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Unravelling the nature of stable isotope signals in bulk honey samples to establish a UK ‘honeyscape’

Ayla Paul (1), Stuart Black (2), and Steven Brookes (3)

(1) University of Reading, School of Archaeology, Geography and Environmental Sciences, Reading, United Kingdom (a.paul@pgr.reading.ac.uk), (2) University of Reading, School of Archaeology, Geography and Environmental Sciences, Reading, United Kingdom (s.black@reading.ac.uk), (3) Iso-Analytical Limited, The Quantum, Phase 3, Marshfield Bank, Crewe, Cheshire, CW2 8UY, United Kingdom (steve@iso-analytical.com)

The provenance and the traceability of foodstuffs and wildlife has gained increased interest, especially after food scares such as the horse meat scandal in beef products (O’Mahony, 2013). Recent studies (Opatić et al., 2017 and Zhou, et al., 2018), have shown the potential of stable isotope analysis as analytical methods for detecting geographic origins of foodstuffs and wildlife, but further research is needed on the mechanisms of isotopic signals in food and the environment in order to understand the mechanisms that control these.

This study investigated honey to examine localised environmental signals in honey using stable isotope analyses, to investigate the nature of the variation at various scales as a function of geographical areas. As honey bees forage nectar from localised areas around the hive to produce honey, honey should record the localised isotopic signals. Comparison of these signals to isotopic composition of precipitation (e.g. West et al., 2006) should therefore, produce predictable distributions which has been undertaken in US (Chesson et al., 2011) but not systematically throughout Europe.

The overall aim of this study was to identify the extent to which it is possible to detect localised isotopic signals in honey, and the potential for up-scaling these results as well as the potential of using the isotopic signatures to detect honey adulteration.

We analysed 134 different honey samples, of which 100 samples originated from the UK, 20 from within the EU and a further 14 samples from outside the EU. These samples were all grouped into local (county level), regional (Nomenclature of Territorial Units for Statistics) and country level groupings to analyse their distribution and relationship to their isotopic signals. We believe this is the first time a combined isotope approach has been used on UK honey samples to detect their geographic origin. Bulk honey samples sources from local producers and store-bought samples were analysed for the isotopic rations of hydrogen (δ2H), oxygen (δ18O), carbon ([U+F064]13C) and sulphur ([U+F064]34S). The δ2H and δ18O data were compared to predicted isotopic values of precipitation using the Online Isotopes Precipitation Calculator (IOPC) (Bowen, 2018) for each hive location. The relationship between bulk honey δ2H and δ18O versus predicted precipitation δ2H and δ18O was significant for all samples (p-value <0.005), as well as for just the UK samples (p-value <0.005). These data show that UK honey samples follow predictable relationships for δ2H and δ18O which can be used to detect food fraud and investigate environmental signals.