Faculty of Natural and Mathematical Sciences
Department of Chemistry
Open Access Labs – Separation Science: TLC Analysis of Food Dyes

Worksheet

Use your schoolbook to answer the following questions related to the experiment.

1. Setting up your TLC – practical considerations:
   a) Why is it not a good idea to use a pen (as opposed to a pencil) to draw on the sheet?
   b) Why do we not want the sheet to touch the sides of the jar or cup?
   c) Why should the mobile phase not travel beyond the solvent front?
   d) If the mobile phase did travel beyond the solvent front, what adjustments would we need to make to be able to correctly calculate the R_f values?
2. Experiment 5a
   a) Take a photo of your best TLC and paste it below.
   b) What is the R_f of the red spot?
   c) What is the R_f of the pink spot?
3. Experiment 5b
   a) Take a photo of your best TLC and paste it below.
   b) What is the R_f of the blue spot in the red dye?
   c) What is the R_f of the blue spot in the blue dye?
   d) Is the blue component of the red dye the same chemical as in the commercial blue dye?
4. Experiment 5c
   a) Take a photo of your TLC and paste it below. Which shot glass (1 or 2) contains the mixture of blue and yellow dyes?
   b) Is the commercial green dye a mixture of blue and yellow dyes or an authentic single-component green dye?
   c) If the commercial green dye is a mixture, is either the blue or the yellow component the same as the one present in the commercial blue and yellow dyes?
   d) Why is the R_f value of the blue spot different for pure blue dye as compared to a mixture of blue and yellow dyes?

5. Experiment 5d

a) Take a photo of your best TLC and paste it below.

b) What are the R_f values of the red, pink and beetroot spot?

c) Is beetroot part of the red or pink commercial dye? Refer to the TLC and R_f values in your answer.

6. Experiment 5e

a) Assign the commercial dye colours to their natural sources in the table below.

Natural source	**Commercial dye colour**
Turmeric (curcumin)	
Beetroot	
Paprika extract	
Blue spirulina	
Green spirulina	
Anthocyanin pigments	

b) What colour is the commercial dye containing vegetable carbon extracts?

Optional advanced experiments

7. Experiment 6a

a) Why is the insolubility of curcumin in water an important factor to consider when trying to make it travel up the TLC sheet?

b) Can you think of 2 examples of solvents (other than vegetable oil) that curcumin would be soluble in?

c) Rubbing alcohol is typically sold as a 70% solution of isopropanol in water. How would you prepare 50 mL of a 1:1 isopropanol:water solution?

d) How could we change the mobile phase from a 1:1 isopropanol:water to make curcumin travel higher up the TLC sheet?

e) Why does the orange curcumin spot move different amounts in the turmeric sample dissolved in vegetable oil compared with the commercial yellow food dye?

8. Experiment 6b

a) What is the colour of anthocyanins in acidic and mildly basic pH?

b) What gas was responsible for the effervescence when we added sodium bicarbonate to the red dye containing citric acid? Express this process using a balanced chemical equation. What class of reactions does it belong to?

c) Can you think of any naturally occurring and/or chemically synthesised indicators?

9. Experiment 6c

a) Draw a TLC plate that would correspond to a reaction being 50% complete.

b) What are the risks if we do not have the product of a reaction available as a reference (i.e. we are only able to spot the starting material (SM) and reaction mixture (RXN))?

Bonus material

10. Experiment 7a

a) Calculate the ratio of components in each of the four solutions.

b) Give at least one example of an instrument or a spectroscopic technique that would be able to quantify components in a given mixture.

c) How can you distinguish solutions of red and blue dyes (“1”, “2” and “3”) in this experiment using UV-vis spectroscopy?

d) Use the UV spectra in the protocol (see Page 14, Figure 21) to extract an approximate λ_{max} value and the absorbance at this wavelength for each of the three dyes.

	Red dye	Yellow dye	Blue dye
λ_{max}			
A			

e) Given that the pathlength of the cell is 1 cm, calculate the concentration of each of the three solutions above (red, yellow and blue dye) knowing that the molar extinction coefficients at λ_{max} are 1.54×10^6 $M^{-1}cm^{-1}$ for phycocyanin, 26 900 $M^{-1}cm^{-1}$ for anthocyanin and 55 000 $M^{-1}cm^{-1}$ for curcumin, respectively.

f) How could you use UV-vis spectroscopy to determine which colours are present in the M&M? Would you also be able to calculate the percentages (concentrations) of each dye that make up the brown colour?

g) Knowing that the brown M&M candy consists of red, blue and yellow dyes, sketch and label its UV-vis spectrum in aqueous solution between 350–750 nm. You may assume that the ratio of concentrations is 4:1:0.05 (red:yellow:blue), the molar extinction coefficients at λ_{max} are the same as in question 10e, and the absorbance of the red dye is 3.20.

11. Experiment 7b

a) What are the main parallels between TLC and column chromatography?

b) Describe in detail how you would separate the components of a commercial red dye by column chromatography at home.