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# A greener and fast approach for determination of phenolic compounds by smartphone-based colorimetry

MARTINS, L.C.; SILVA, A.F.S.; MORAES, L.M.B.; GONÇALVES, I.C.; GODOY, B.B.R.; ROCHA, F.R.P.

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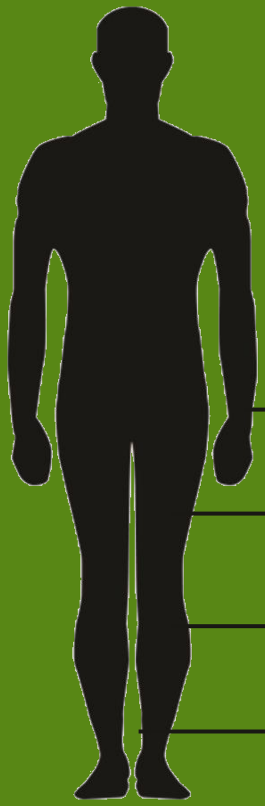
# Phenolic compounds

- Are secondary metabolites produced by plants in response to ultraviolet-light, water stress and attack by pests, like insects, viruses, and bacteria.

- These compounds have been investigated due to their benefits to human health, such as:



**Antioxidants properties**

**Cardioprotective and anti-inflammatory properties**

**Antimicrobial property**

**Carcinogenesis inhibitor**

- Regular consumption of fruit, vegetables and plant-based beverages.

# Phenolic compounds

## Acerola (*Malpighia emarginata* D.C)

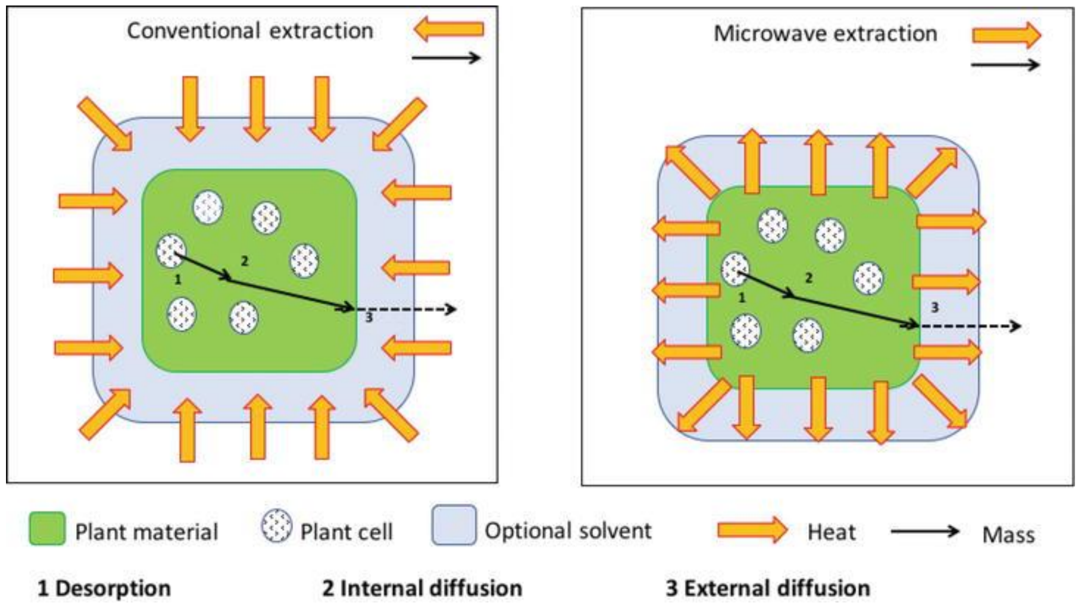
- Tropical and subtropical climate fruit
- High ascorbic acid and bioactive molecules content

**Potential substitute for synthetic antioxidants**

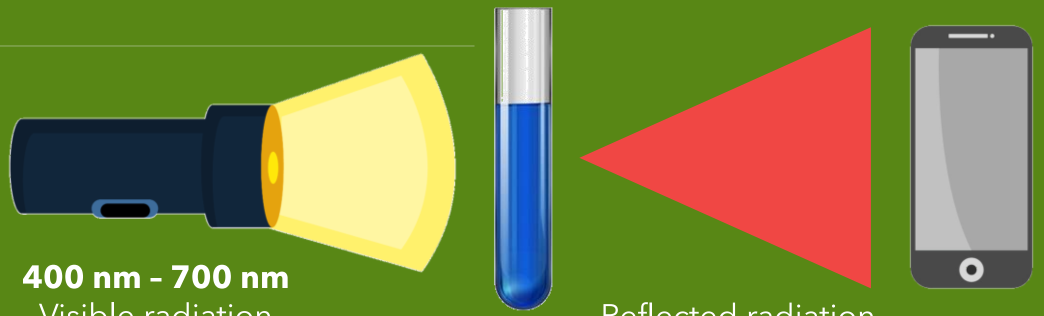
# Microwave-assisted extraction



- Fast heating produced by non-ionizing electromagnetic waves (300 MHz to 300 GHz)
- HEATING MECHANISM: **Dipolar rotation** and **ionic conduction** occur due to alternating electric field (2,45 GHz)
- High pressure inside the cell causes the disruption and release of bioactive compounds

# Digital image photometry

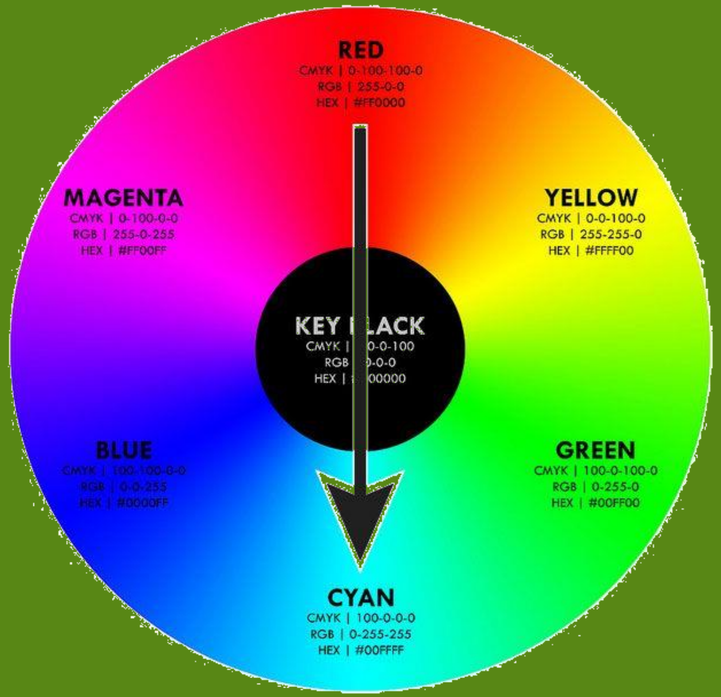


**400 nm - 700 nm**
Visible radiation

Reflected radiation

**R =** 0
**G =** 136
**B =** 172

RGB system




- The RGB system ranges from 0 to 255
- The reflected radiation is converted in mensurable data from the RGB system
- The channel corresponding to the complementary color of the sample is more attenuated

# Materials and Methods

Acerola lyophilized

Microwave oven
(Ethos 1600, Milestone)

Hydroalcoholic extract

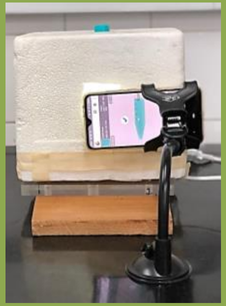
Centrifugation and filtration

Hydroalcoholic extract filtred

Total phenolic content (TPC) (Folin-Ciocalteau reagent)


Spectrophotometer - Femto®

## Smartphone-based photometric detection



Styrofoam box with LED lamp and smartphone holder

+

(48 MP)

+

Colorgrab app

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# Results

Real values, coded values, and TPC content in extraction conditions indicated by the Doehlert design

| Experiment | Variables | | | Analytical response[1] | |
|---|---|---|---|---|---|
| | Temperature (°C) | Ethanol concentration (% v/v) | Extraction time (min) | Reference method | Proposed method |
| 1 | 60 (1) | 50 (0) | 30 (0) | 107 ± 2 | 107 ± 2 |
| 2 | 53 (0.500) | 99 (0.866) | 30 (0) | 101.4 ± 0.8 | 102 ± 2 |
| 3 | 53 (0.500) | 66 (0.289) | 50 (0.817) | 106 ± 2 | 107 ± 3 |
| 4 | 30 (-1) | 50 (0) | 30 (0) | 131 ± 1 | 131.1 ± 0.8 |
| 5 | 38 (-0.500) | 0 (-0.866) | 30 (0) | 76.5 ± 0.9 | 77 ± 2 |
| 6 | 38 (-0.500) | 33 (-0.289) | 10 (-0.817) | 121.3 ± 0.9 | 124 ± 4 |
| 7 | 53(0.500) | 0 (-0.866) | 30 (0) | 79 ± 2 | 78 ± 1 |
| 8 | 53 (0.500) | 33 (-0.289) | 10 (-0.817) | 129 ± 2 | 132 ± 1 |
| 9 | 38 (-0.500) | 99 (0.866) | 30 (0) | 124.4 ± 0.9 | 126.3 ± 0.8 |
| 10 | 45 (0) | 83 (0.577) | 10 (-0.817) | 114.6 ± 0.6 | 119.0 ± 0.8 |
| 11 | 38 (-0.500) | 66 (0.289) | 50 (0.817) | 145.0 ± 0.7 | 146 ± 4 |
| 12 | 45 (0) | 17 (-0.577) | 50 (0.817) | 120 ± 5 | 120 ± 5 |
| 13 (CP) | 45 (0) | 50 (0) | 30 (0) | 122 | 123 |
| 14 (CP) | 45 (0) | 50 (0) | 30 (0) | 113 | 113 |
| 15 (CP) | 45 (0) | 50 (0) | 30 (0) | 120 | 116 |
| 16 (CP) | 45 (0) | 50 (0) | 30 (0) | 126 | 124 |
| 17 (CP) | 45 (0) | 50 (0) | 30 (0) | 113 | 116 |

The experiment n. 11 presented the highest efficient of extraction

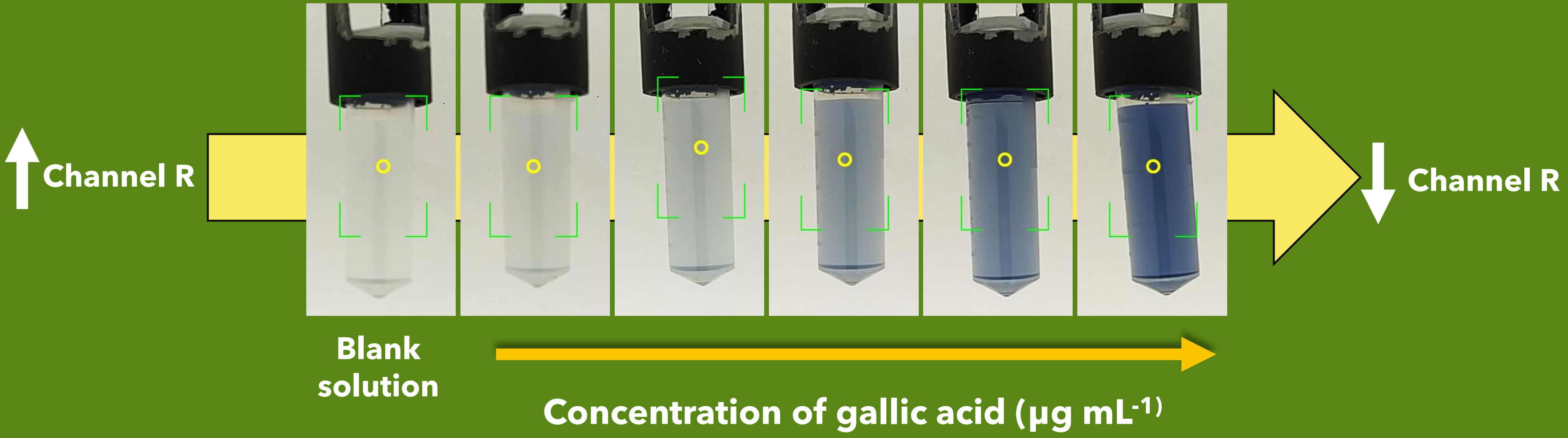
Extraction by convective heating (extraction with 14.5% (v/v) ethanol, at 55.6 °C for 50 min)

↓ Temperature ↑ TPC

# Results

**LOD =** 3 μg $mL^{-1}$
**LOQ =** 10 μg $mL^{-1}$

**Volume per analysis**
1 mL

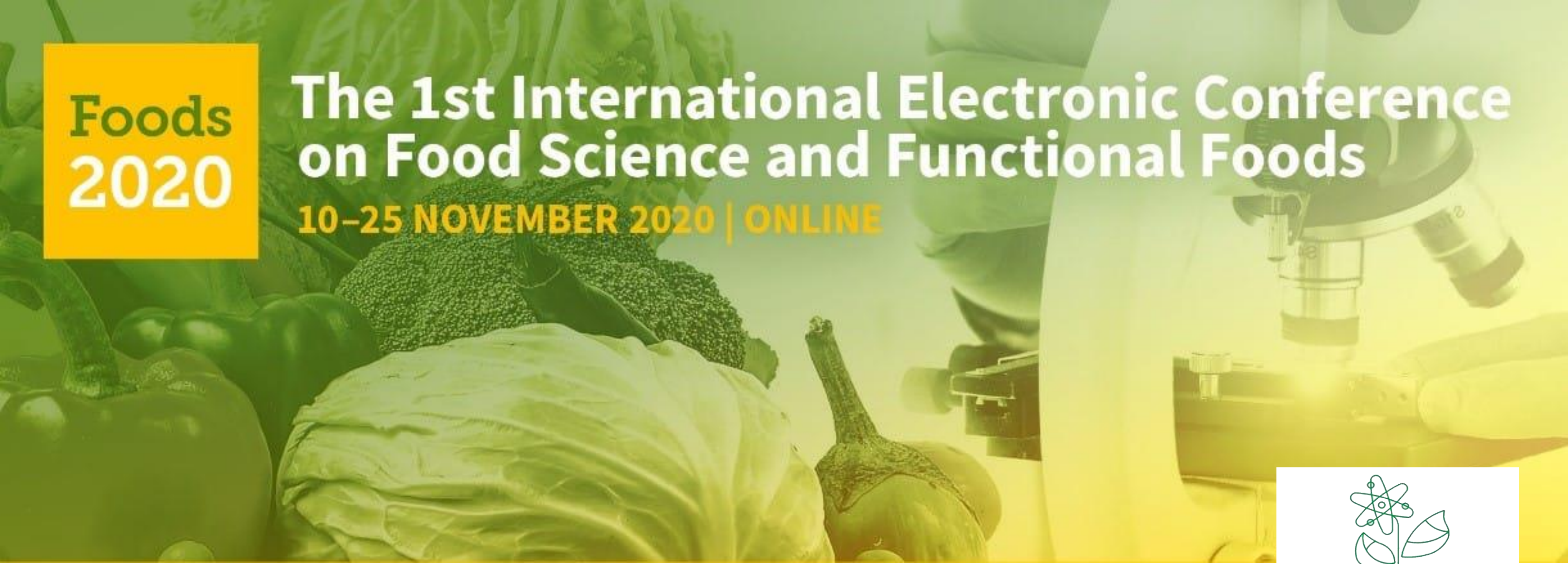


# Conclusion



- More efficient extraction achieved by microwave-assisted extraction
- The smartphone-based detection presented an efficient, cost-effective, simple, and fast approach to determine the total phenolic content in acerola extracts
- Minimization of reagent consumption and waste generation (Green Chemistry)

- **Next steps:** determination of the phenolic profile using HPLC




**Luís Cláudio Martins**
luis.claudio.martins@usp.br