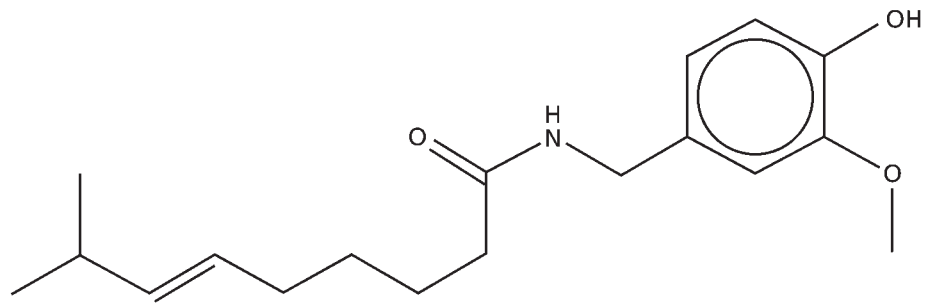


## *How hot are chilli peppers?*

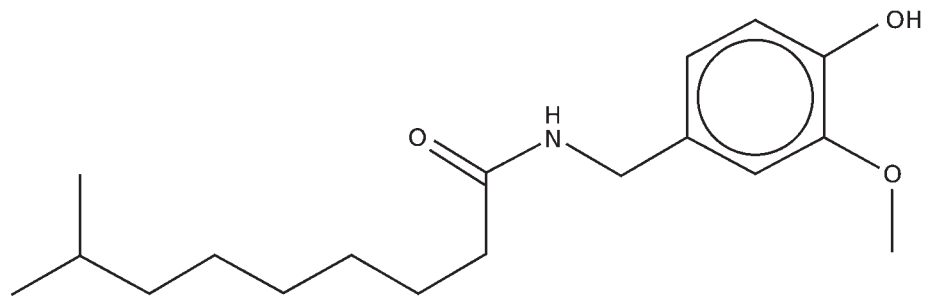


*Chilli peppers*

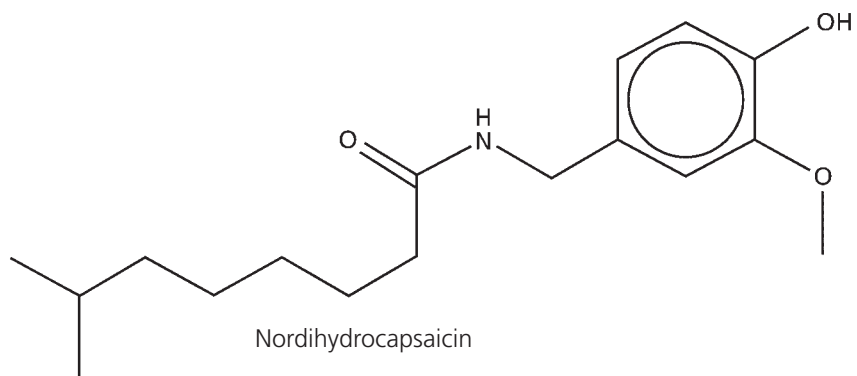
Chilli (often spelled 'chile') peppers are used to spice up many food recipes, including curries and various types of Mexican food. If you have ever tasted one, you will know that these peppers cause a hot, burning sensation in the mouth which is not removed even by drinking lots of water. Chemists have identified a group of compounds that cause this sensation – they are called capsaicinoids. The structural formulae of some of them are given overleaf.



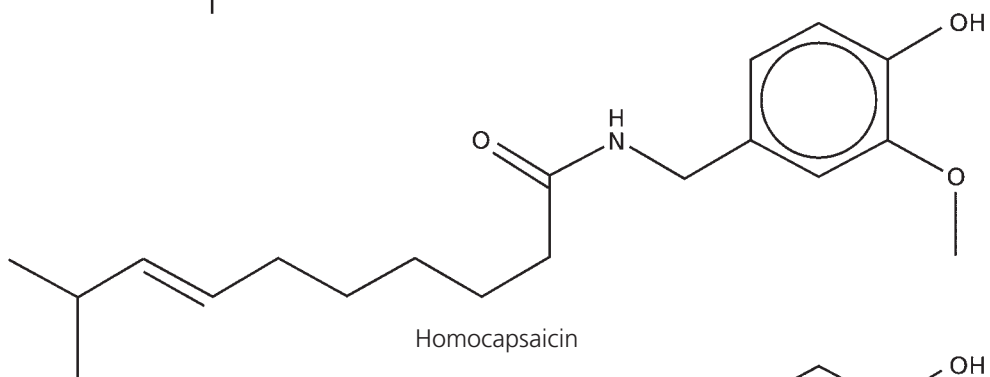
Capsaicin



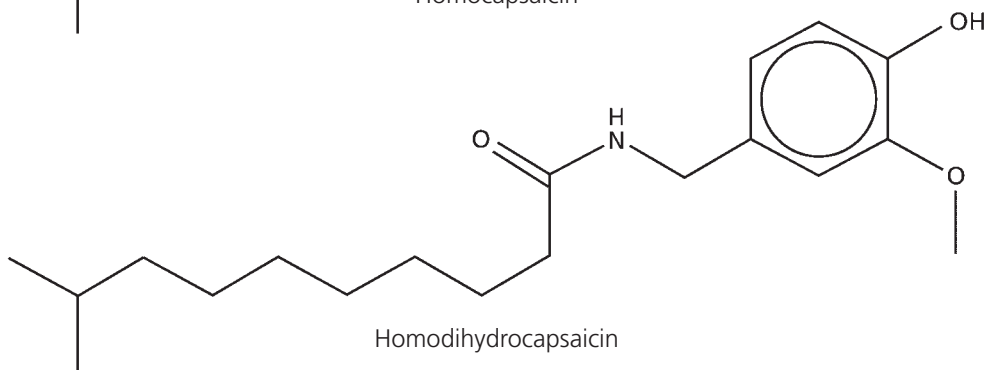
Dihydrocapsaicin



Nordihydrocapsaicin



Homocapsaicin



Homodihydrocapsaicin

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Food scientists have developed two methods of measuring how hot chilli peppers are. One is called the Scoville test and involves human tasters, the other uses a technique called High Performance Liquid Chromatography (HPLC) to measure the amount of capsaicinoids in different chillis.

### The Scoville test

In this test (which is named after its inventor), the chilli is ground up with a solution of sugar in water and a sample of the resulting liquid tasted. It will inevitably produce a burning sensation. The solution is then gradually diluted with water until the taster can no longer notice a burning sensation. The more dilute the solution when this occurs, the hotter the original chilli. The amount of dilution measures the heat of the chilli in Scoville units. Different types of chilli vary widely in their heat – sweet peppers are around 1000 units while Habanero peppers are about 100 000 and pure capsaicin is 350 000.

### HPLC

This technique is essentially about separating mixtures. It works on the same principle as paper chromatography in that it involves a solvent moving through a solid and carrying with it the components of a mixture, which travel at different rates. In HPLC, the solid phase is a powder enclosed in a metal tube called a column and the solvent is forced through the column by a high pressure pump, so HPLC is sometimes said to refer to High *Pressure* Liquid Chromatography. A sample of the mixture to be separated is injected into the solvent just before it enters the column, see Figure 1.

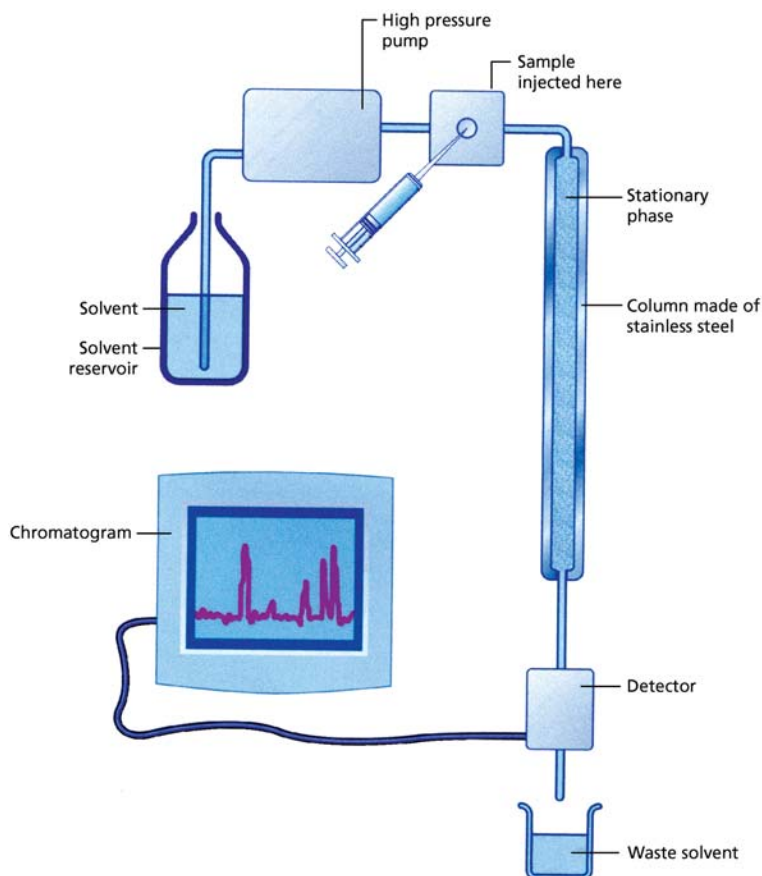


Figure 1 HPLC apparatus

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The better a component forms intermolecular bonds with the liquid, the faster it moves through the column and the sooner it emerges from the other end. The time a component spends on the column is called the **retention time**. A particular substance will always have the same retention time provided that the solid phase and the solvent are kept the same so the retention time can be used to identify components of a mixture. (It is possible that two unrelated substances may have the same retention time so we need to have some idea of the likely components of the mixture to use the retention time to identify them.) A detector times when the different components emerge from the column and measures how much there is of each. A computer is then used to plot a graph (called a chromatogram) like the ones shown in question 4. The height of each peak (strictly the area below it) represents the amount of that component present in the mixture while the position on the horizontal axis shows the retention time, which can be used to identify the substance causing the peak.

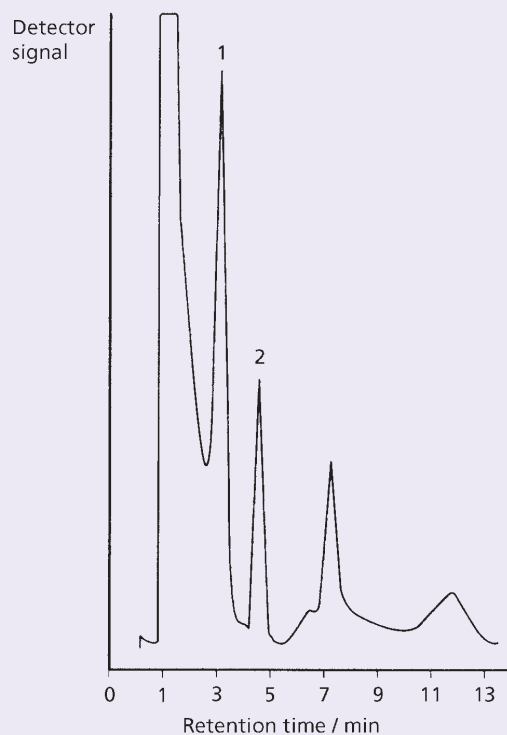
When using HPLC to measure the hotness of a chilli, the analyst uses the chromatogram to measure the amounts of different capsaicinoids present. The greater the amount of these, the hotter the chilli. She or he must also allow for the different hotnesses of the different capsaicinoid compounds – homocapsaicin is only about half as hot as capsaicin, for example. The method must be calibrated by a human taster to convert the measured amounts of capsaicinoid compounds into Scoville units as no machine can actually measure the sensation of taste.

To carry out the test, a chilli is dried, weighed, ground and a solvent is added in which the capsaicinoid compounds will dissolve. A known volume of this solution is injected onto the HPLC column.

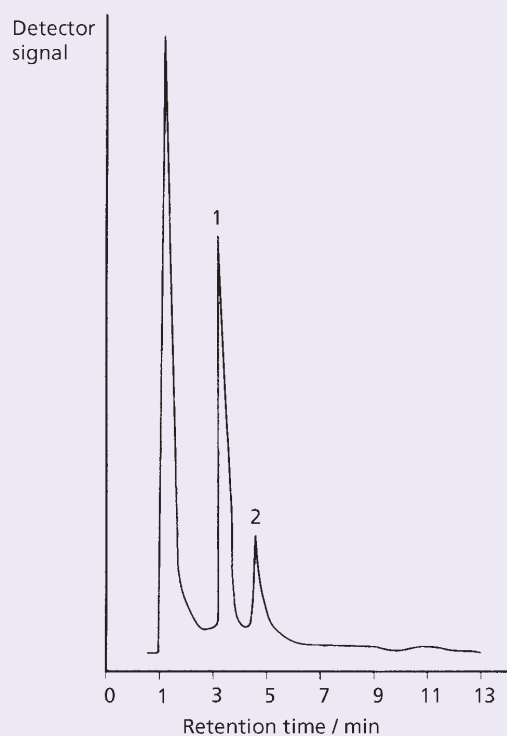
### Questions

1. Look at the structures of the capsaicinoids and suggest why the burning sensation of chillies in the mouth is not greatly affected by drinking water. Suggest a drink that might be more effective at reducing the sensation.
2. What factors (other than those mentioned above) must be kept constant if the HPLC procedure is to be a fair test?
3. Which procedure, the Scoville test or the HPLC test, is likely to give the most reliable results? Explain your choice.

4. Chromatograms (a) and (b) below are obtained from different types of chilli – Patna oleoresin and Tezpur oleoresin respectively – and show the amounts of capsaicin (peak 1) and dihydrocapsaicin (peak 2) in each. Which would you expect to be hotter and why? Assume the units of the vertical axis are the same in each case.

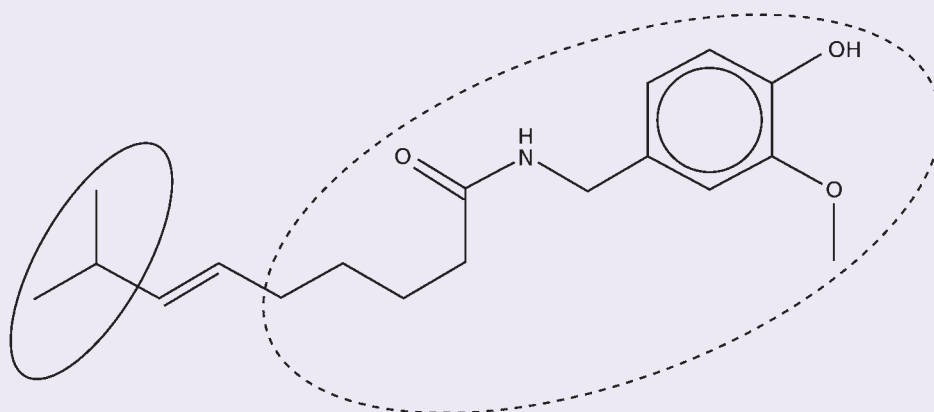


Chromatogram a

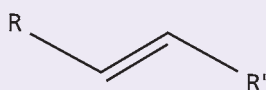


Chromatogram b

5. Look at the structural formulae of the capsaicinoid compounds above.
- What is the difference between capsaicin and dihydrocapsaicin?
  - Name all five functional groups in capsaicin.
  - What type of isomerism will be shown by capsaicin and homocapsaicin, but not by the other three compounds? Explain how this type of isomerism arises.
  - Suggest a reagent that will convert capsaicin into dihydrocapsaicin.
6. You will probably have separated the dyes in ink by paper chromatography. What are the solid phase and the solvent in this method?
7. Suggest why it is useful to know how hot different types of chilli are.
8. Look at the formula for capsaicin below



It can be written more simply as



where R represents the group of atoms in the solid oval and R' represents the group of atoms in the dotted oval. Draw the formulae of dihydrocapsaicin, nordihydrocapsaicin, homocapsaicin and homodihydrocapsaicin in the same way (using R and R' to represent the groups as above). Use these representations to help you to describe the differences between the molecules.