

ABSTRACT

Tea is one of the widely consumed beverages all over the world due its delicious taste, herbal and medicinal importance, etc. Quality of tea is varied from garden to garden depending on geographical origin and processing techniques. Mainly three types of tea such as unfermented green tea, fully fermented black tea and semi fermented oolong tea are available to consume among which black tea covers maximum share of the world tea market. Tea is one of the largest foreign exchange earner agricultural products of India. Taste, colour and aroma are the main three parameters that attribute the quality of black tea. Quality evaluation of tea is traditionally accomplished by the inspection judgment of sensory analyst or a tea taster. Applying their professional acumen and experience, tea tasters evaluate the quality of tea by means of its sensory appearance, viz., taste, colour, aroma, etc. and provide the score on an arbitrary scale of 1-10 for individual tea sample. The market price is decided on the basis of this scoring. However this method is purely subjective and suffers from inconsistency and irreproducibility due to various factors like individual variability, habituation at prolonged exposure, human health hazard, etc.

Taste, colour and aroma arise due to presence of varieties of chemical compounds in tea samples. Variation in concentration of these chemicals leads to the variation in taste, colour and aroma in tea samples. Thus quantification of these chemicals by means of instrumental techniques like HPLC, GCMS, FT-NIR, MALDI-TOF MS, NMR, Raman spectroscopy, etc., has been considered important for tea quality evaluation instead of inspection-judgment of sensory analyst. However, these methods are expensive, involve large operational or maintenance cost and require skilled manpower. As a consequence these techniques cannot be applied for day-to-day usage and appear unattractive for routine works in tea industries. Due to these shortcomings of existing techniques, a low cost, fast, simple, reliable and efficient technique for tea quality evaluation is urgently required.

Sensation of taste and smell/aroma arises due to the chemical interaction of the tastants and odorants with the corresponding receptor cells in our gustatory and olfactory system respectively. To, mimic these sensations, development of artificial sensors based on some physico-chemical interactions has been taken into account for quality gradation among tea varieties.

Instead of lipid-polymer composites and other materials so far reported for quality evaluation of tea, functionalized polymer membranes based potentiometric electronic tongue (E-T) or taste sensor has been introduced. This E-T showed linear correlation with the taster's score (for taste & colour both) and have excellent ability to discriminate the tea varieties. Ease of fabrication, tailoring selectivity, possibility of miniaturization, long term stability and reproducibility etc. can also be possible with such polymer membranes. A prototype sensor device using this membrane electrode has also been fabricated in this work, which was potentially able to provide stable and consistent results. A plasmonic material (silver nanoparticle) was also introduced to interact with the water soluble tea chemicals for tea quality evaluation through its photo physical change and outcome was correlated with the testers score.

A non destructive technique based on the color differences through image analysis after addition of lemon juice with the tea solution to distinguish the black tea varieties was demonstrated in this study, which showed highly promising results.

Aroma, an important quality attribute of tea is enormously reported to be optimized by metal oxide sensors. But high operating temperature and extreme moisture sensitivity are the major problems of these sensors. Taking all the discrepancies into account, graphene based room temperature sensors for tea quality evaluation, which is expected to be better alternative and easiest approach, was also explored here for the first time. The Facile and cost effective synthetic processes of these sensors materials and fabrication procedures of sensing devices made of these sensors are also discussed in this work.

As whole we have proposed four user-friendly ways (viz., membrane based artificial sensor, plasmonic based optical tongue, image analysis based e-vision and graphene material based e-nose) for tea quality evaluation. Very facile ways have also been developed for material preparation.

Key words: Taste sensor, aroma sensor, image analysis, functionalized polymer membrane, graphene