Optical Isomers in Healthcare

AIM

To build your own polarimeter and see how chiral compounds interact with light, and which chiral receptors in your nose

YOU WILL NEED

- glucose syrup
- spearmint essential oil or R-(−)-carvone
- caraway essential oil or S-(+)-carvone
- 3 glass vials, 6-7 cm in height (plastic vials cannot be used, as plastic tends to polarise the light. The diameter of the vials is not important, but those used in in the images on the site were 2 cm in diameter)
- a clamp
- a small beaker
- a clamp
- a sheet of paper
- 2 linearly polarised filters

PROCEDURE

Place the beaker face down in the centre of the sheet of paper, and draw a circle around it. Make sure the “lip” of the beaker is facing towards you, and treat this as the origin of the circle. Then draw a cross intersecting the circle.

Place one of the polarised filters on top of the beaker. When you later rotate the beaker (in order to rotate the filter sat on top of it, as in the video above), rotate it within the circle, using the lip of the beaker as a marker for the rotation.

Use a clamp and retort stand to suspend the second filter above the first one, at a sufficient distance so that one of the glass vials can be stood on top of the first filter. Make sure the filters are lined up, so that you can look at the bottom one through the top one.

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Once the setup is completed, try rotating the beaker and bottom filter, whilst looking down through the top filter. Depending upon the rotation, you should observe that the filters appear dark and block the cross, or light and allow the cross to be visible. Align the two filters so that they are as dark as they can be, and mark where the lip of the beaker is, on the circle, labelled ‘0’.

Fill one of the vials with glucose syrup, and place this open on top of the bottom filter. Glucose syrup is a good starting solution to use as it very strongly rotates the plane of polarisation. Glucose is a chiral molecule and the most common enantiomer that occurs in nature (and what you will buy in shops) rotates the plane strongly in the clockwise direction. Rotate the beaker as before, and see what happens as you rotate the beaker. Can you see the cross through the solution when it appears dark in the absence of the solution? Why can you see the cross through the solution, but not (or barely) through the filter?

Repeat this with the R-(−)-carvone and the S-(+)-carvone. These solutions will not rotate the polarisation plane as much as the glucose syrup, but you will be able to see that they rotate the plane in different directions. Rotate each so that the solution looks as dark as possible (obscuring the cross as much as possible), and then mark where the lip of the beaker is.

QUESTIONS

1. When you place the R-(−)-carvone in the vial, does it rotate the plane of the light's polarisation?

2. When you place the S-(+)-carvone in the vial, does it rotate the plane of the light's polarisation?

3. Do the two isomers behave differently to one another? If so, how?

4. Do the two isomers of carvone smell different to one another? Describe their smells. What does this tell us about the receptors that detect them in the nose?

5. Many chemical reactions can lead to the production of a racemic mixture of isomers. If a drug is made as a racemic mixture, do you think that it is important to separate the two isomers? If so, why?