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Application of Digital Sensory in Odor and Taste Differentiation

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Introduction of research

Digital sensing technology combines multisensory array and a data processing software so that multiple chemical compounds can be identified simultaneously in a sample [1, 2]. It has been widely used for odor and taste analysis in the food industry [3, 4]. However, its application in the cosmetic and consumer care space has been limited. This research is designed to explore the feasibility of using digital sensory detection devices, such as eTongue and eNOSE, to differentiate the taste and odor profiles of some consumer products.

Methods

Test samples: A set of mouthwash samples were selected for the experiments. There were total of 8 samples from 3 different brands with 2-4 samples of different flavors per brand. 2 flavors from each Brand B and D were included, and 4 flavors from Brand E were incldued.

eNOSE: Hercules NEO 100 electronic nose system from AlphaMOS was used for odor detection. This e-nose technology is based on flash gas chromatography technique. The assay was conducted in a headspace injection mode by weighing 1g of sample in 20mL vial. Triplicate assays were run for each sample. The samples were agitated to generate vapors then injected into the e-nose. The vapors were concentrated in the solid adsorbent trap to achieve efficiency and greater sensitivity then split into two which passed through the two metal columns of different polarities (DB5 and DB17) in parallel and were subsequently detected using two flame ionization detectors (FID). The instrument conditions were set as the following: headspace generation 20min at 40°C, injection volume 0.5mL, trap temperature 40°C/240°C (desorption), columns program 40°C(2s) to 280°C (18s) by 3°C/s, FID temperature 280°C.

Characterization of the samples was done by comparing the chromatographic peaks against the AroChemBase library to identify the chemical compounds in each sample. Discriminant function analysis (DFA) and principal component analysis (PCA) were used as the statistical analysis tool for sample grouping and differentiation.

eTONGUE: Astree e-tongue system from AlphaMOS was used for taste detection. The e-tongue technology is based on potentiometric measurements using sensing electrodes that are cross-sensitive to different molecules responsible for taste. The sensors used in this experiment are ion selective field effect transistor. The assay was conducted by transferring 25mL of each sample in triplicates into a e-tongue carrousel. DFA was applied to the result to assess the differences among the samples. The saltiness of the samples was ranked and compared to human perception.

Human tasting test: 10 volunteers were recruited to sample to the mouthwash samples and rank their saltiness on a scale of 0-12. Each volunteer held 15 mL of the mouthwash in their mouth for 30 seconds before expelling. They then rinsed their mouth with water and waited for 7 minutes before sampling the next sample. The average result from the whole panel was compared to the saltiness ranking obtained from the e-tongue system.

Results

Unique Chemical Signatures Associated with Different Flavors of The Same Brand Mouthwash Products

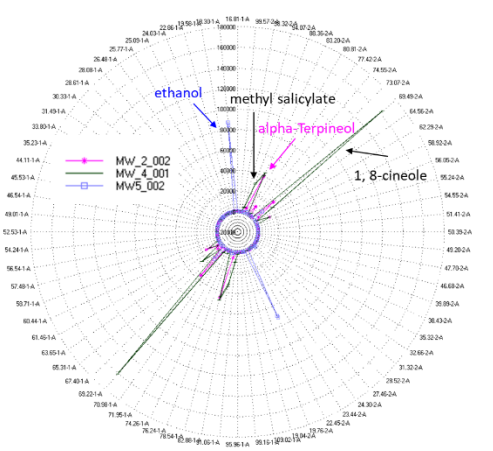
The results revealed that for brand B and D the differences between different flavor products within each brand can be accounted for by unique chemical signatures on the chromatograms. For Brand B products, flavor 1, which is fennel flavor, showed a strong peak corresponding to anethole; while flavor 2, which is mint flavor, showed stronger peaks corresponding to methyl salicylate and alpha-phellandrene. For Brand D products, flavor 1 (mint) showed stronger peaks at alpha-phellandrene, 1,8-cineole, and geranial; flavor 2 (tea) showed stronger peak corresponding to alpha-terpineol. However, for Brand E, all four products displayed dominant peak for ethanol; there were some unique peaks for each flavor but at much lower intensity.

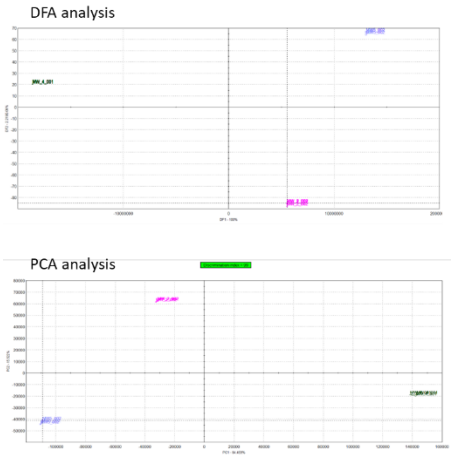
Odor Profile Among Different Brands

Discriminant function analysis (DFA) showed that all four products from Brand E formed a very tight cluster, indicating these products have very similar odor profile and are distinct from other brands. However, for Brand B and D, the two products within each brand are relatively far apart from each other. In fact, flavor 2 of each of the two brands are closer to the Brand E cluster than to the other flavor of its own brand.

Comparing Mint Flavored Products from Different Brands

There was one mint flavored product included in each brand of the test samples. When these mint-flavored products were compared, it was found that the three products are quite distinct based on DFA and PCA analyses and the source of mint flavor can be contributed to distinct chemical signatures as shown in Figure below.





Taste Comparison and Saltiness Ranking

Analysis done by e-tongue showed that the test products formed clusters within each brand. When the saltiness of the products was ranked, Brand B flavor 1 had the highest score and Brand E flavor 1 had the lowest score. A small human panel, N=10, was recruited to rank the saltiness of these products by tasting. The average result showed good correlation with the instrument data.

Conclusions

Both eNOSE and eTongue systems successfully detected the differences among the set of mouth wash samples from different brands and with different flavors. Importantly specific chemical signatures were identified that appear associated with the differentiation. This information can potentially be applied to product reformulation when needed. Use of digital sensory detection system can provide objective and quantitative results. In comparison to human testing, they are unbiased, reliable, safe, and high throughput. But the result has yet to be compared and verified with human perception tests.

References

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About the speaker

Dr. Lily Jiang obtained her PhD from California Institute of Technology and has served as a faculty member at UT Southwestern Medical Center prior to joining SGS. In 2012 Dr. Jiang joined the SGS Stephens team in US and became its Chief Scientist overseeing a group of MD/PhD investigators. She has served as Principal Investigator on numerous pharmaceutical and cosmetic clinical trials. Her work has been published in peer-reviewed journals and presented at society and international conferences. In 2021 Dr. Jiang joined SGS global team and is currently the Global Scientific Advisor for SGS Cosmetic and Hygiene subdivision. She works with all the clinical testing sites within the SGS global network, provides scientific guidance and technical support, leads efforts to continued development of novel technologies and methodologies in the cosmetic testing space, and facilitates client engagement to find the best solutions and high-quality testing services for SGS' clients.