



XVIII Feria Internacional del Aceite de Oliva e Industrias Afines
XVIII International Fair of the Olive Oil and Allied Industries

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CLASSIFICATION OF OLIVE OILS ACCORDING TO SENSORY DEFECTS USING A POTENTIOMETRIC ELECTRONIC TONGUE

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INTRODUCTION

Olive oils may be graded according to their overall physicochemical composition and sensorial attributes as:

- extra-virgin olive oils (EVOOs);
- virgin olive oils (VOOs);
- lampante olive oils (LOOs).

Olive oils are quite prone to frauds thus there are legal protection EU Commission regulations:

- EU Commission Regulation, 1991;
- EU Commission Regulation, 2011.

Maximum levels are established for:

- Chemical and physicochemical parameters (e.g., free acidity, peroxide value, UV extinction coefficients and alkyl esters content);
- Sensory attributes (presence/absence of organoleptic defects, fruity sensation and positive attribute).

Several analytical techniques have been described in the literature to detect and/or verify possible frauds.

Official methods and recommended practices have been established by the American Oil Chemists' Society to assess olive oil quality.

However, some of these methods are quite expensive, non-green techniques, and require fulfillment of straight standardized procedures to ensure accuracy.

At the present time, the only homologated method to assess the sensory attributes of olive oils involves their evaluation by an official taste panel.

However, this official methodology has several drawbacks, namely experts' subjectivity, variability of responses over time, lack of reference standards and low number of analyses per day.

OBJECTIVES

To develop a sensor-based technique to assess sensory attributes of olive oils, which could be used as an alternative/complementary solution to taste panels:

sensor-based approaches have been reported to evaluate the quality of olive oil (positive and/or negative attributes) (Veloso et al., 2016; Borràs et al., 2016a,b; Escuderos et al., 2013; García-González & Aparicio, 2004; Apetrei et al., 2010):

- Electronic noses (E-nose);
- Electronic tongues (E-tongue); and/or,
- Electronic eyes (E-eye)

MAIN GOALS

→ Potentiometric E-tongue for olive oils' discrimination according to the sensory defect predominantly perceived (DPP);

→ Chemometrics: linear discriminant analysis (LDA) with simulated annealing (SA) variable selection algorithm;

→ Cross-validation variants: leave-one-out cross validation (LOO-CV) and repeated K-fold cross-validation (repeated K-fold-CV with 10 repeats and 4 folds).

OLIVE OIL SAMPLES

42 Portuguese olive oils from different commercial brands bought in supermarkets or obtained from local producers (Trás-os-Montes region, northeast of Portugal).

SAMPLE PREPARATION

- Olive oils were extracted using hydro-ethanolic solutions (H₂O:EtOH, 80:20 v/v)

- Samples were electrochemically analyzed in the same day.

E-TONGUE ANALYSIS

E-tongue included two print-screen potentiometric devices, containing different cross-sensitivity membranes as chemical sensors (Table 1, Figure 1)

OLIVE OIL SAMPLES AND SENSORY EVALUATION

Olive oils were evaluated by 4 trained panelists, following the methods and standards adopted by the International Olive Council (IOC) for sensory analysis of olive oils (COI/T.20/Doc. No 15/Rev. 6 and COI/T.30/Doc. No 17).

Negative attributes (namely, winey-vinegary, wet wood, rancid and musty/muddy sediment) of olive oils were assessed (olfactory and/or gustatory-retronasal sensations)

Defects' intensities graded in a scale ranging from 0 (no defect perceived) to 10 (maximum intensity of defect perceived).

Each olive oil sample was classified according to the defect predominantly perceived, if more than one sensory defect was perceived.

Table 1 – E-tongue sensors details

Sensor code		Plasticizer (~65%)	Additive (~3%)
1 st array	2 nd array		
S1:1	S2:1	2-Nitrophenyl-octyl ether	Octadecylamine
S1:2	S2:2		Oleyl alcohol
S1:3	S2:3		Methyltriethylammonium chloride
S1:4	S2:4		Oleic acid
S1:5	S2:5	Tris(2-ethylhexyl) phosphate	Octadecylamine
S1:6	S2:6		Oleyl alcohol
S1:7	S2:7		Methyltriethylammonium chloride
S1:8	S2:8		Oleic acid
S1:9	S2:9	Dibutyl sebacate	Octadecylamine
S1:10	S2:10		Oleyl alcohol
S1:11	S2:11		Methyltriethylammonium chloride
S1:12	S2:12		Oleic acid
S1:13	S2:13	Bis(1-butylpentyl) adipate	Octadecylamine
S1:14	S2:14		Oleyl alcohol
S1:15	S2:15		Methyltriethylammonium chloride
S1:16	S2:16		Oleic acid
S1:17	S2:17	Bis(2-ethylhexyl)phthalate	Octadecylamine
S1:18	S2:18		Methyltriethylammonium chloride
S1:19	S2:19		Oleyl alcohol
S1:20	S2:20		Oleic acid

RESULTS

Sensory analysis

At least one organoleptic defect was perceived in all the 42 commercial olive oils evaluated, being possible to detect up to 3 different sensory defects in some olive oils.

Based on the defect predominantly perceived, each olive oil was classified as:

- **winey-vinegary olive oil**: 12 olive oils;
- **wet-wood olive oil**: 12 olive oils;
- **rancid olive oil**: 14 olive oils;
- **fusty/musty olive oil**: 4 olive oils.

Olive oils classification (physicochemical + sensory data)

18 olive oils were classified as VOO
24 olive oils were classified as LOO.

E-tongue analysis

E-tongue-LDA-SA model (3 discriminant functions) established based on the signal profiles of 19 sensors:

Correct classification rates:

- 81% for the LOO-CV (Figure 2)
- 74% ± 10% for repeated K-fold-CV

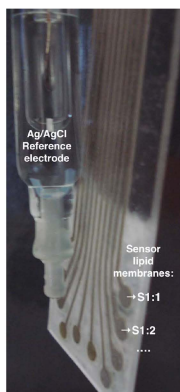


Figure 1 – Potentiometric E-tongue

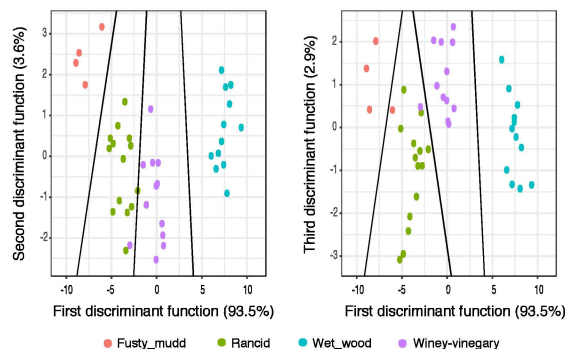


Figure 2 – E-tongue-LDA-SA model: discrimination of commercial olive oils according to the defect predominantly perceived by trained sensory panelists

CONCLUSION

It was demonstrated the feasibility of applying a potentiometric E-tongue (with lipidic cross-sensitivity polymeric membranes) with chemometric tools, for the successful discrimination of olive oils with negative organoleptic defects, which assessment is usually carried out by official trained sensory panels, turning out in an expensive and time-consuming task.

This preliminary study shows the applicability of this type of electrochemical device (E-tongue) as taste sensors for sensory evaluation of organoleptic defects detected in olive oils, which conditions their quality commercial grade classification.

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