XXI Encontro Sociedade Portuguesa de Eletroquímica

XVIII Encontro Ibérico de Eletroquímica

XXI Meeting of the Portuguese Electrochemistry Society
&
XVIII Iberian Electrochemistry Meeting
Abstract Book

XXI Encontro da Sociedade Portuguesa de Eletroquímica
&
XVIII Encontro Ibérico de Eletroquímica
Livro de Resumos

Bragança, Portugal ◆ 14-17 setembro 2016

ipb INSTITUTO POLITÉCNICO DE BRAGANÇA

Title
XXI Meeting of the Portuguese Electrochemistry Society &
XVIII Iberian Electrochemistry Meeting

Título
XXI Encontro da Sociedade Portuguesa de Eletroquímica &
XVIII Encontro Ibérico de Eletroquímica

Event Abbreviation / Abreviatura do Evento
SPE2016

Coordination / Coordenação
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Edition / Edição
Instituto Politécnico de Bragança · 2016
5300-253 Bragança · Portugal
Tel. (+351) 273 303 200 · Fax (+351) 273 325 405
http://www.ipb.pt

Imaging services / Serviços de imagem
Atilano Suarez (Instituto Politécnico de Bragança, Portugal)

URI
http://hdl.handle.net/10198/12931

ISBN
978-972-745-213-2

PC13

Qualitative evaluation of Tunisian olive oils using an electronic tongue and chemometric tools: a prospective study.

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Olive oil commercialization has a great impact in the regional economy of several countries including Tunisia. It is a high-value food product, quite prone to frauds. So, it is important to establish analytical techniques that can ensure labeling correctness regarding olive oil quality as well as its origin, namely concerning the olive(s) cultivar(s) used in the production, which is of major importance for monovarietal olive oils. Traditional analytical techniques like those based on chromatography are quite expensive, time-consuming, not portable and difficult to implement in-situ, considering the usual harsh environments of the olive industry. In this work, the feasibility of using an electronic tongue as a classification tool for discriminating Tunisian olive oils according to their quality level (i.e., extra virgin olive oil, virgin olive oil or lampante olive oil) and olive cultivar (i.e., Chetoui, Shali and others, according to the label information) was evaluated for the first time. Olive oil quality was assessed quality parameters (free acidity, peroxide values, K_{232} and K_{270} extinction coefficients) and on the organoleptic evaluation carried out by a sensory panel parameters (according to the International Olive Council directives). The potentiometric signal profiles recorded with the electrochemical multi-sensor device during the electrochemical analysis of olive oils' hydroethanolioc extracts (≈ 5 min), coupled with linear discriminant models, established based on the most informative sub-sets of sensors, selected by a simulated annealing algorithm, were able to satisfactorily perform olive oils discrimination according to:
(i) Olive cultivar: sensitivities of 88% for leave-one-out cross-validation and mean sensitivities of 79% for the repeated K-folds cross-validation (4 folds with 10 repeats), achieved with a multivariate model based on the information gathered by 20 sensors of the electronic tongue; and,
(ii) Quality level: sensitivities of 91% for leave-one-out cross-validation and mean sensitivities of 84% for the repeated K-folds cross-validation (4 folds with 10 repeats), achieved with a multivariate model based on the information gathered by 26 sensors of the electronic tongue.

Overall, the results show the satisfactory performance of a potentiometric electronic tongue containing cross-sensitivity lipid membranes as sensors, which may be tentatively attributed to the capacity of the electrochemical device in discriminating olive oils with different polar compounds contents, which are related to specific sensory attributes of olive oils such as bitterness and pungency. Furthermore, the present study, concerning Tunisian olive oils analysis using an electronic tongue, confirms the results previously reported in the literature for olive oils from other geographical origins.

QUALITATIVE EVALUATION OF TUNISIAN OLIVE OILS USING AN ELECTRONIC TONGUE AND CHEMOMETRIC TOOLS: A PROSPECTIVE STUDY

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INTRODUCTION

✓Olive oil commercialization has a great impact in the regional economy of several countries including Tunisia.

✓It is a high-value food product, quite prone to frauds.

✓Traditional analytical techniques are quite expensive, time-consuming, not portable and difficult to implement in-situ, due to the harsh environments of the olive industry.

✓ In this work, the feasibility of using an electronic tongue as a classification tool for discriminating Tunisian olive oils

OBJECTIVES

ELECTRONIC TONGUE

(multi-sensor system)

↓

Chemical sensors with high stability and cross-sensitivity to different substances in solution

↓

TO OBTAIN

Olive oils' signals profiles corresponding to a *fingerprint* of sample matrix

TO APPLY

Chemometric methods:

- Linear discriminant analysis (LDA)
- Simulated annealing (SA) variable selection algorithm
- Leave-one-out cross-validation (LOO-CV)
- Repeated K-folds-CV (repeated K-folds-CV)

↓

TO ALLOW

Olive oils's identification/classification according to:

- Olive oil quality (EVOO, VOO & LOO)
-Olive cultivar (Chetoui, Sahli & others)

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**:

32% of PVC;
65% of plasticizer;
3% of additive compound.

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

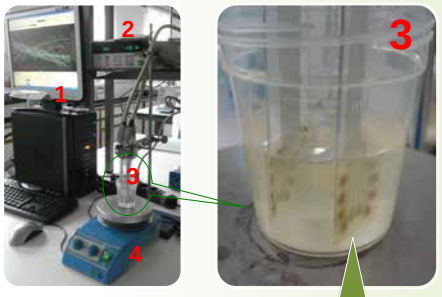


Figure 1 – Multi-sensor analytical system:
1 - PC for data acquisition;
2 - DataLogger Agilent;
3 – Electronic tongue;
4 – Magnetic stirrer.

Electronic tongue analysis

↓

TUNISIAN OLIVE OILS

Quality: EVOO (3); VOO (4) & LOO (36)

(according to physico-chemical & sensory analysis)

Cultivar: Chetoui cv. (11); Sahli cv. (26) & others cvs. (4)

(according to the label information)

↓

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

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

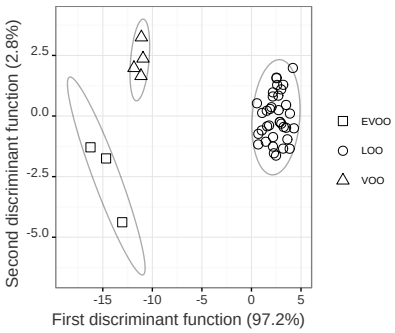
- repeated K-folds-CV: K=4 folds { **75% data for training** / **25% data for internal validation** } × **10 repeats**

i) Olive oils' quality discrimination: EVOO, VOO & LOO

→ model with 26 potentiometric sensor signals

→ 91% of predictive correct classifications for LOO-CV

→ 84% of predictive correct classifications for repeated K-folds-CV

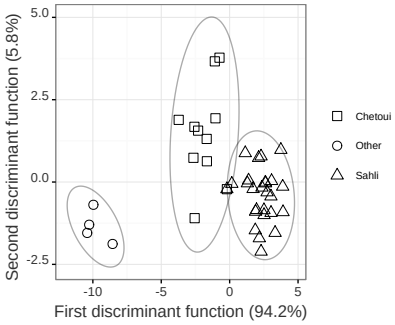


ii) Olive oils' discrimination according to Tunisian cultivars: Chetoui, Sahli & others

→ model with 20 potentiometric sensor signals

→ 88% of predictive correct classifications for LOO-CV

→ 79% of predictive correct classifications for repeated K-folds-CV



CONCLUSIONS

- The potentiometric E-tongue coupled with a LDA-SA procedure demonstrated to be a fast and cost-effective tool for :

  → ***Tunisian olive oils' predictive classification according to olive cultivar***;

  → ***Tunisian olive oils' predictive classification according to quality grade***.

- The overall results achieved confirmed the E-tongue potential for olive oil analysis, previously reported by our research group [1-6] as well as other reearch groups [7-12].

Acknowledgements
This work was co-financed by Project POCI-01-0145-FEDER-006984 – Associated Laboratory LSRE-LCM funded by FEDER funds through COMPETE2020 - Programa Operacional Competitividade e Internacionalização (POCI), by national funds through FCT - Fundação para a Ciência e a Tecnologia; and by the strategic funding of UID/BIO/04469/2013 unit. Nuno Rodrigues thanks FCT, POPH-QREN and FSE for the Ph.D. Grant (SFRH/BD/104038/2014).

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