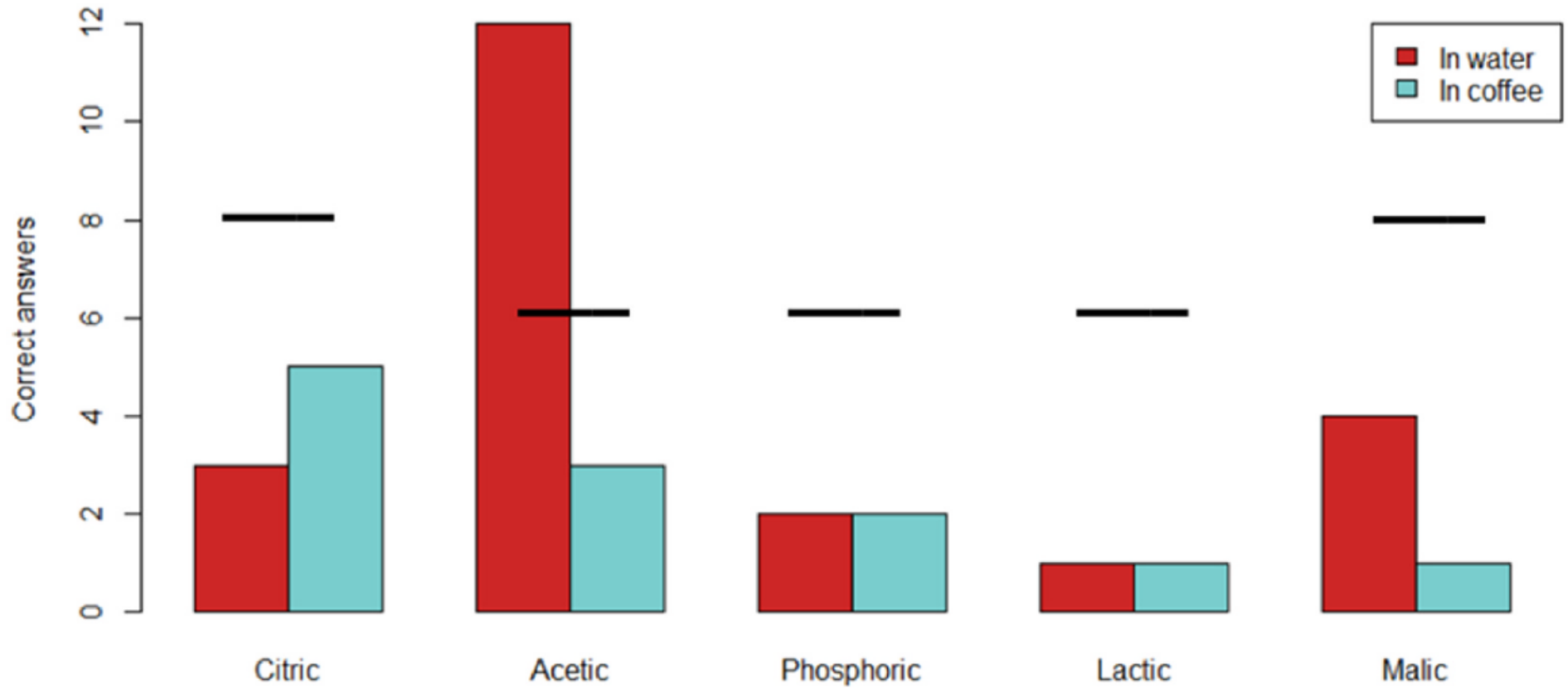

A Chlorogenic acid
Conc. (mg/mL)
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
A
B
C
*
Lighter
Medium
Darker
B Citric acid
0.7
0.6
0.5
0.4
0.3
0.2
BRAZIL
KENYA
C Malic acid
0.3
0.2
0.1
0
D Quinic acid
1
0.9
0.8
0.7
0.6
0.5
B
B
A
E Acetic acid
0.4
0.3
0.2
C
B
A
F Phosphoric acid
0.4
0.3
0.2
B
A
A
G Glucolic acid
0.2
0.1
0
C
B
A
H Lactic acid
0.3
0.2
0.1
0
B
A
A
I Formic acid
0.3
0.2
0.1
NS
NS
NS
Brazil 1
Brazil 2
Bolivia
Kenya 1
Kenya 2
Average


Acid consentration g/L
0.0
0.1
0.2
0.3
0.4
0.40
<0.16
0.28
>0.38
0.27
0.25
0.17
0.20
0.16
0.20
Average concentration
Detection threshold
Citric *
Acetic
Phosphoric *
Lactic
Malic




**Appendix Fig. D.** Recognition test of acids in water and coffee. The correct answers in water (red) and coffee (light blue), respectively. The black line indicates the requirements for correct answers in order to obtain significance ($p < 0.05$). Acetic, phosphoric, and lactic acid were each evaluated 13 times, while citric and malic acid were each evaluated 18 times. Only acetic acid in water was significantly identified.

# Conclusion

The **concentration** of **individual acids** systematically **varies** with the **roasting degree** for all acids

Only **citric** acids **varies** systematically with the **origin**

**Recognizing** the **geographical origin** of coffee **based on organic acid** content is **not supported** or understood from a **chemical perspective**

Only **citric acid** can clearly be **detected** in concentrations **above** average **measured concentration**

**None** of the five **acids** were significantly **identified in coffee**, by coffee experts.