Classification of single-cultivar Tunisian olive oils according to the geographical origin using an electronic tongue

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Engineering, University of Minho, Braga, Portugal 7: CQ-VR – Centro de Química – Vila Real, University of Trás-os-Montes, Vila Real, Portugal 8: Associate Laboratory
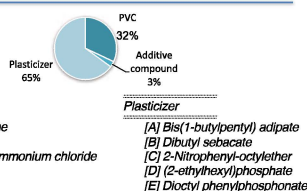LSRE-LCM, ESA, Instituto Politécnico de Bragança, Bragança, Portugal (*) peres@ipb.pt

INTRODUCTION

✓ Developing analytical techniques for EVOO authentication is a challenging task.

✓ Moreover, if a specific meteorological or geographical factor affects different geographical regions similarly, olive oils' geographical discrimination may be a hard task.

✓ Improved classification of olive oils may be achieved by combining electrochemical fingerprints with multivariate statistical techniques.

✓ In this work, we used an electronic tongue, comprising 40 lipid membrane sensors, to extract suitable potentiometric fingerprints of Tunisian monovarietal olive oils that could be used in combination with linear discriminant analysis to classify olive oils according to the geographical origin.

ELECTRONIC TONGUE

Potenciometric system
(all-solid-state electrodes)

20 lipidic polymeric membranes (✕ 2)
Ag/AgCl reference electrode
Data acquisition with DataLogger Agilent

Each lipidic polymeric membrane contains:

PVC 32%
Plasticizer 65%
Additive compound 3%

Additive compound
[1] Octadecylamine
[2] Oleyl alcohol
[3] Methyltrioctylammonium chloride
[4] Oleic acid

Plasticizer
[A] Bis(1-butylpentyl) adipate
[B] Dibutyl sebacate
[C] 2-Nitrophenyl-octylether
[D] (2-ethylhexyl)phosphate
[E] Dioctyl phenylphosphonate

Electronic Tongue Analysis

Tunisian Olive Oils

Physicochemical Analysis
Free Acidity, Peroxide Value, Extinction Coefficients (K232, K270, ΔK)

Sensory Analysis

Extraction with H2O:EtOH (80:20, v/v) to obtain a polar compounds rich-solution
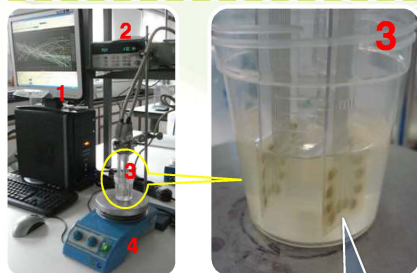
Analysis with the E-tongue

Figure 1 – Multi-sensor analytical system:
1 - PC for data acquisition; 2 - DataLogger Agilent;
3 – Electronic tongue; 4 – Magnetic stirrer.

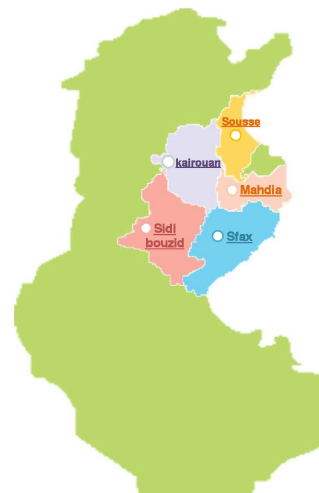Double multi-sensor system:
40 sensors

AIMS

ELECTRONIC TONGUE
(multi-sensor system)

Comprising
Chemical sensors → featuring high stability and cross-sensitivity to different substances in a solution.

To obtain
Olive oils signal profiles, which correspond to unique *fingerprints* within a sample matrix

To analyze with
Chemometric methods:
- Linear discriminant analysis (LDA)
- Simulated annealing (SA) variable selection algorithm
- Leave-one-out cross-validation (LOO-CV)

To achieve
Olive oil's classification according to the geographical origin

RESULTS

Establishment of the best E-tongue-LDA-SA models:
→ Variable selection with simulated annealing (SA) algorithm
→ Sub-set with minimum number of sensors => maximum correct classification, LOO-CV

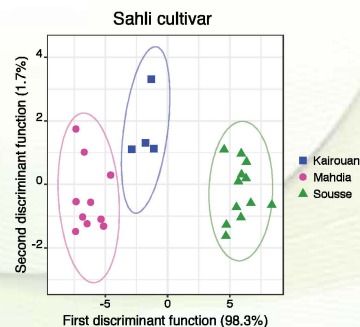**Olive oils' discrimination according to geographical origin**

i) For Chemleli cultivar
→ E-tongue-LDA-SA model: 12 sensor signals
→ 100% of original grouped data (FIGURE 2)
→ 94% of correct classifications for LOO-CV
→ Selected sensors: "S1:1" "S1:7" "S1:8" "S1:9" "S1:16" "S1:19" "S2:1" "S2:4" "S2:7" "S2:8" "S2:17" "S2:19"
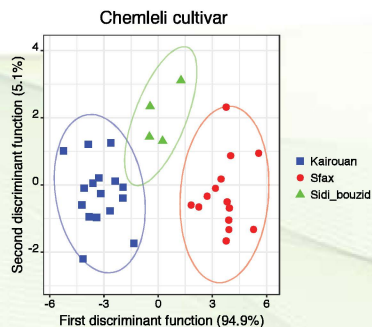
ii) For Sahli cultivar
→ E-tongue-LDA-SA model: 8 sensor signals
→100% of original grouped data (FIGURE 3)
→100% correct classifications for LOO-CV
→Selected sensors: "S1:1" "S1:12" "S1:19" "S2:1" "S2:5" "S2:17" "S2:19" "S2:20"

CULTIVARS

Chémleli cv (17 olive oils in duplicate) :
Kairouan (8), Sidi Bouzid (2) and Sfax (7)

Sahli cv (13 olive oils in duplicate):
Mahdia (5), Sousse (6) and Kairouan (2).

CONCLUSIONS

• The potentiometric E-tongue, coupled with a LDA-SA procedure, is demonstrated to be a fast and cost-effective solution for :
Distinguishing between the geographical origins of Tunisian monovarietal olive oil.

• the combination of potentiometric data recorded using cross-sensitivity lipid based sensors and statistical multivariate models coupled with a variable selection algorithm results in a satisfactory, fast and low-cost experimental-modeling approach to discriminate geographically monovarietal olive oils with different quality grades, even if their production sites are impacted by similar geographical and climatic parameters.

• Overall the achieved results confirmed the E-tongue potential for olive oil analysis, previously reported by our research group and others .