Can minerals be used as a tool to classify cinnamon samples?

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November, 2020

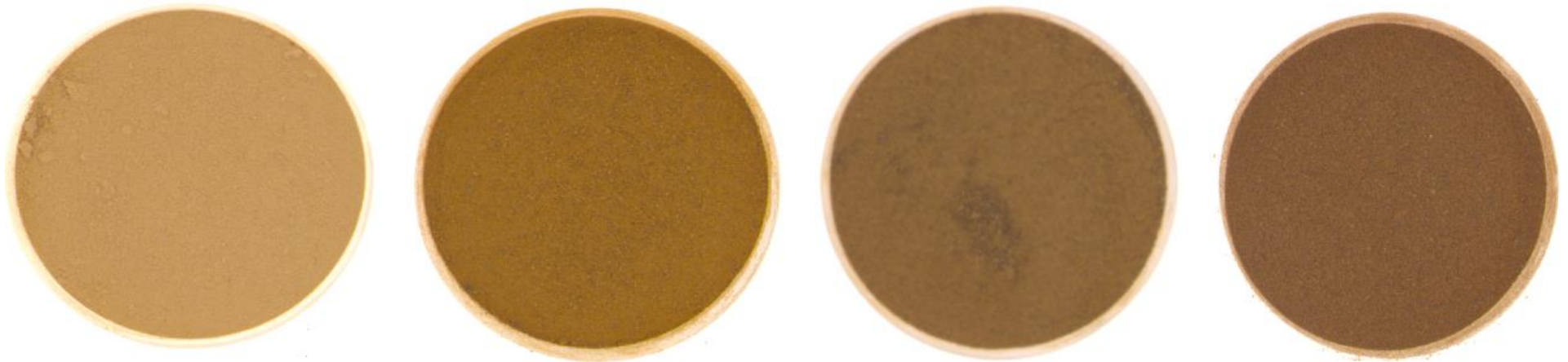# Presentation topics

1. Introduction

2. Material and Methods

3. Results and Discussion

4. Conclusions

5. Acknowledgements

Introduction

Cinnamomum zeylanicum

Rich in bioactive compounds

Benefits for human health

Uses: food and medicinal purposes

Pictures from Internet

Cinnamomum cassia

Similar composition with *C. zeylanicum*

Lower commercial value

Spices' vulnerability to food fraud

- **$ 13.8 billions (2019)**

- **Market growing expectation: 6% (period 2020-2027)**

- **30% of the Market concentrated in Asia**

- **Healthiness, New Ingredients**

GRV, 2020; Silvis et al *Food Control* **2017**, 81, 80-87. Pictures from Internet

Mineral composition as a target marker

- Mineral profile can be exploited under *terroir* and traceability concepts. Some examples are: white tea, Spanish virgin olive oils, and yerba mate.

- Other examples are strategies to discriminate authentic and non-authentic foods, considering mineral composition as a target marker. Some examples are: ethnical foods, honey, and organic sugarcane juice.

Kamiloglu. *Food Chem.* **2019**, 277, 12-24; Oliveri; Downey. *Trends Anal. Chem.* **2012**, 35, 74-86; Ye et al. *Food Anal. Methods* **2017**, 10, 191-199; Beltrán et al. *Food Chem*. **2015**, 169, 350-357; Marcelo et al. *Microchem. J.* **2014**, 117, 164-171; Kokhar et al. *Food Nutr. Res.* **2012**, 56(1), 1-8; Chudzinska; Baralkiewicz. *Food Chem. Toxicol.* **2010**, 48, 284-290; Barbosa et al. *Food Chem* **2015**, 184, 154-159.

Objectives

The aim of this work was to evaluate the feasibility of mineral composition as a possible authenticity marker for classifying cinnamon samples commercialized in Brazil. To this aim, 12 elements (P, S, Mg, Ca, K, Cu, Zn, B, Fe, Al, Mn, and Si) were investigated as targets, also considering their importance for human nutrition. The analytical procedure was based on microwave-assisted acid digestion and elemental determination by inductively coupled plasma optical emission spectroscopy (ICP OES). Principal component analysis was exploited for sample classification.

Material and Methods
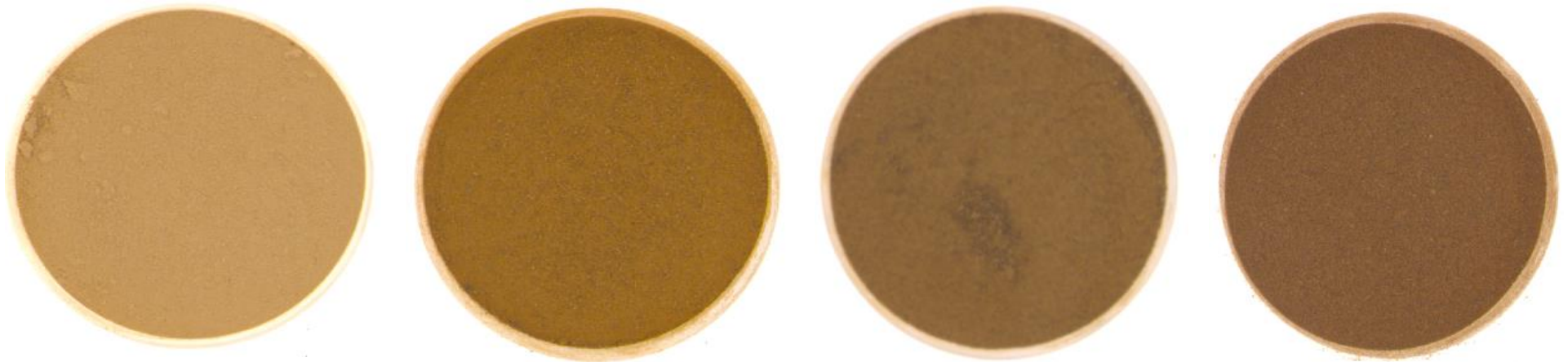
Samples overview

48 samples (conventional supermarket)

8 samples (bulk)
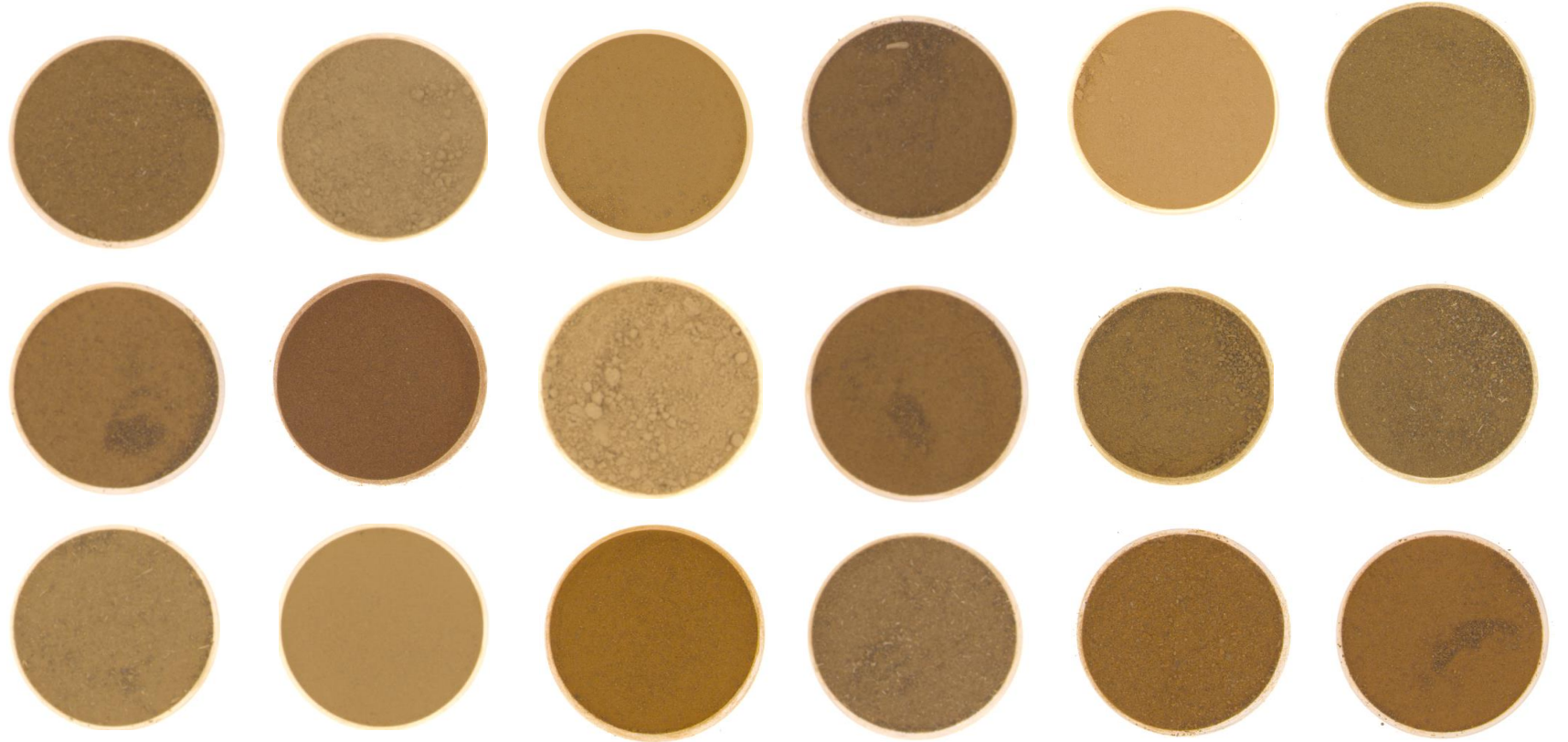
n = 56 of ground samples
4 cities in Sao Paulo region, Brazil

Procedure for mineral determination

Cinnamon sample

Cryogenic grinding (10 min)

500 mg (sample)

Ethos 1600Milestone

$6,0$ mL 2 mol L^{-1} HNO_3
+
$2,0$ mL 30% v/v H_2O_2

Adjust volume (with water H_2O) to 25 mL

Digested Sample

ICAP 7400 Thermo

Mineral Profile (Quantification)

Sample classification: PCA analysis at 95% of confidence level (The Unscrambler X, version 10.4, CAMO Software, Norway, 2016)

Results and Discussion
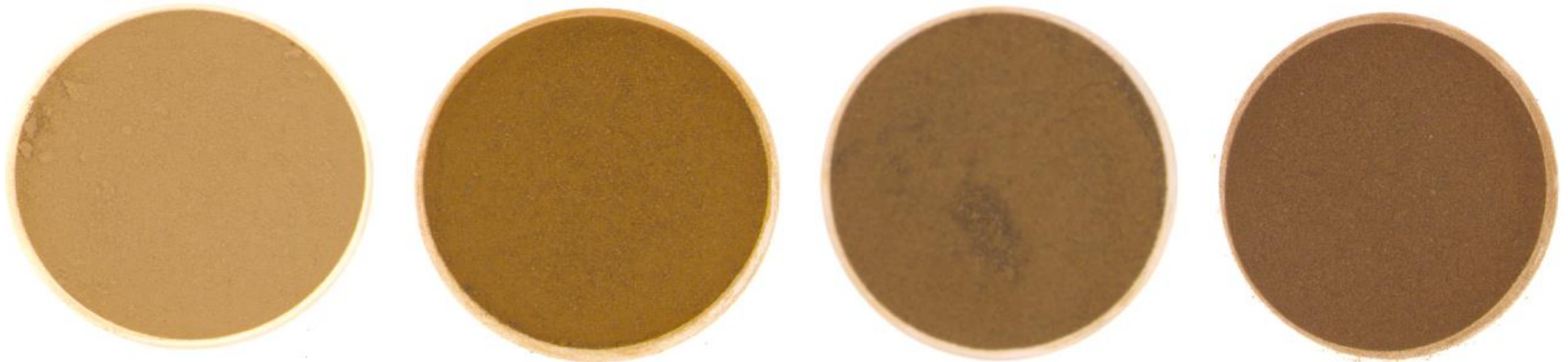
General information about cinnamon samples
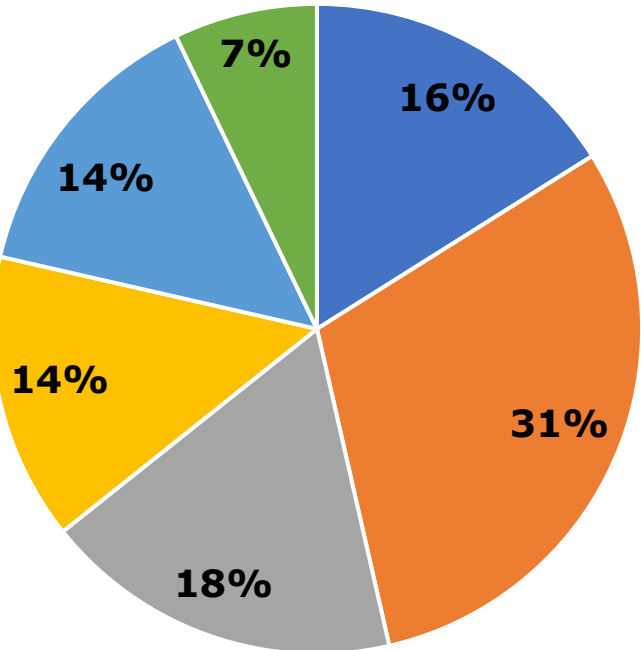
- (A) Cinnamon powder (n = 9)
- (B) 100% cinnamon powder (n = 17)
- (C) Cinnamomum zeylanicum (n = 10)
- (D) Not informed (n = 8)
- (E) Chinese cinnamon (n = 8)
- (F) Ground cinnamon (n = 4)

Pie chart values: 16%, 31%, 18%, 14%, 14%, 7%

A = Contain gluten
B = *C. zeylanicum*
C = *C. zeylanicum*
(origin: Sri Lanka)
D = Samples bought in bulk
E = Chinese cinnamon
(*Cinnamomum cassia*)
F = Contain traces of celery, mustard, and/or other spices

**Prices varied from
US$ 0.02/g to US$ 0.14/g**

13
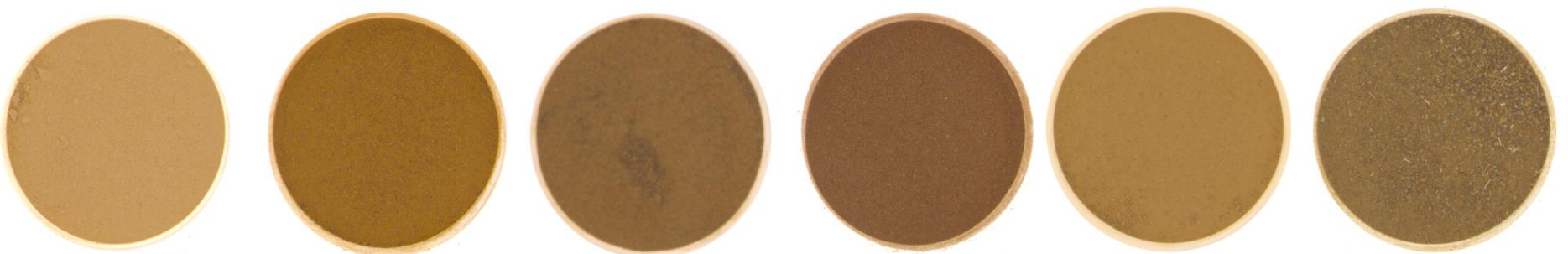
Mass fractions (mg kg^{-1}) of cinnamon powder samples

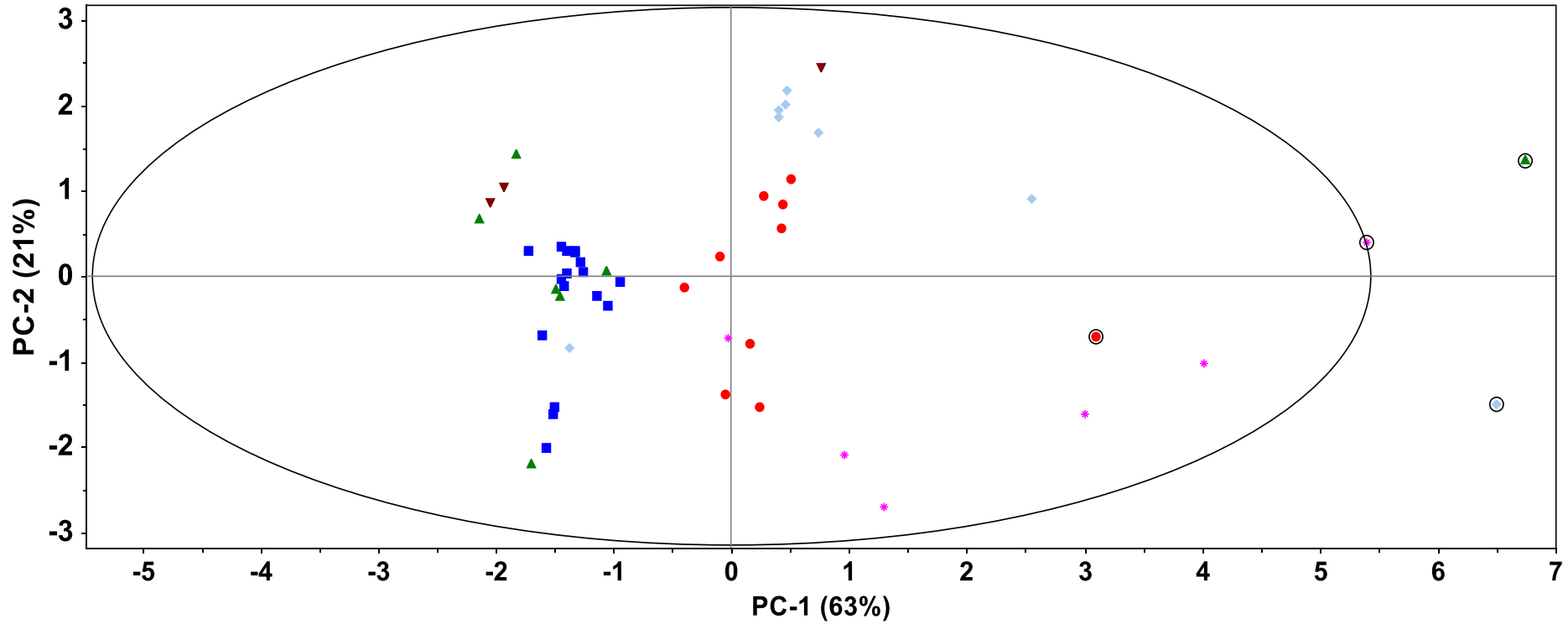| Element (spectral line)	Minimum found	Maximum found	NIST 1515 found	NIST 1515 certified values	LOD	LOQ
P (213.618 nm)	5.19 ± 0.08	1223 ± 22	1583 ± 2	1610 ± 20	0.03	0.08
S (182.034 nm)	7.59 ± 0.06	1681 ± 16	1078 ± 6	N.A.	0.05	0.14
Mg (280.270 nm)	479 ± 2	1352 ± 17	2835 ± 8	2710 ± 80	0.06	0.18
Ca (422.673 nm)	5300 ± 30	13225 ± 49	13720 ± 93	15260 ± 150	0.34	1.01
K (766.490 nm)	3877 ± 27	7183 ± 74	14075 ± 175	16100 ± 100	0.32	0.95
Cu (324.754 nm)	2.55 ± 0.03	10.5 ± 0.1	5.50 ± 0.07	5.6 ± 0.2	0.04	0.12
Zn (213.856 nm)	5.4 ± 0.1	24 ± 1	12 ± 1	12.5 ± 0.3	0.04	0.11
B (249.773 nm)	9.34 ± 0.04	17 ± 1	31.50 ± 0.06	27 ± 2	0.02	0.06
Fe (259.940 nm)	18.0 ± 0.5	1994 ± 49	61.6 ± 0.6	83 ± 5	0.01	0.04
Al (396.152 nm)	28.4 ± 0.4	2142 ± 13	295.87 ± 16.91	286 ± 9	0.10	0.30
Mn (257.610 nm)	137.9 ± 0.3	367 ± 2	56.11 ± 0.03	54 ± 3	0.0002	0.0006
Si (251.611 nm)	40.4 ± 0.9	2743 ± 52	551.24 ± 3.48	N.A.	0.60	1.80

PCA analysis: perceptual maps

PC1, PC2, and PC3 are responsible for explaining 93% of the observed variance.
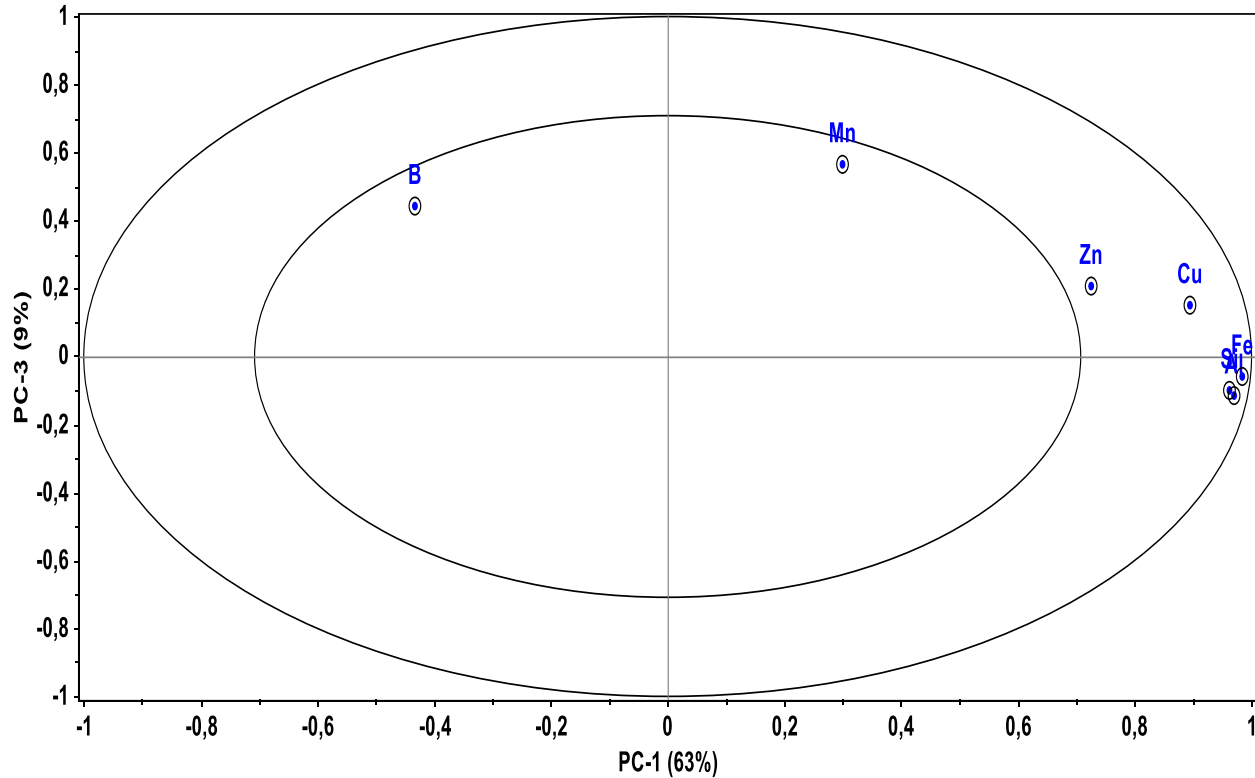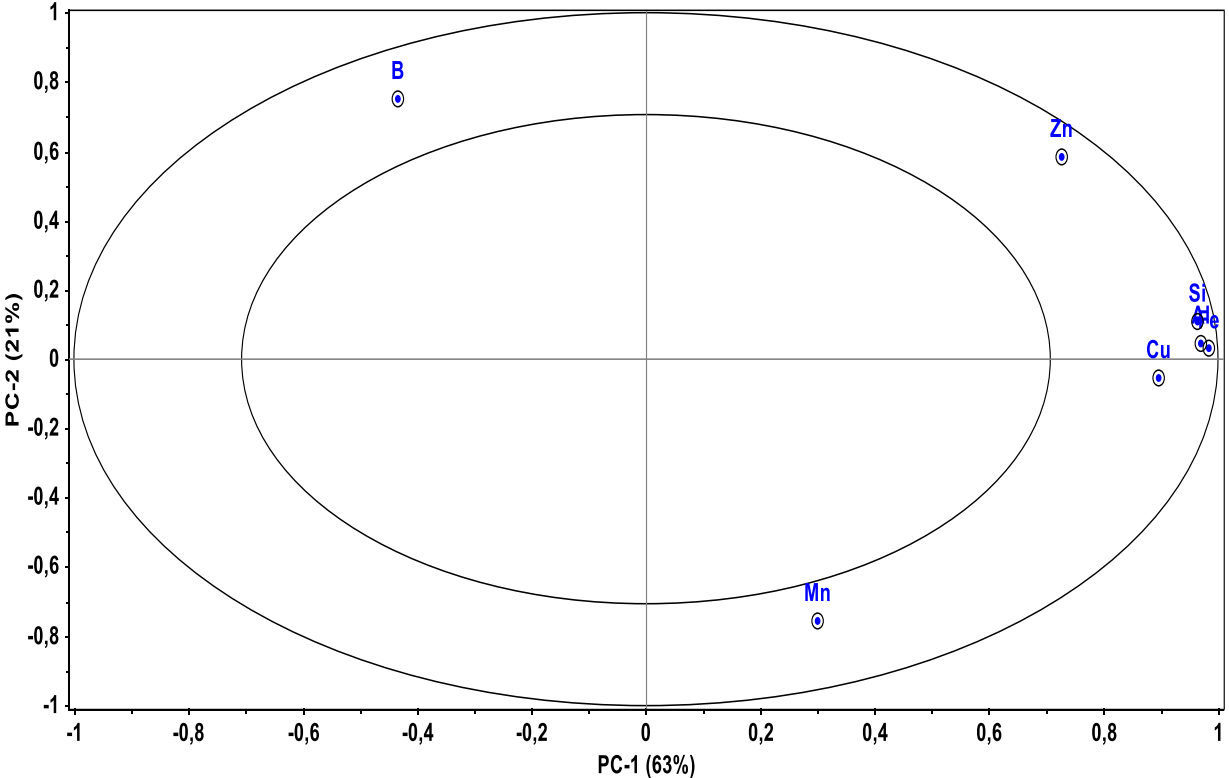
PC1 explains 63% of the observed variance, PC2 21%, and PC3 9% (95% confidence level).

PCA analysis: perceptual maps

Groups *C. zeylanicum* and 100% cinnamon powder highly clustered.

Highly variability in other groups; 4 outliers (circled); only 4 samples of Chinese cinnamon (C. *cassia*) were highly clustered.

Conclusion

The proposed **strategy pioneering indicated the possibility to identify** *C. zeylanicum* **in commercial cinnamon powders, using microelements determined by ICP OES as authenticity markers. It also indicated the possibility to distinguish samples from** *C. cassia* **and others containing other grains, spices, and gluten, even though more studies are required to establish standard models for the classification of this product.**
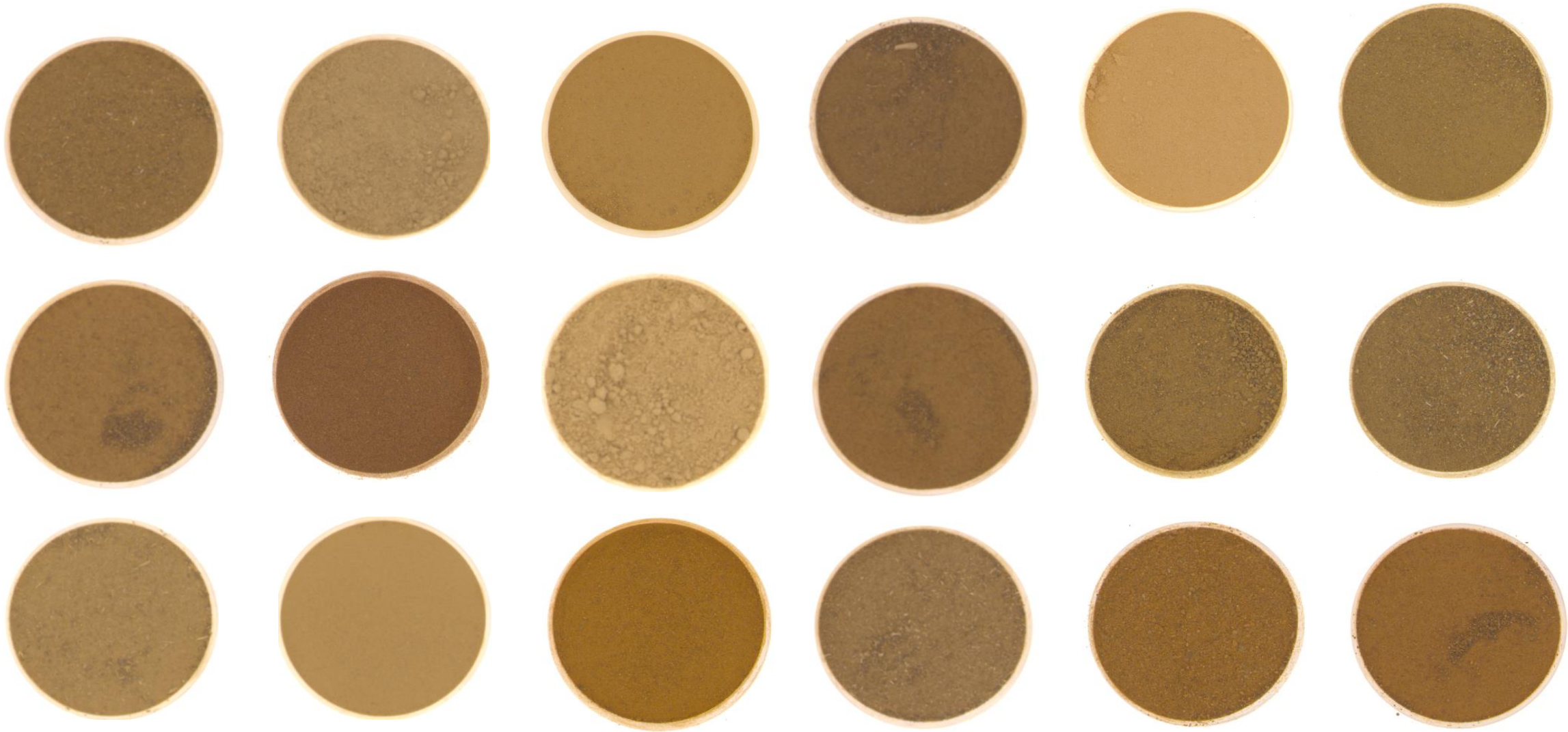
Acknowledgments
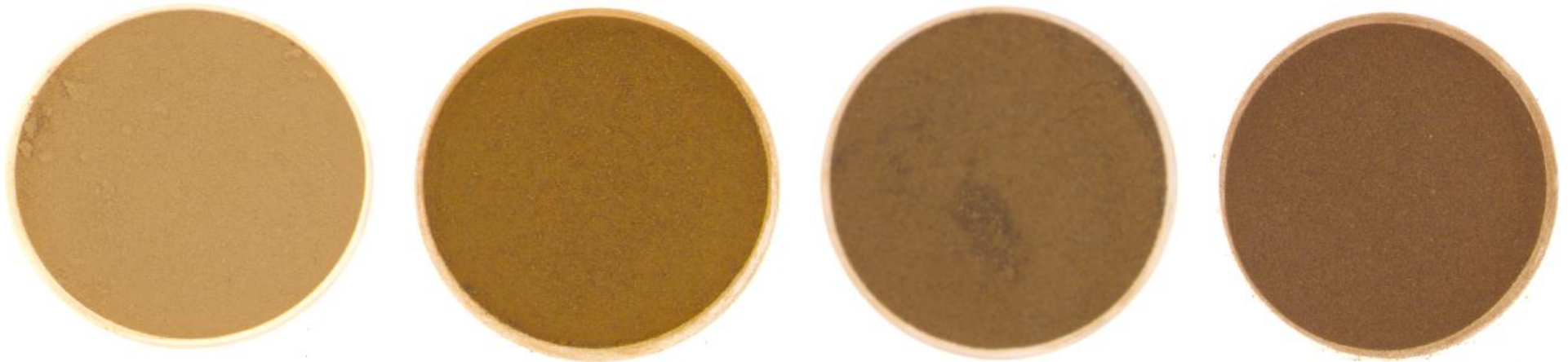
Funding

Thanks for your attention!

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