

Identification and quantification of preservative chemicals (parabens) in common household products

Tutor Notes

Overall aims

The primary aim of this study is to provide students with the opportunity to investigate the chemical composition of some household materials including foodstuffs and personal care products. The chosen analytes, parabens (para-hydroxybenzoates), have effective preservative (bactericidal and fungicidal) properties, yet there is some concern about their safety which has resulted in the so-called 'Paraben Controversy'. The EU has strict guidelines for the use of parabens and so an additional 'hook' to the study involves ascertaining whether materials conform to these regulations.

Briefly, the students are involved in designing an experimental procedure to extract paraben(s) from various household products, perform the agreed protocol to identify and quantify individual parabens in extracts and, finally, evaluate the outcomes with respect to product packaging and EU legislation. There is also the opportunity to evaluate the different analytical procedures, if desired.

The experimental work was originally designed with second year (or mid-stage) undergraduate chemistry students in mind, although it can be adapted quite easily for use with more/less experienced students, including those conducting a final year research project. As written, the resource assumes a basic knowledge of the structures and properties of organic chemicals, together with the principles and applications of chromatographic methods. Some basic data manipulation is also required. The investigation is normally carried out over 3 laboratory sessions, but this can be modified quite easily depending on the group size and which analytical technique (GC or HPLC) is used.

Learning opportunities

This investigation provides laboratory experience in carrying out extractions and performing quantitative analytical measurements using either gas chromatography (GC) or liquid chromatography (LC) methods. Emphasis is placed on obtaining extracts that are suitable for analysis by GC or LC methods, so partial purifications (following extractions) and the use of a suitable internal standard are essential. Since there is an applied context to the study, students need to read some relevant literature on parabens and access some EU regulation documentation during the course of the investigation.

The extractions work well with a range of household materials, but shampoos, toothpaste and moisturising creams work particularly well and have the added attraction that students may potentially work with their own products. Further, some products are sold 'paraben-free' so this claim can also be tested.

Timeline

Session 1 (1-2 hours depending on whether the post- and pre-lab exercises are carried out in the session. *Note: this session does not need a laboratory*)

In the first session, students are given some basic background information on parabens, the main elements to the 'Paraben Controversy' and an extract from an EU Council Directive (this will need to be accessed (on-line) by the students to obtain key concentration data).

By completing a post-laboratory exercise (within the session) and a pre-laboratory exercise before Session 2, students will create a 'timeline' plan for recording information and gather further information regarding the structures of specific parabens to be studied, along with quantitative information from the EU Council Directive.

Session 2 (2-3 hours)

Following a brief discussion of findings from the pre-laboratory exercise, students are given the task of creating an experimental protocol for extracting and analysing parabens in household products. Specifically, students are given (Doc A) a general list of objectives and constraints to work within (e.g. the procedure must be achievable within a specified timeframe), a list of available chemicals and laboratory equipment, and a generalised scheme that has some practical issues that students will need to think about in detail (e.g. use of an internal standard and the potential need to purify extracts prior to analysis). Having completed this, the students are given a more detailed experimental protocol (Doc B) to follow or adapt, as required. The remainder of the session is dedicated to carrying out the extractions and purifications. If the cohort is relatively inexperienced or, if time is an issue, some of the standard solutions could be prepared beforehand; however, the objectives are best met if the students do all of the laboratory work.

Analysis of extracts (Session 2 or 3)

The timeframes associated with the chromatographic analysis depends largely on the method of choice (LC or GC). For LC, it may be possible to carry out the analyses during the same session as the extraction and purification steps; in contrast, the use of GC will likely require an additional session. The analysis of the data from each analytical method is outlined in the post- and pre-laboratory worksheets for each method.

Documents available (Note: these are available as 'GC' or 'HPLC' versions)

1. Laboratory instruction sheets for students and tutors. The tutor versions are annotated versions of the student sheets with additional comments and suggestions.
2. Risk Assessments (COSHH) for laboratory session
3. A suggested template for the report to be completed at the end of the investigation.
4. Pre- and post-lab exercises (these are contained within the instruction sheets).
5. Technical notes (lists of chemicals and laboratory equipment).
6. Background literature relating to parabens (will need updating over time)

Assessment

A report template document is provided that integrates the various aims of the investigation. This can be easily modified according to the tutor's individual aims. It is also recommended that students keep an on-going account of their note-taking and experimental work which should demonstrate progression throughout the study (a flow diagram might be suitable for this).