Laboratory Investigations

The series of laboratory-based investigations entitled “Laboratory investigation of . .” have been compiled by myself and colleagues at the University of Plymouth during recent years. At the outset, they were not designed or written with wider dissemination particularly in mind, but our experiences tell us that they work well with students and therefore may be of interest to other chemistry teaching staff.

There is not a single format to the different activities and this is reflected, in part, by the various file presentation styles. In some cases (*Aspirin, Chewing Gum, Fatty Acid Supplements*), there are individual files for Student Sheets, Tutor Sheets (generally annotated versions of the Student sheets), Risk Assessments, Technical Notes, Report Templates (suggested) and Pre/Post-Laboratory Exercises. For others (e.g. *Contaminated Water*), the files are more integrated, while in two cases (*Parabens, Vitamin C*), there are options to run the analytical measurements using different techniques/instrumentation (e.g. GC, HPLC, Titration).

What is probably missing from the attached worksheets is a detailed rationale for why we created the activities in the first place, an account of how they have evolved over time, or a detailed ‘pedagogic assessment’ describing the specific learning outcomes that we want(ed) students to achieve from the various laboratory experiences. It would be challenging to attempt to correct this here, and any mapping exercise would undoubtedly do a disservice to the authors responsible for the final documents. However, for illustration purposes, it may be helpful to provide some background for selected examples.

Investigation of Aspirin

The primary aim of this study is to provide students with the opportunity to investigate the chemical composition of commercially available Aspirin tablets. This is achieved over a series (4 maximum) of laboratory sessions and is suitable for early-stage undergraduate chemists. Students plan for, and carry out, a ‘simple’ and more advanced method of extraction, and determine the composition of the extracts by titration. Pre- and post-laboratory exercises encourage students to contribute to the experimental design, and they reflect on outcomes as they progress. By using commercially available tablets, it is straightforward to introduce additional lines of enquiry into the investigation, including comparisons between experimental data and packaging (QA), relationship between content and cost, etc. An evaluation of alternative extraction methods is central to the investigation.

Investigation of flavourings in chewing gum

This investigation is more in-depth than the Aspirin project, although we have used it successfully with Year 10 school children through to final year undergraduate chemists. After a brief introduction to 'chemical flavourings', where students discuss their knowledge of common fragrances/flavourings, a problem is presented, which takes the form of some correspondence sent by a local manufacturer of chewing gum who have been receiving complaints about one of their products. The students consider various potential solutions to the problem and set about an experimental procedure that should address these alternatives. Over a series of sessions, students carry out extractions from chewing gum samples (adulterated beforehand), perform purifications, and analyse their purified extracts using GC or GC-MS. Samples of typical flavourings are also provided. The analysis reveals that the most probable explanations to the problem (incorrect flavourings and/or quantities used) are not supported by the experimental data. Instead, the most likely explanation is contamination of the authentic mint flavouring (R-carvone) with its enantiomer which has a different smell/taste (S-carvone). An additional experiment involving polarimetry can be introduced if desired.

Overall, the investigation integrates elements of introductory laboratory techniques (e.g. extractions, small-scale purifications) with structural organic chemistry (e.g. stereochemistry) and instrumental analysis. If the latter involves mass spectrometric detection (for 'real' or as supplied spectra), basic MS methods can be introduced to evidence theory. All selected flavourings are volatile, separate well by GC and have characteristic mass spectra. Students contribute to experimental design throughout, but also work to agreed procedures. They also reflect on progress as the investigation progresses by completion of pre-and post-laboratory exercises.

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