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Popular Article

Application of Electronic Nose, Electronic Eye and Electronic Tongue System in the Seafood Quality Assessment

Vignaesh Dhanabalan[1*], Mohammed Akram Javith S.[1], Sarojini A.[1], Vinoth kumar L.[2], Masilan K.[1] and Somu Sunder Lingam R[3]

[1]Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Madhavaram Campus, Chennai,
[2]Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Ponneri Campus, Chennai,
[2]Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Barur Campus, Krishnagiri, Tamil Nadu

Abstract

Seafood quality assessment in the processing and value addition industry poses a significant challenge due to the essentiality of high-cost equipment and tedious analysis to ensure that the products reaching the consumers are of safe and high quality material. Current technologies often require abundant resources, skilled personnel and complex analytical procedures, raising a demand for fast and inexpensive methods. Electronic nose, eye and tongue system are emerging methods capable of identifying and differentiating various flavours, aromas and colours through an array of electronic sensors depicting likely results when applied to different seafood products. This article encompasses the principle, working mechanism of e-nose, e-tongue and e-eye systems and its application in the assessment of seafood quality. These methods could be beneficial in the detection of pathogenic microorganisms and toxins, grading quality, adulteration and monitoring quality decay during shelf life.

Keywords: Seafood quality evaluation, Non-destructive Method, electronic nose (e-nose), e-eye and e-tongue system

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Introduction

The global demand for rapid and accurate quality evaluation of seafood composition has increased significantly due to hygiene and safety considerations in the seafood supply chain. Seafood being one of the highly perishable foods is an essential component of the human diet. Seafood adulteration and fraudulent has become a common practice, posing a substantial challenge to seafood processing sector. Seafood adulteration is the fraudulent practice of misrepresenting seafood products, often to deceive consumers about the type, quality or origin of the fish. For adulteration, poisonous chemicals like formalin are commonly added in the fish preservation. Other adulterants such as urea are used to increase the profit by compromising the nutritional quality of fish. This can lead to chronic diseases like liver disorders, cancer and cardiovascular illnesses. In order to overcome these problems, it is important to monitor the seafood products throughout the entire seafood supply chain with an intelligent and low cost system.

There are different methods to evaluate seafood quality. The most conventional and simple method is sensory evaluation but it can be biased and can be affected by human fatigue and mental state. Various laboratory methodologies such as microbial analysis, microscopic examination, and different chromatographic and spectrophotometric techniques like gas chromatography – mass spectrometry, liquid chromatography, differential scanning colorimetry, Fourier Transform Infrared Spectroscopy and Nuclear Magnetic Resonance are used but they are also expensive, time – consuming and required skilled labours to perform the analysis. Hence, an inexpensive, efficient, real-time rapid detection method is required. Developments in Artificial intelligence (AI), electronics and sensor technology have made it possible to build instruments like the electronic nose, electronic tongue and electronic eye system that are capable of characterizing Seafood quality factors.

The onset of the e-nose system has provided a new option for non-destructive quality assessment of seafood commodities. The e-nose system gives a rapid assessment as compared to the conventional, high-cost time-consuming methods.

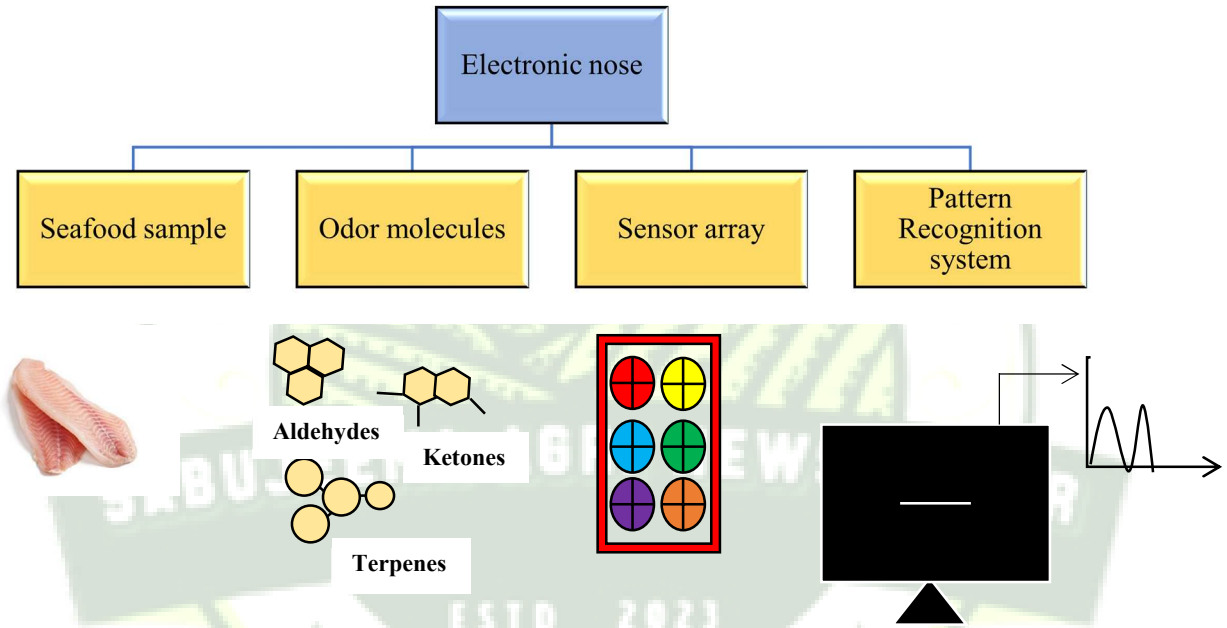
e-nose

It is an instrument that comprises electrochemical gas sensors and a pattern recognition system. An e-nose is an artificial olfactory system that is used for automated simulation of the sensor odour. The advantages of e-nose are as follows;

1. Cost-effective
2. Potable

3. Easy to handle
4. Provide analysis in short time

Electronic nose is also known as mechanical nose, aroma sensor, odor sensor, flavour sensor, artificial nose, odor sensing system and electronic olfactometry. An e-nose system consists of both software and hardware components. The seafood aroma is composed of complex volatile compounds also known as odor active compounds that stimulate the olfactory system. The e-nose first collects a sample of the odor or gas to be analysed. It then exposes the gases to a sensors array in which the signals are processed and the data generated is fed in to pattern recognition system to classify and identify the odor or chemical composition based on



the unique sensor response patterns. The mechanism of e-nose is summarized in Fig. 1

Fig. 1. Working mechanism of Electronic nose (own source)

The sensors can be categorized into various types;

1. Metal Oxide Semiconductors
2. Conductive Polymers
3. Piezoelectric sensors
4. Electrochemical sensors

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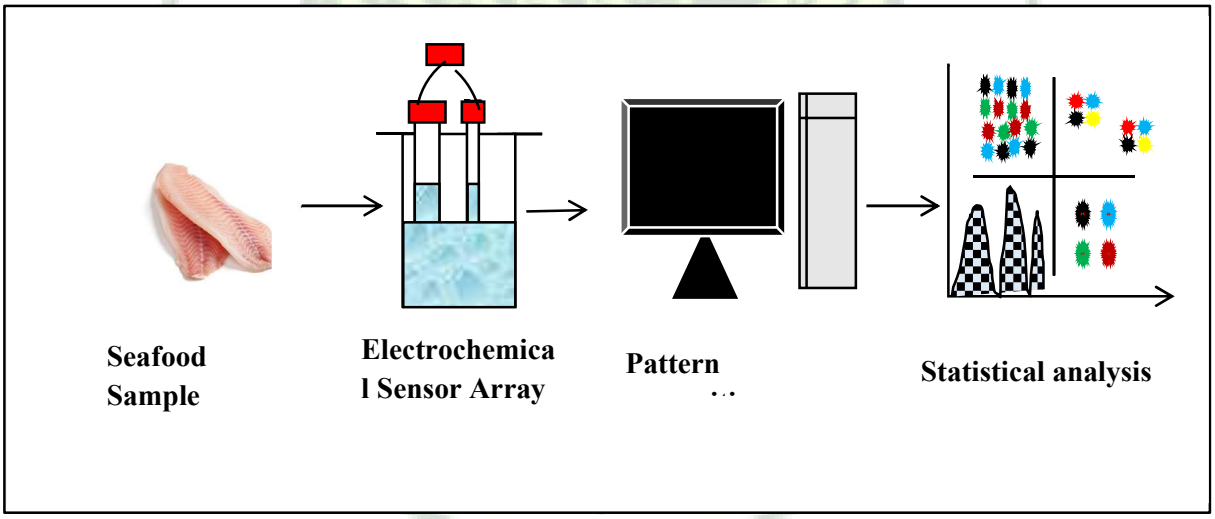
e-eye system

An e-eye is a detection technology based on recognition and analysis of visual information applied to seafood quality evaluation. Color spaces vary according to the sensitivity based on the hue saturation (HS) space, such as hue, saturation and value (HSV), hue, saturation and lightness (HSL), hue, saturation and brightness (HSB) and hue, saturation and intensity (HSI). The e-eye is able to capture the appearance-related parameters of the samples. The sensors and color identification techniques are based on the calorimetric, spectrophotometric and color vision. The most widely used color spaces is L*a*b* system in which L* is a measure of the lightness of the samples, a* is a measure of green or red colors and b* indicates yellow or brown colors.

e-tongue system

An e-tongue system is a technology composed of set of sensors that react when immersed with chemical solutions. It also consists of an electrochemical sensor array, a measurement module and appropriate pattern recognition capable of recognizing simple and



complex systems of molecules that form the taste. The sensory array of an e-tongue generates multidimensional information in a short period of time that recognizes the different patterns of classes of compounds that are responsible for flavour. This complex information generated from e-tongue is further processed for statistical analyses. The working principle of electronic tongue system is summarized in Fig. 2.

Fig. 2. Working mechanism of e-Tongue system (own source)

Application of e-nose, e-eye and e-tongue

1. The e-nose is used in the early detection of pathogenic microorganisms and toxins, grading quality, adulteration and monitoring quality decay during shelf life.
2. E-nose technology is also able to indicate meats stored in different temperature conditions.
3. The e-eye is used in the evaluation of color, marbling level, quality prediction, detection of defects and sorting operation
4. Marbling is the distribution of the amount of intramuscular fat present in the meat which affects the sensory parameters such as tenderness, juiciness and flavour. Higher marbling is generally associated with more desirable eating experience. Using e-eye, higher accuracy of grade marbling can be achieved in fresh meat
5. The e-tongue is used in the identification of meat adulteration and meat samples

Conclusion

In recent years, a several number of studies were carried out on the application of e-nose, e-eye and e-tongue systems in the area of seafood quality assessment such as adulteration and freshness determination. The electronic systems mimicking the senses of odour, vision and taste and their applications have expanded to assist in the evaluation of quality and shelf life of seafood products. The advantages of these electronic systems are their flexibility to characterize and disseminate the application of preservation techniques such as chilling, freezing or irradiation, detect adulteration methods, quality grading, indicate the presence of toxic compounds and microorganisms without laborious, complex and long-lasting methods.

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