Characterization and Authenitcation of Meat with DART-MS and Chemometric Modeling

Introduction

Ground beef is a popular meat that is increasingly susceptible to adulteration and mislabeling by meat processing companies. Accurate labeling of various ground beef products are important to consumers for health reasons such as vegetarianism, or preference for organic vs conventional products as well as for lower fat content. However, often these 'healthier' ground beef options are more expensive, giving meat processing companies higher financial incentives for mislabeling of these charactersistics[1]. During authentication of labeling studies the US in the last decade, raw ground beef products showed mislabeling in 15.9% of cases, and cooked ground beef products found mislabeling in 22.9% of cases[2].

In these experiments, we developed a method for the quick screening of both cooked and raw ground beef using DART-MS (Direct Analysis in Real-Time Mass Spectrometry) for subsequent classification via chemometric modeling. A 24-Pin Sampler which has 24 metal pins was dipped directly into the ground beef with no sample preparation, and that pin sampler was directly introduced to the DART ambient ionization source for MS analysis followed by statistical processing of these data files for chemometric modeling.

Methods

The DART ionization source was coupled to a Waters QDa, and the sample introduction module used for analysis following the direct sampling was the reusable 24-Pin Sampler. Analysis conditions included a desorption temperature of 450°C, negative polarity, and a linear rail speed of 0.5 mm/sec. The total analysis time for a single run of 24 replicates via the Pin Sampler was just over 3 minutes.

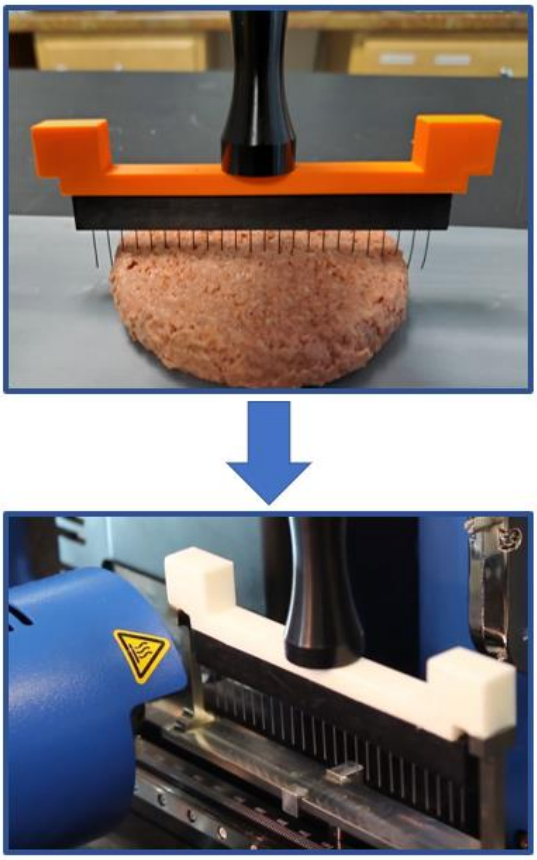

Fig 1: Direct sampling of beef followed by introduction to DART-MS of the 24-Pin Sampler via the automated linear rail

Each replicate sample generated was parsed in separate data files via AnalyzerPro XD software for easier statistical processing. The PCA plot used to distinguish cooked plant-based vs beef patties was also created using this software. The PCA-LDA plot to distinguish between various brands and raw ground beef products with varying fat content was created using Waters LiveID statistical software.

Results

In the the comparison between the plant-based Impossible Whopper and the animal-based Whopper patties, a clear distinction of the respective clusters is visible with the PCA plot.

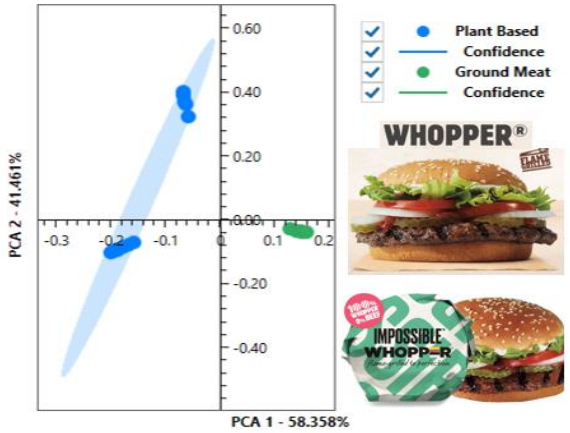

Fig.2: PCA plot showing clear distinction of plant vs animal-based cooked Impossible and Whopper patties

This same distinction between plant and animal based raw beef is present in the PCA-LDA plot, as well as further distinction between varying brands and differences in fat content.

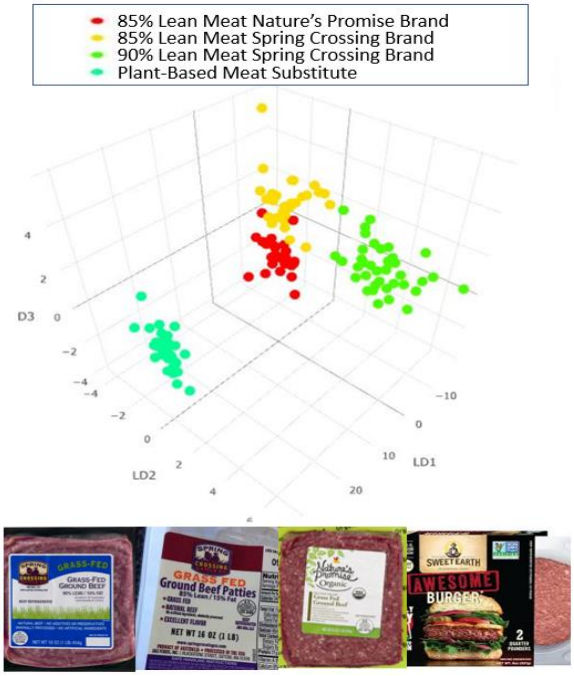

Fig.3: PCA-LDA plot showing distinction between various types of raw ground beef

Conclusion

This method for sampling and screening various cooked and raw beef products has presented a fast, simple way to characterize them using statistical modeling. Compared to extremely lengthy sample preparation necessary in traditional methods, DART as an ambient ionization source allows for eliminating sample preparation and going straight to the analysis of a sample in its native state. Using the 24-Pin Sampler for direct dipping and sampling of the cooked and raw ground beef not only is a quick and easy method of sampling, but it also is an extremely efficient way to analyze many replicates at once and facilitate statistical model creation.

The PCA plot shows clear differentiation between the plant-based Impossible Whopper, and the conventional animal-based Whopper. The PCA-LDA plot shows the capability of even further differentiation between ground beef products. Raw ground beef of the same percentage lean meat but different brand presents in distinct clusters on this plot. Additionally, raw ground beef of the SAME brand and only a 5% difference in lean meat/fat content also presents in distinct clusters. The possibility of classification between only 5% differnce in lean meat reveals the sensitivity capability of this method.

This method could also be adapted for analysis and easy classification of many other food and beverage matrices. Removing the burden of lengthy sample preparation among various food and beverage applications will allow for more efficient analysis across the industry.

References

[1] Ballin N.Z. *Meat Science*. 2010, 86: 577-587.
[2] Hsieh, Y. H. P., Woodward, B. B., & Ho, S. H. (1995). *Journal of Food Protection*, 58(5), 555–559