# THE STUDY OF AN ELECTRONIC NOSE ON BATCH-TO-BATCH QUALITY CONTROL OF CHINESE TRADITIONAL DRY-CURED HAM

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## Introduction

Inspired by higher quality of living standards, quality control of Chinese traditional food, such as dry-cured ham, is becoming more and more important. Due to unique manufacturing process, quality control of flavor has been mainly performed by human sensory. However, panels fatigue easily and the results are subjective. Other analytical technologies such as GC/MS could be useful to address potential safety issues or identify specific components of the flavor; however, it is not feasible for overall flavor quality control.

Fingerprinting technology has being an useful tool for food quality control to detect overall product quality impacted by coherent effects of many constituents. Within this scope, a sensor arrays system, that is "Electronic-nose" using metal oxide sensors coupled with chemometric methodologies has generated a great interests in the analytical laboratories of the world's leading food, flavors and fragrance companies, as well as in the environment as a fast, simple, and reliable method of aroma/VOC analysis. In meat industry, electronic-nose was reported to identify spoiled beef (Panigrahi, 2006), determine meat freshness (Galdikas, 2000), evaluate ripening time of Iberian hams etc (Santos, 2004). This paper utilizes electronic-nose to differentiate three types of Chinese traditional dry-cured ham from different origins. Through analyzing different batches of each brand name, batch-to-batch consistency and quality control of ham flavor were evaluated and compared.

## Materials and Methods

*Materials*: Five different batches of Chinese traditional dry-cured ham from different origins: coded "Ham A", "Ham B" and "Ham C" were selected and the femoral biceps were chopped into 1-2 $mm^3$ for further analysis.

*Electronic-Nose Analysis*: FOX 4000 E-Nose Finger-Printing Analyzer coupled with headspace auto sampler HS100 and full chemometric workstation Alpha soft V9 (all by Alpha M.O.S., French). Two grams of each sample were sealed in 10 ml headspace vials, and loaded into the auto sampler tray. The vial was incubated at 40°C with shaking for 15 minutes to allow the volatilization of flavor components into the headspace. Then 1.5 ml of the sample headspace was extracted by the auto sampler syringe and flow-injected into the carrier gas flow (synthetic air mixture). The detector includes 18 different metal oxide sensors divided into three chambers. Multiple types of sensors are used in the instrument to ensure adequate sensitivity and selectivity. Odorants were adsorbed to the sensors and then reacted with the metal oxide sensors, depending on the type of sensor and the odorant molecular functionality. The reaction changes the resistances of the sensors, and these changes in sensor resistance are monitored and output as raw signals. The sensors are re-generated to initial state by reaction with oxygen in the carrier gas after each injection.

## Results and Discussion

*Differentiation of hams:* Figure 1 showed the raw signals as resistance changes of 18 sensors as a function of time for Ham A and Ham B samples. There were great differences between flavor patterns, which were used to characterize the flavor component In order to analyze data more efficiently, only the maximum responses from each sensor were used. A model (Figure 2) was then built by these Hams from different origin then using the samples tested as training standards so as to identify unknown Hams, employing discriminate factor analysis (DFA). Depending on the distance between the center of the clusters of the unknowns and the closest clusters of the training map, the recognition percentage was calculated to indicate the various unknown samples. Table 1 showed the unknown prediction results based on the model. Overall, the discrimination and prediction capabilities of the Electronic-nose would be promising. Once a statistical model is built using different standards, the Electronic-nose could be used for rapid identity testing for unknown samples. Stabilization for ham A and C but not for ham B. The flavor of ham B is different from one piece to another.

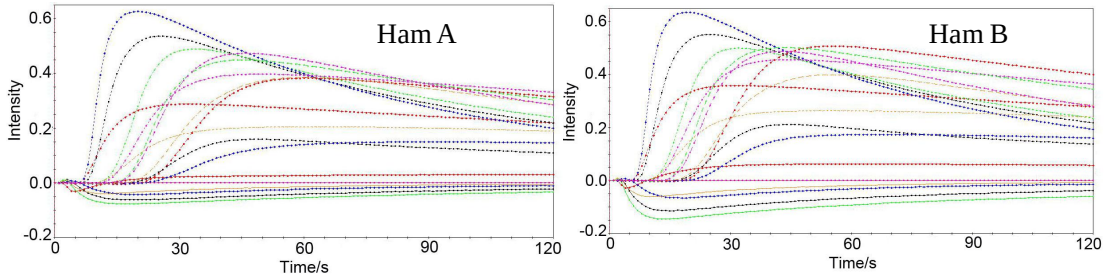


Figure 1. Comparison of sensor responses between Ham A and Ham B

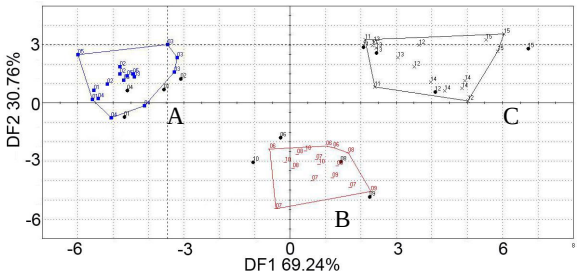


Figure 2. Differentiation of Hams from different origins

| Sample # | Predicted | Actual | Iden. Index |
|---|---|---|---|
| 2 | A | A | 93.5 |
| 4 | A | A | 100 |
| 9 | B | B | 97.4 |
| 10 | B | B | 88.5 |
| 11 | C | C | 98 |
| 12 | C | C | 100 |

Table 1. Identification of unknown samples

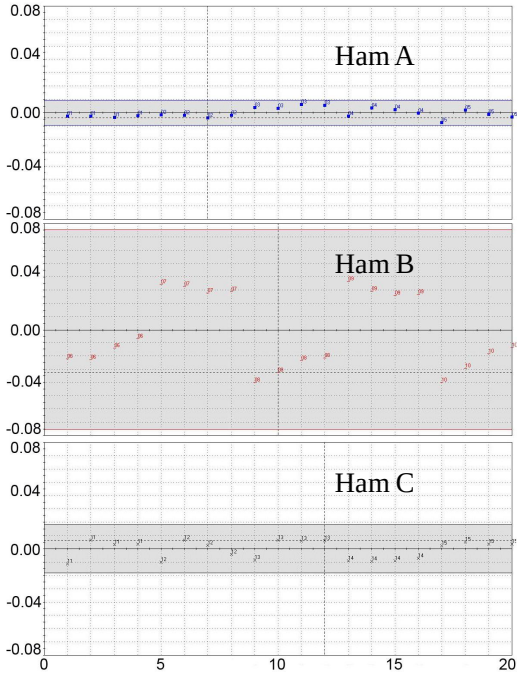


Figure 3. Batch-to-batch comparison

*Batch-to-Batch Consistency:* Figure 3 showed the comparison of batch-to-batch consistency among hams from different origins according to the Statistical Quality Control (SQC) analysis. The marked grey areas in each plot represented the accepted quality control bandwidth for different hams based on the 95% confidence level. The band widths were measured at 0.019, 0.16, 0.036 odor units, respectively, for ham A, B and C. This indicated that flavours in ham A and C having better batch-to-batch consistency comparing to Ham B.

**Conclusions**

The flavor of ham A and C had better stabilization .The electronic nose could be very feasible to determine the origin of unknown ham samples and could be a useful tool for batch-to-batch quality control. The instrument could provide a good combination of speeded, accuracy and sensitivity.

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