BaySpec
Pervasive Spectroscopy

Pesticide Screening in Tea

Compact and portable mass spectrometers bring real-time analysis into the field for pesticide screening.

Figure 1: Portability shown with ionization Source (left); Continuity shown without ionization source (right).

Application

Screening of pesticides in tea using BaySpec's Portability mass spectrometer paired with Thermal Desorption – Atmospheric Chemical Ionization (TD-APCI) ionization source.

Introduction

After water, tea is the most popular beverage worldwide. Tea has been around for close to 5,000 years and has become a symbol of comfort, culture, ritual, and ceremony richly steeped throughout the world. Tea is also known for healthful properties such as antioxidants, the possibility of lowering blood pressure, and even improving insulin levels. True tea is derived from one plant, camellia sinensis. The distinguishing characteristics between types of teas, such as black, green, and oolong, come with the treatment and oxidation of the camellia sinensis leaves. Herbal teas, also called tisanes, are not made from camellia sinensis, but herbs, spices, and other plant material and often do not contain caffeine. In 2020, the global tea market was valued at approximately 200 billion USD and is projected to rise to over 300 billion by 2025. With much invested into the global tea market, tea like fruits and vegetables, may be subject to different chemicals to keep pests and fungal growth away. Using BaySpec's Portability mass spectrometer coupled with TD-APCI ionization, eighteen teas commonly found in California Bay Area grocery stores were screened for potential pesticides in each brew.

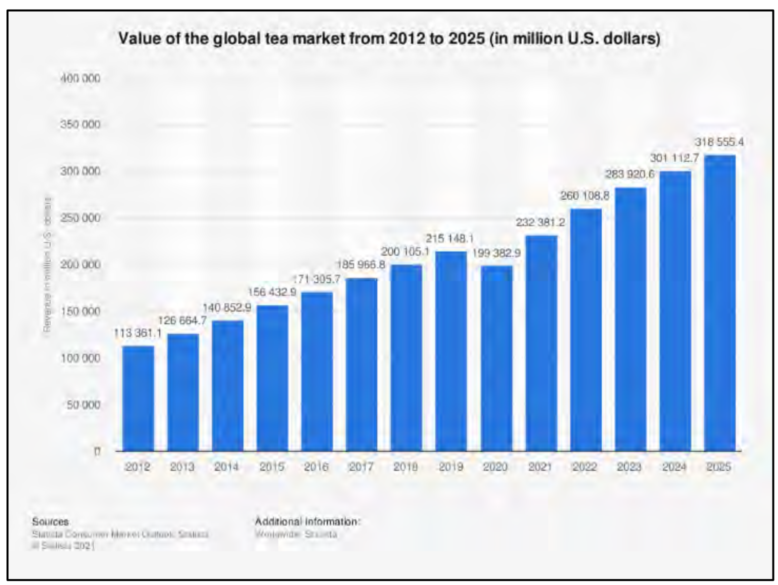

Figure 2: Value of global tea market from 2012-2025. Source: Statista Consumer Market Outlook; Statista

Experimental Procedure

A single tea serving from each type of tea was brewed using 100 mL of hot water at ~93°C (~200°F) and steeped for five minutes. The temperature was chosen assuming the average tea drinker either uses a hot water dispenser or boils hot water in a kettle and does not take a temperature reading of the hot water before steeping tea. The average temperature of a hot water dispenser is ~93°C, which is also about 1-2 minutes off a rolling boil at room temperature at 0-meter altitude.

The experimental steep time was used as it is a temperature most people would use when preparing tea, which is a using different temperature ranges of hot water varying from 77-100°C, the lower range being for green and white teas, the middle for oolongs, and the high range for black and herbal teas. The resulting steeped tea liquid was then set in a room temperature environment until cooled. A sample probe was used to collect the liquid sample and the sample introduced into the TD heater sample inlet of the TD-APCI ionization source, which only consumed a few seconds of time. Once the sample was introduced, the mass spectra was displayed in real-time.

Results

Based on the presumptive results, of the eighteen types of tea analyzed, eight were classified as acceptable to drink. Classification was based on peaks >2,500 intensity count. The m/z value of peaks with >2,500 intensity was compared to a list of over 100 pesticides and other compounds commonly found in teas. If the m/z value correlated to that of a pesticide, the result was considered presumptive positive for the pesticide. All three organic teas analyzed were classified as being acceptable to drink. Two teas were classified being of questionable risk, as there were presumptive positive peaks at m/z values that correlated with pesticides, however the peaks were not significantly greater than the 2,500-intensity count threshold. Eight out of the eighteen teas analyzed were classified as not acceptable to drink as they had multiple large peaks associated with pesticides found on tea.

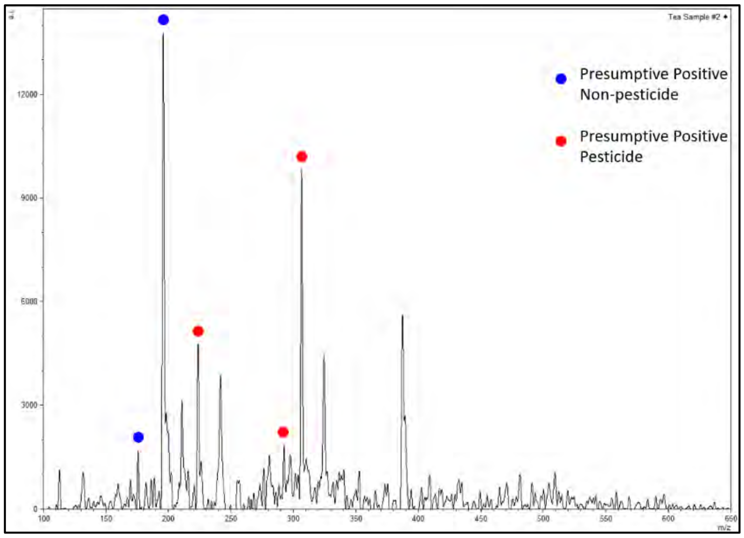

Figure 3: Spectrum of Tea Sample #1

Two examples of the spectra from the tea analysis are shown in Figures 3 and 5. The spectra show teas with presumptive positive results for pesticides as well as other compounds commonly found in teas. The labeled peaks on the spectra indicate the m/z value of the peak that had >2,500 intensity had a corresponding m/z value on the list used to determine the presumptive presence of a given pesticide or compound. The presumptive positive results are shown in the table below the spectra. The unlabeled peaks >2,500 intensity count did not have a correlating compound from the comparative list.

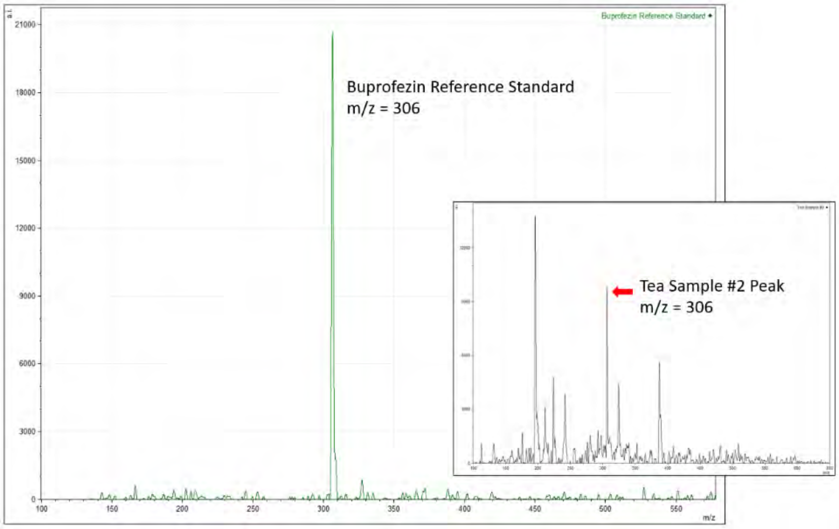

Figure 4: Spectrum of Buprofezin reference standard and Tea Sample #1

Four of the eight teas that were classified as not acceptable to drink had presumptive positive results for the insecticide, Buprofezin, which was the most prevalent among the teas analyzed. The insecticide has low toxicity to humans, however has large environmental impacts and is toxic to animals and insects not targeted by the usage. An analytical standard of Buprofezin was purchased from Sigma-Aldrich and the measurement performed using Portability with TD-APCI, the same instrumentation as the tea samples, shown in Figure 4.

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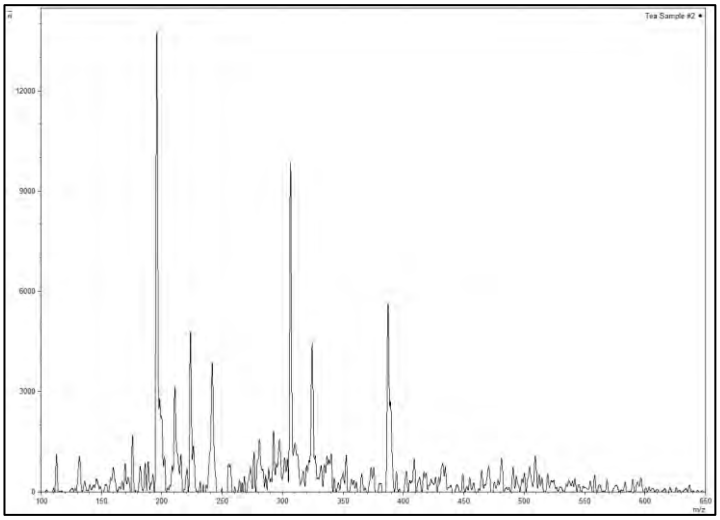

Figure 5: Spectrum viewer (Tea Sample #2)

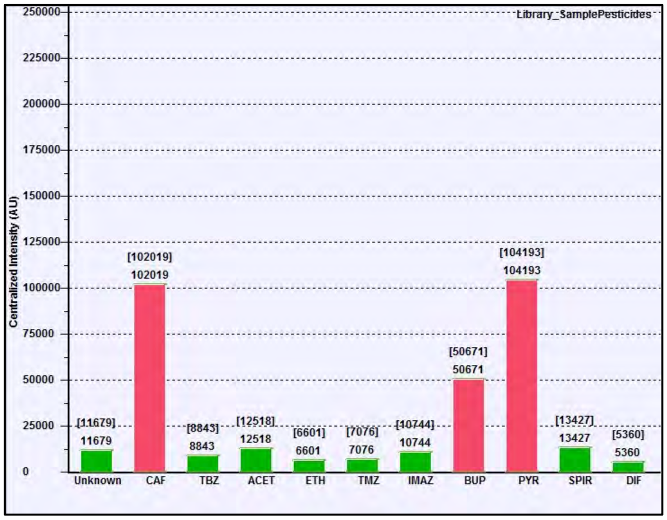

Figure 6: Survey viewer shows identification of analytes in library

Conclusion

The results of the analysis of tea for pesticides showed BaySpec's portable mass spectrometers to be a quick and effective way for obtaining presumptive positive results. Additionally, in keeping with their all-in-one usability, both Portability and Continuity are capable confirming the results utilizing tandem MS (MS/MS) capability. Using the MS/MS capability does not add any additional steps or time to the sampling process, sample introduction, or in obtaining real-time results.

Portability and Continuity are built for rugged reliability and to be accessible to anyone, anywhere. In addition to being able to view both raw and centralized spectrum in real-time, both instruments have an additional real-time viewer called the Survey Viewer. Figure 6 shows the Survey Viewer option that is used in conjunction with a user-defined library. The viewer shows a bar plot, where each bar represents a library entry, or a compound of interest. Once the defined conditions have been met for a given compound, the bar for a library entry will turn from green to red, indicating the compound has been positively identified. Other additional alerts are also available to signal compound identification in real-time. Libraries can be added or modified easily and using a replay feature, a given measurement can be replayed and used in conjunction with different libraries thus not limiting the user by a single library per measurement. The Survey Viewer, along with many other features, broadens the scope of accessibility to mass spectrometry analysis allowing for the interpretation of the real-time results in real-time without having to have previous experience or background in science or instrumentation.

About BaySpec

BaySpec, Inc., founded in 2000 with 100% manufacturing in the USA (San Jose, California), designs, manufactures, and markets advanced spectral instruments, including portable mass spectrometers. BaySpec's compact mass spectrometers provide real-time results with high sensitivity, MS/MS capability, and the flexibility to perform in-situ chemical analysis anytime and anywhere.

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