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## Geographical classification and Adulteration detection of cumin by using electronic sensing coupled to multivariate analysis

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### Abstract

The objective of this work is to report the improvement obtained in the discrimination of complex aroma and taste with subtle differences in odor and flavor, by the use of fast suitable procedures for the cases of measurements in the field demanding decision-making in real time. The proposed electronic sensing systems, formed by an E-nose and VE-tongue, were used to discriminate cumin cultivars from different geographical origins, as well as to quantify the cumin adulteration percentages by using unsupervised and supervised chemometric tools. Thus, the results obtained are sufficiently encouraging as a starting point for the development of new electronic sensing systems with more improvement such the reliability of the sensors' performance as well as the chemometric tools in order to deal with a complex dataset.

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### 1. Introduction

Cumin (*Cuminum cyminum* L.) is a small annual plant belonging to the Apiaceae family, and is native to the Mediterranean region. Cumin's distinctive flavor and warm aroma is due to its essential oil content that may be considered as an interesting source of antibacterial, antifungal, antioxidant components and for therapeutic or nutraceutical industries. The composition of cumin has been subject of previous studies [1], it depends on many factors, such as plant part, harvest-time, extraction-method, type of cultivar, geographic origin and storage

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conditions. The aim of this work is to evaluate the feasibility of electronic sensing systems formed by an E-nose based on metal oxide semiconductor sensors, and VE-tongue consists of a sensor array of voltammetric electrodes, coupled with chemometric tools, firstly to characterize and differentiate cumin cultivars from different geographical origins, and secondly to detect the adulteration in cumin with different proportions of coriander.

## 2. Materials and methods

This study was carried out on a set of 5 different non-adulterated cumin samples of 4 different origins (Morocco, Egypt, India and Syria) collected from the local market. For the measurements, 2 g and 1.5 g of non-adulterated cumin powder of each sample were measured using E-nose and VE-tongue, respectively. However, classification of cumin samples is not enough to ensure its quality. In this context, mixture of cumin with Moroccan coriander in different concentration (5 %, 20 %, 50 % and 70%) were made to evaluate the systems to detect adulteration. For this purpose, 2 g and 1.5 g of each mixture of cumin and coriander powder were analyzed using E-nose and VE-tongue, respectively. It should be noted that in E-nose measurement, the samples were measured without any pre-treatment. For VE-tongue measurement, the samples were dissolved in 100 mL of distilled water. 0.7 g of potassium chloride (KCl) was added as a supporting electrolyte. The electronic sensing systems used in this study were described in our previous works [2, 3].

## 3. Results and discussion

As a result, VE-tongue analyses have shown that five pristine cumin samples coming from four different countries can be successfully discriminated using PCA (Fig. 1.(a)). Furthermore, the discrimination of adulterated samples from pure Beldi cumin based on features extracted from voltammograms was possible. Moreover, PCA plot of Beldi cumin and its mixture with coriander in different proportions is shown in Fig. 1.(b). However, the application of PCA of E-nose data shows a certain area of overlapping in which no clear differentiation could be made between the samples of cumin cultivars picked from different geographical origins, this means that the measurements show no distinct separation between samples by using the chemometric tools, which indicates that the cumin samples share almost the same VOCs. Regarding the adulteration detection of Beldi cumin with coriander using E-nose, the measurements were inconclusive and cannot be used to differentiate among pure and adulterated cumin. Altogether, the work carried out showed that the proposed VE-tongue system could be used in practice as a fast and economic tool to estimate, in a real time basis, the possible adulteration of foodstuffs. Moreover, another point that deserves further investigation is the improvement of the E-nose system as a routine methodology by including some further sensors for providing more diversified signals.

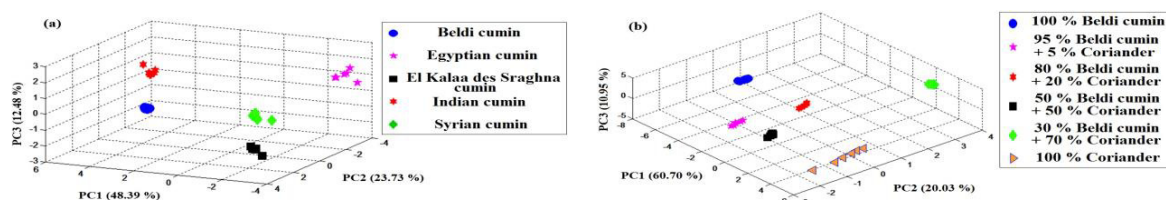


Fig. 1. PCA plot using an VE-tongue on the measurement of: (a) different non-adulterated cumin samples; (b) Beldi cumin and its mixtures with coriander.

## References

- [1] Oroojalian FR, Kasra-Kermanshahi R, Azizi M, Bassami, MR. Phytochemical composition of the essential oils from three Apiaceae species and their antibacterial effects on food-borne pathogens. *Food Chemistry* 2010;120:765-770.
- [2] Amari A, El Bari N, Bouchikhi B. Conception and development of a portable electronic nose system for classification of raw milk using principal component analysis approach. *Sensors & Transducers Journal* 2009;102:33- 44.
- [3] Tahri K, Tiebe C, Bougrini M, Saidi T, El Alami El Hassani N, El Bari N, Hübert T, Bouchikhi B. Characterization and discrimination of saffron by multisensory systems, SPME-GC-MS and UV-Vis spectrophotometry. *Analytical Methods* 2015;7:10328-10338.