

## ANALYSIS OF THE QUALITY OF SOFT DRINKS USING INNOVATIVE E-NOSE AND E-TONGUE TECHNOLOGY

Odour and taste control evaluation can be performed by gas and liquid sensor array systems – the so-called electronic nose and tongue. Due to the simplicity, rapidity and objectivity of these systems, they have become extensively more attractive for use within major food and drinks companies. The E-Nose and E-Tongue can be used for a wide range of applications including quality control, product matching, origin identification, spoilage detection and flavour quantification.

### HOW SENSOR ARRAY SYSTEMS WORK ?



Electronic Nose FOX

Without needing any prior fractionation, the electronic nose and tongue can determine the fingerprint of a complex volatile or dissolved compound mixture by an array of semi-specific sensors coupled to a pattern recognition system. Similar to the human nose, the electronic nose operates by recognising the overall pattern of components. In addition, the “odour/aroma and taste fingerprints” may then be stored in a database in a manner analogous to the recollection of olfaction perception in the human brain (Figure 1).

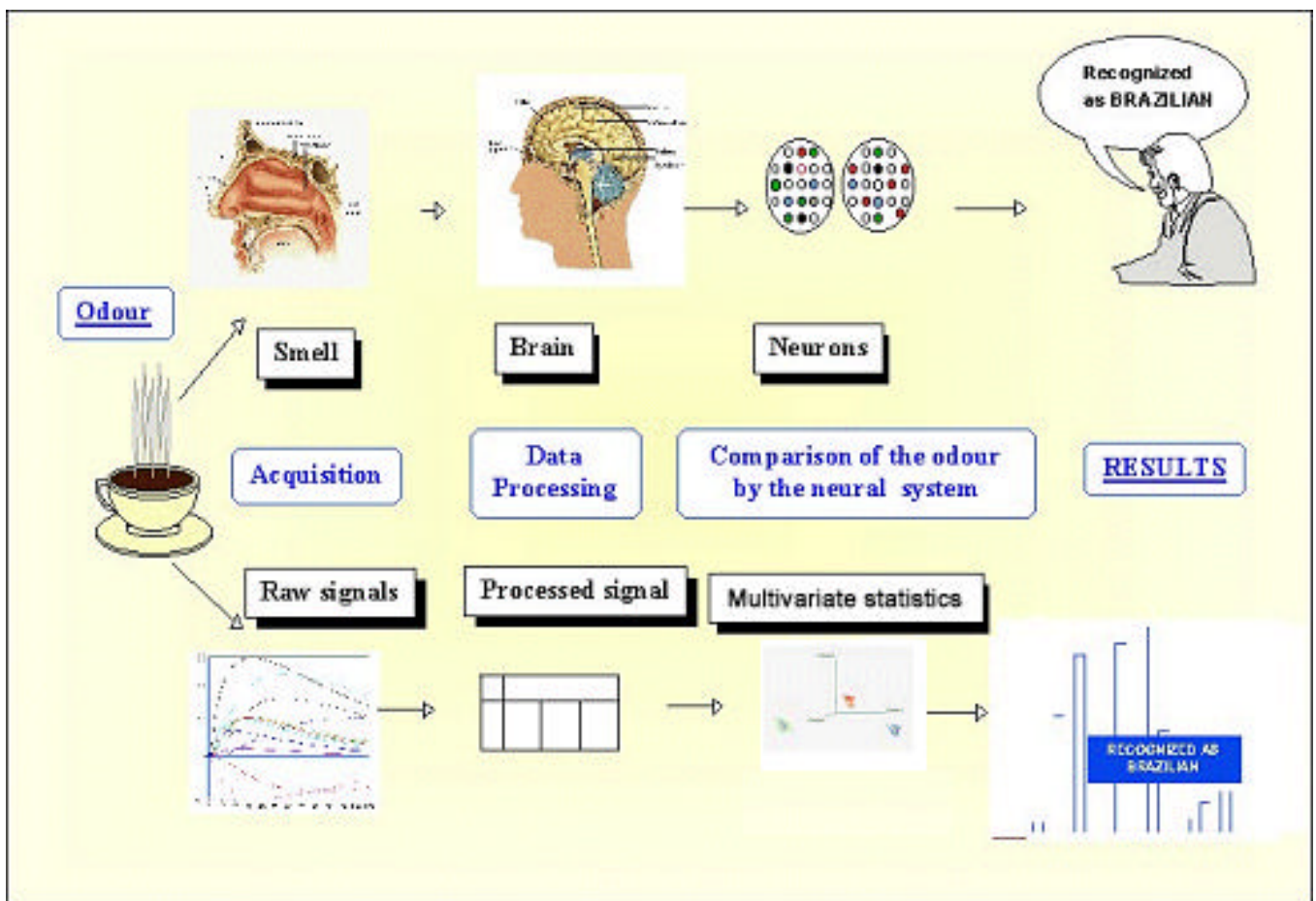


Figure 1 : Schematic representation illustrating the principle of the electronic nose

**Principle of Operation:**

E-noses comprise of several different features such as a sampling system, an array of sensors, an electronic data acquisition, a control system and pattern recognition software.

The sampling system introduces the odour or headspace sample to the chemical sensors and in a reproducible manner.

**Sensors:**

The chemical sensors (Metal Oxide Sensors) are detectors that measure conductance changes upon contact with volatile chemical compounds. The volatiles react with the sensitive material on the surface of the sensors, thereby enabling important information to be obtained.

**Pattern Recognition Software:**

The dynamic sensor signal depends on many physical parameters. Examples include the speed of the flow that carries the odour from the source to the sensor array, the chemical nature of the odour itself, the diffusion and reaction of the odour within the active sensing material and the ambient conditions such as pressure, temperature and humidity.

Sophisticated software is required to handle the complex information yielded by the sensor responses. This software is based on powerful algorithms for pattern recognition. The most well established algorithms are those used for static pattern recognition and include techniques such as principal components analysis (PCA), discriminant function analysis (DFA) and cluster analysis.

**EXAMPLES OF SOFT DRINKS APPLICATIONS****1. Discrimination of the Quality of Apple Juice**

The objectives of this study are:

- To obtain a correlation between the electronic nose/tongue, the trained sensory panel and consumer acceptance
- To predict sensory characteristics and consumer acceptance

A broad range of apple juices, including a three-apple blend, vitamin C- fortified apple juice, apple pear juice, and apple cider were analysed for the comparison of the results generated by the E-Tongue with those obtained by sensory testing panels.

The relationship between the sensory and E-Tongue results are shown in Figure 2. It can be seen show that certain E-Tongue sensors (*e.g.* ZZ36 and the CA07) are highly correlated to the sweetness attributes whereas other sensors (*e.g.* BA07 and AB07) are more correlated with apple flavours.

These results highlight the accuracy of the E-Nose and E-Tongue for the routine control of the products and demonstrate the synergy between the analytical analysis and sensory evaluation. In summary, the E-Nose and E-Tongue may be used to ensure the consistency of “consumer-defined quality” of apple juice. Electronic sensors can be used to predict acceptance in a more precise manner allowing greater tolerances on less important attributes while maintaining strict control over key QDA sensory attributes.

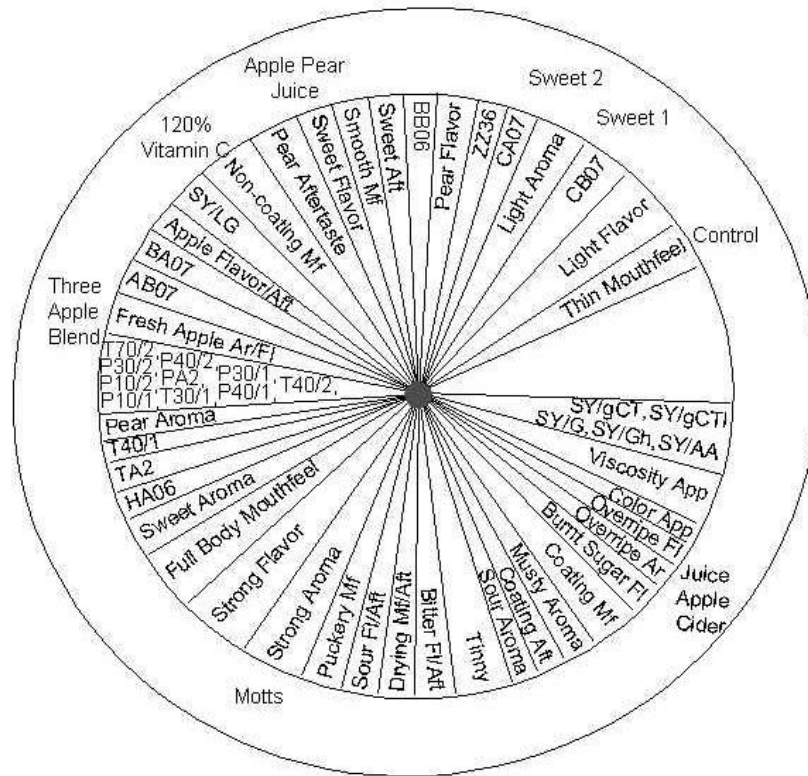


Figure 2 : Relationship between sensory and instrumental analysis

## 2. Differentiation of Premium Orange Juice

The electronic nose can be used to differentiate between different brands of premium orange juices (six non-concentrate and one concentrate juice samples). The different brands were successfully discriminated apart from the slight overlap of two samples (Figure 3). This may indicate that the two samples were obtained from similar sources or indeed a single processor may provide the juice for two different brands.

The orange juice samples for this study were obtained from a local supermarket and were all stored at  $-20^{\circ}\text{C}$  prior to analysis. The Citrus and Subtropical Products Research Laboratory of the United States Department of Agriculture (USDA) found that the E-Nose performed admirably on what was determined to be very similar orange juice samples.

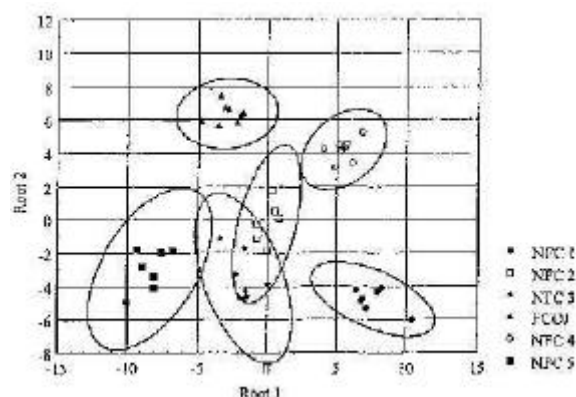


Figure 3 : Principal Component Analysis (PCA) of orange juices

## **Conclusion:**

The examples described above have shown that the electronic nose/tongue technology may be successfully applied to soft drink samples. The study on different apple juices yielded a high correlation of the instrumental results with the sensory panel. After the initial model building by the sensory panel, the E-Nose and E-Tongue may be used for quality control and quality assurance (QC and QA), thus improving batch-to-batch consistency.

The orange juice study also yielded fruitful results where sufficient discrimination was achieved on samples previously determined as very similar by a sensory panel.

To conclude, the E-Nose and E-Tongue are excellent tools for performing rapid and objective sensory measurements within a QC/QA environment, one that is very important in the food and beverage industries. Both quantitative and qualitative results may be obtained thereby allowing systems to be utilised for a wide variety of applications.

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