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Monitoring and Optimizing Beer Flavour and Quality Using Raman Spectroscopy

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There is a particular interest to improve the characterization of the bitterness of beer which is derived primarily from the addition of the annual flowers (cones) of the perennial climbing vine Humulus lupulus, better known as common hops. The hops cones contain important acids called humulones. During the brewing process, the humulones are thermally isomerized into isohumulones which are highly bitter and contribute to the beer's flavour profile. Despite significant contributions to beer flavour and quality, the degree of humulone isomerization is typically not monitored in microbreweries, due in part to the lack of easy-to-use, cost-effective and on-site testing methods. Raman spectroscopy is being explored to 1) measure humulones in hops plants and processed hops pellets and 2) measure isohumulones and the resulting sensory bitterness in beer. Raman spectroscopy probes molecular vibrations and, as such, is an attractive analytical tool for the identification and quantification of specific molecules of interest in plants/food. A portable, hand-held Raman spectroscopy system (NanoRam, B&W Tek) with excitation at 785 nm is being tested. Preliminary data demonstrates the capability to measure humulones in the glands on the underside of hops leaves (Chinook variety) and in hops pellets with varying humulone concentrations. Raman spectra of wort samples, provided by a local microbrewery, exhibit a strong fluorescence background. However, by adding methanol to the wort, at increasing concentrations, Raman peaks associated with methanol's C-O and O-H bonds shift to lower wavenumbers, indicating a change in the vibrational/rotational frequency modes of these bonds. It may therefore be possible to use these types of peak shifts to monitor the hops thermalization processes. The overall goal of this research is to develop a field-ready, cost-effective Raman spectroscopy technique for monitoring and optimizing beer flavour and quality.

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