Department of Food Science and Technology
College of Agricultural & Environmental Sciences
UNIVERSITY OF GEORGIA

cocoatown

Cocoa Research Centre

UWI

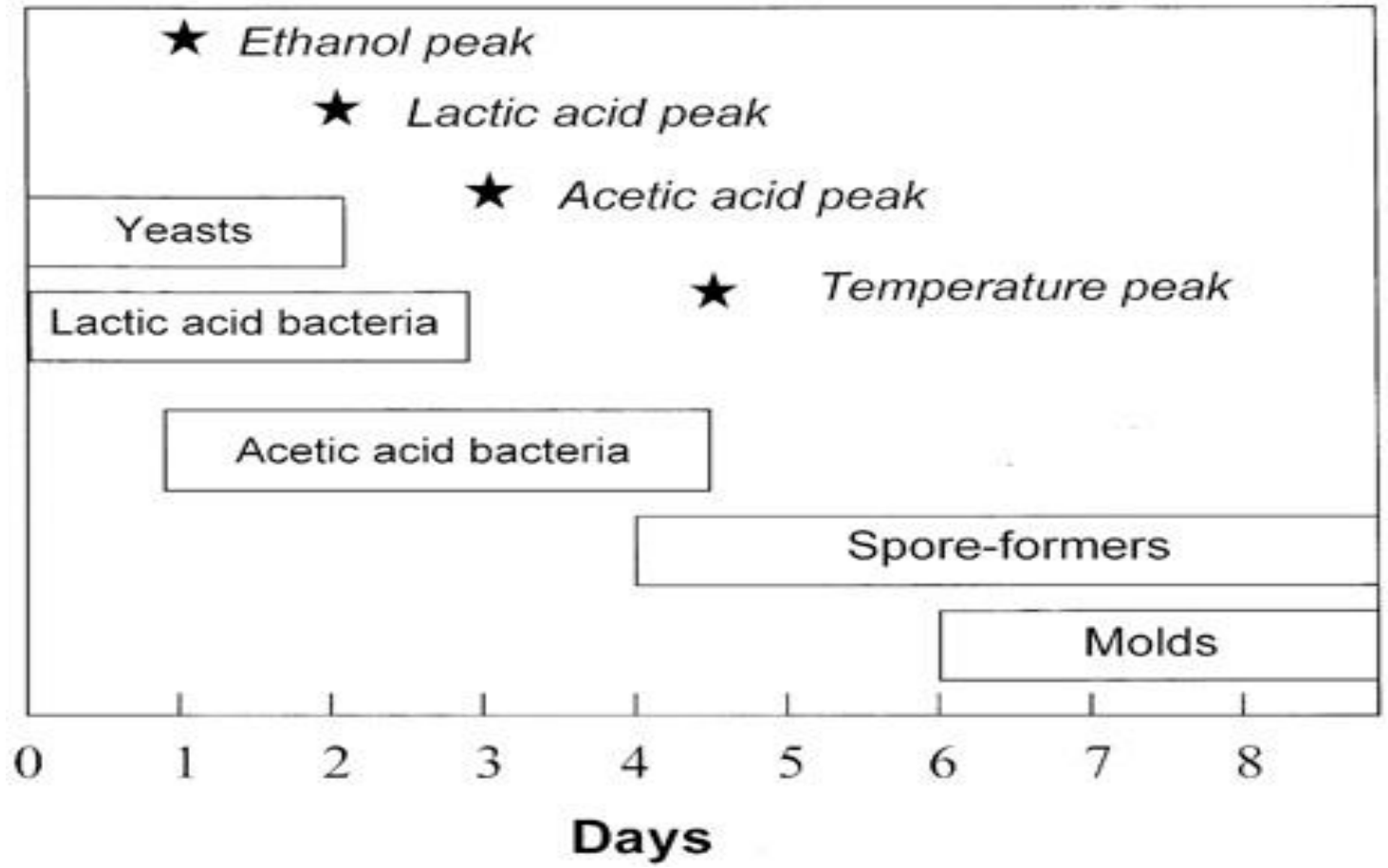
Sensing Fermentation Degree of Cocoa (Theobroma cacao L.) beans by Machine Learning and Traditional Classification Models based Electronic Nose System

By
Juzhong Tan, PhD
Washington State University & University of Idaho
Food Science

Background

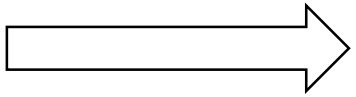
- **Fermentation** remains empirical and does not give rise to beans of consistent quality, which obliges processors continuously to make changes of their formulations. It also helps to trigger biochemical changes inside the beans that contribute to reducing bitterness and astringency, and to the development of flavor precursors.
- Determining the degree of fermentation relies on human specialists or sophisticated chemical analysis that are inaccessible to small manufacturers and farmers.

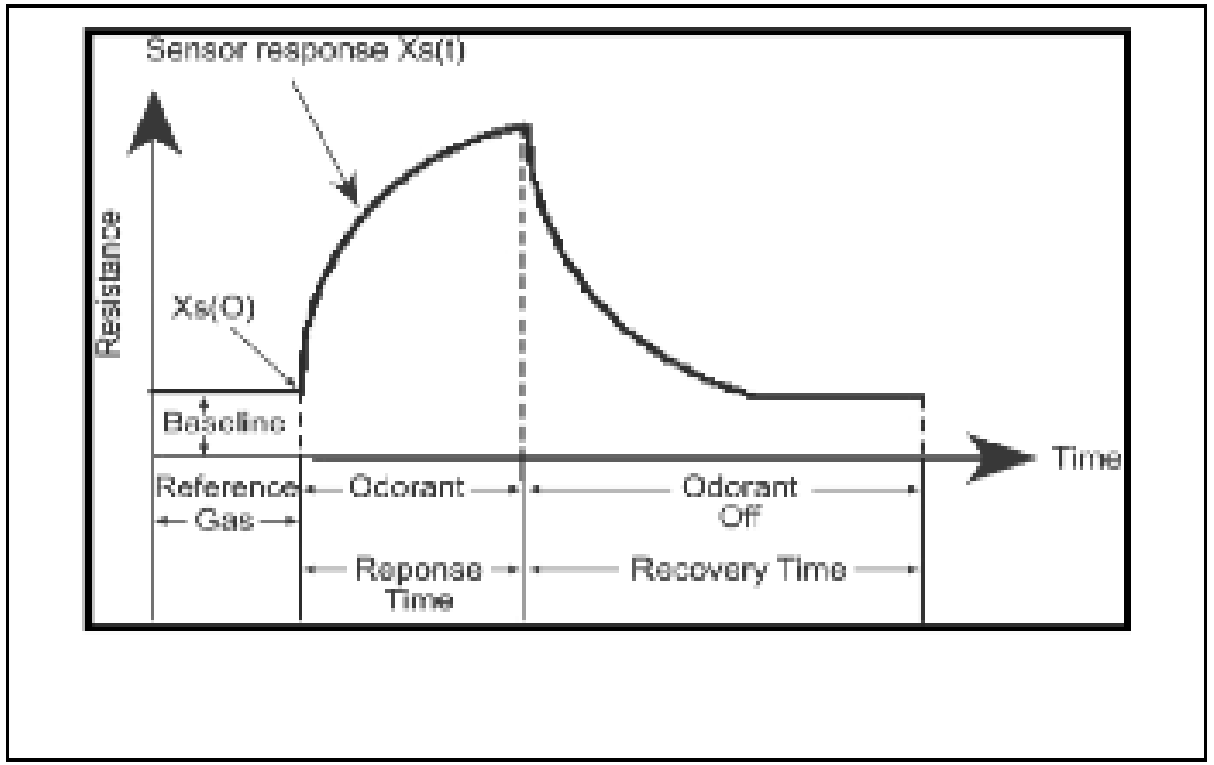
Flavor development-fermentation



E-nose

An e-nose system is a combination of gas sensors that give a fingerprint response (**conductivity**) to a given odor and pattern recognition software that performs odor identification, classification and discrimination.





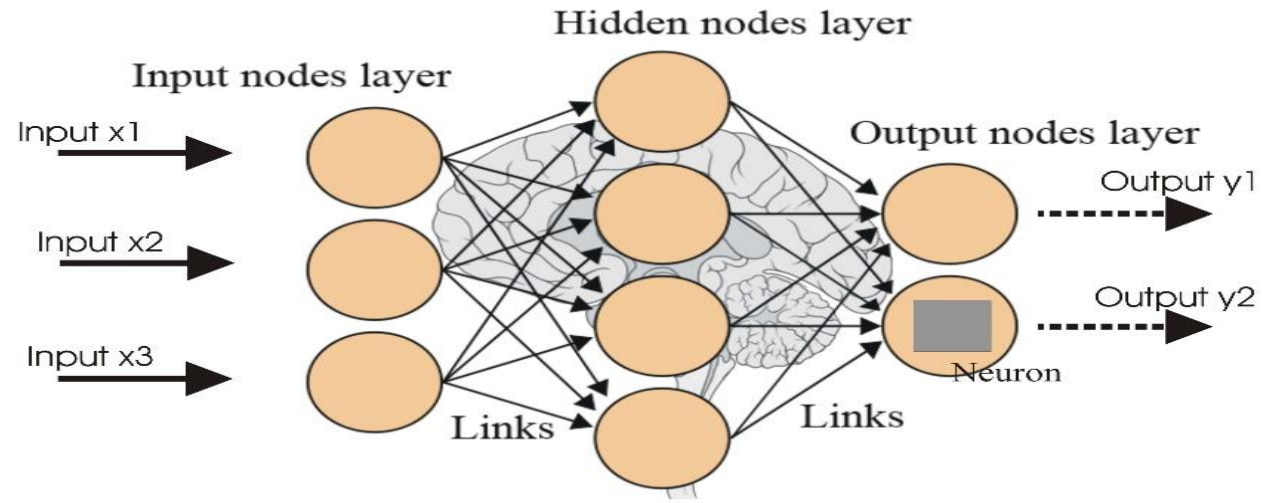
Artificial Neural Network (ANN)

ANN is computational model used in **machine learning**, computer science and other research disciplines, **mimicking the neuronal structure of the mammalian cerebral cortex** but on much smaller scale. The learning and training process of ANN is similar to human cognitive process. Like the human cerebral cortex, a ANN consist of layers of artificial neurons, or simply neurons or nodes.

Location

Date

Star



150 usd

120 usd

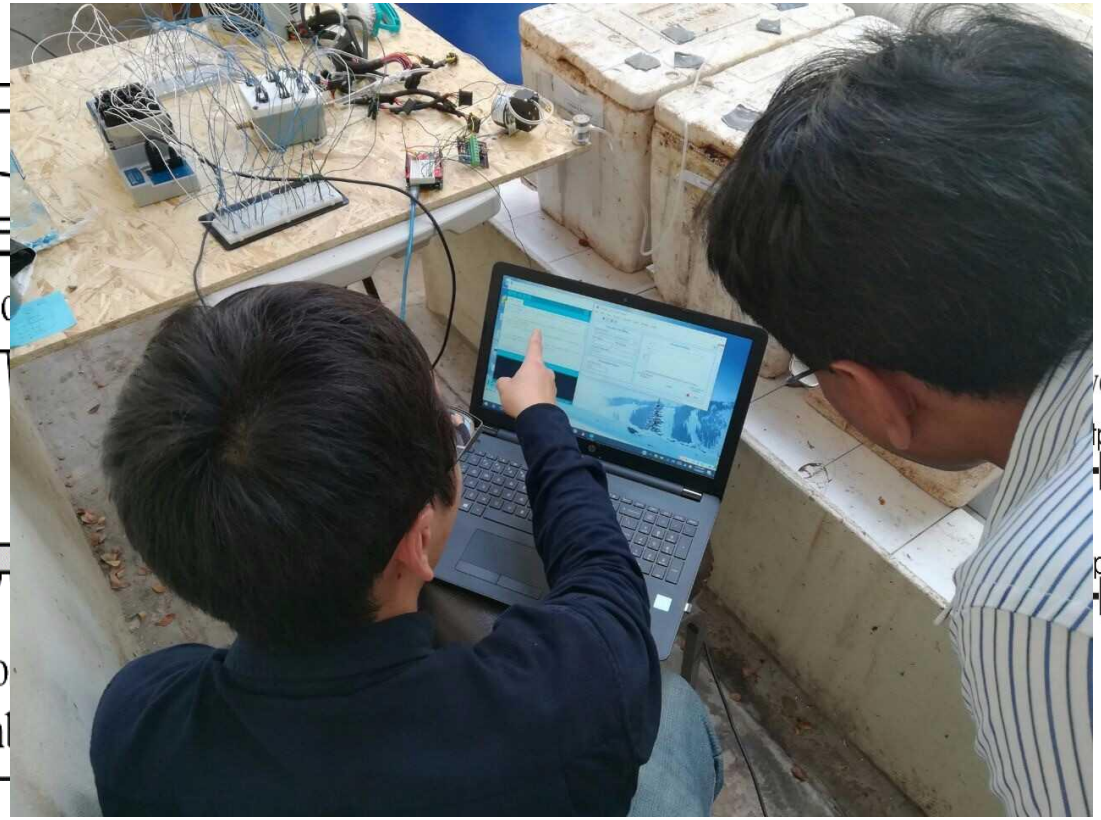
Materials& methods

- *3 chillers with 25 kg wet* cocoa beans respectively were fermented at natural environment. The fermentation were monitored by e-nose and PH, cut test and temperature measurements were conducted for 8 days.

Table 6.1. Sensitivity of the gas sensors used in the electronic nose system.

Sensors	Target gas
TGS821	Hydrogen
TGS813	Methane, propane, butane
TGS2602	VOCs, NH_3, H_2S
TGS822	Organic solvent, alcohols
TGS2610	Butane, propane
TGS2620	Alcohol, solvent vapors
TGS830	R11, R113, other halocarbons
TGS823	Organic solvent, methane, hexane

Materials & methods



Results & discussion

Fermentation time (day)	Misclassification rate (%)
0	34.0
1	12.8
2	6.4
3	10.6
4	12.8
5	10.6
6	8.5
7	6.4
Overall	12.8

Conclusion

- ANN trained by e-nose could predict the stage of fermentation of cocoa beans. As noted, the e-nose system is a much simpler and inexpensive system to use. While not attempted in this study, it is anticipated that the e-nose could be adapted to collect and analyze gases on-line and in real time.
- Thus, the combination of an e-nose system with ANN might be useful for determining whether beans are rotten or not, the grade of the beans, the degree of fermentation and the degree of roasting. Future studies will be focused on these applications.

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Contact: Dr. Juzhong Tan
juzhongt@uidaho.edu
alvindan@uga.edu
+1 706-296-2860