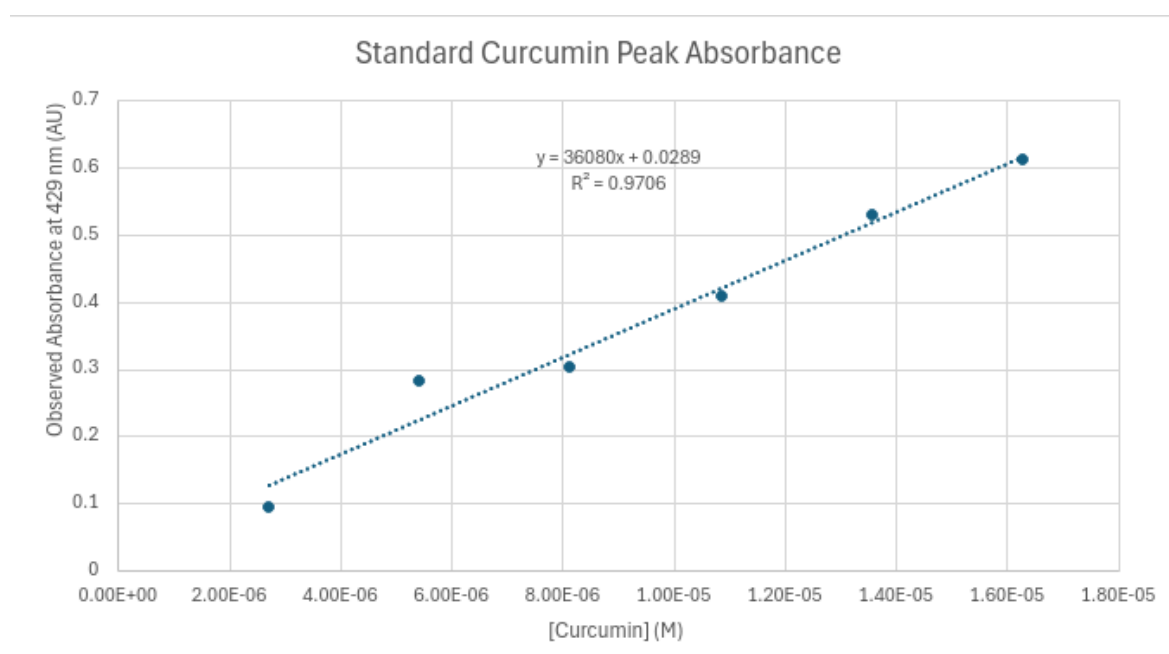# Lab 3: UV-vis Spectrophotometric Analysis of Commercial Curcumin

Questions

1.

Volume (mL)	Concentration (M)	Absorbance at 429nm (AU)
0.1	2.71×10^{-6}	0.094
0.2	5.43×10^{-6}	0.283
0.3	8.14×10^{-6}	0.304
0.4	1.09×10^{-5}	0.409
0.5	1.36×10^{-5}	0.529
0.6	1.63×10^{-5}	0.611

Example calculation: $\frac{0.1 \text{ mL stock solution}}{10 \text{ mL solution}} \times \frac{10.0 \text{ mg curcumin}}{100 \text{ mL stock solution}} \times \frac{1000 \text{ mL}}{1L} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol curcumin}}{368.38 \text{ g}} \times \frac{1 \text{ M}}{1 \text{ mol/L}} = 2.71 \times 10^{-6} M$

Standard Curcumin Peak Absorbance

$y = 36080x + 0.0289$
$R^2 = 0.9706$

2. The slope of the linear regression is 3.61×10^4 M^{-1}. Since we had a 1.0 cm cuvette, applying Beer's Law yields a molar absorptivity constant at $\lambda_{\max} = 429$ nm of 3.61×10^4 M^{-1} cm^{-1}.
3. The correlation coefficient of the data, r, is 0.9852. This is strong evidence of correlation.
4. The y-intercept is 0.0289. This is nonzero despite Beer's Law, and can be used as an estimate of the noise of the calibration curve owing from indeterminate error.
5. The residuals plot shows no apparent pattern, supporting the conclusion that there is a linear trend with the data.
6. Using the y-intercept (0.0289) as an approximation for the standard deviation of the slope, the 95% confidence interval for the slope can be found as the range of values within two standard deviations of the slope, which due to the very low standard deviation, is just $[3.61 \times 10^4$ M^{-1} cm$^{-1}, 3.61 \times 10^4$ M^{-1} cm$^{-1}]$. The true value of 55,000 M^{-1} cm^{-1} is not close to this confidence interval, suggesting strong determinate error.
7. The limit of detection is given by $3 \times \frac{\sigma}{m}$, which in this case results in $2.40 \times 10^{-6} M$. The limit of quantitation is given by $10 \times \frac{\sigma}{m}$ and is in this case $8.01 \times 10^{-6} M$. The limit of linearity occurs at a higher concentration than is seen in this lab. The linear range and dynamic range both start at

the limit of quantitation and extend to the limit of linearity. The sensitivity is the slope of the trendline.

8. The absorbance values for the final diluted solution with the commercially available turmeric were 0.094, 0.102, and 0.108 across the three replicates. Using Beer's Law, the determined $\varepsilon_{429\text{ nm}}$ of curcumin, and the average of those absorbance values, the concentration of the final diluted solution with the commercially available turmeric is $\frac{A}{\varepsilon_{429\text{ nm}} \times l} = \frac{0.101}{3.61 \times 10^4\, M^{-1}\text{cm}^{-1} \times 1\text{ cm}} = 2.81 \times 10^{-6}$ M. Undoing the dilution, we get the original concentration at 2.81×10^{-6} M $\times \frac{25\text{ mL}}{0.600\text{ mL}} = 1.17 \times 10^{-4}$ M. Since the sample of the turmeric was initially dissolved in a 25 mL volumetric flask, we can compute the mass of curcumin by $\frac{1.17 \times 10^{-4}\text{ mol}}{1\text{ L}} \times \frac{1\text{ L}}{1000\text{ mL}} \times 25\text{ mL} \times \frac{368.38\text{ g}}{\text{mol}} \times \frac{1000\text{ mg}}{1\text{ g}} = 1.08$ mg. Only 0.0145 g out of the 0.4587 g pill was in the solution. Scaling up to the entire pill, the mass of curcumin in the pill is 1.08 mg $\times \frac{0.4587\text{ g}}{0.0145\text{ g}} = 34.1$ mg.

9. Claims were not made on the bottle about curcumin contents, but rather *curcuminoid* content. Different curcuminoids may have different UV-vis peaks, thus although the value determined for curcumin content is outside the threshold if it were the only curcuminoid present, there is insufficient evidence to conclude the claims are false. Furthermore, the ingredients listed were 450 mg of turmeric and only 50 mg of turmeric extract, which would imply that it was largely the natural concentration. The bottle indicated that each pill was 500 mg and standardized for 95% curcuminoids, which would imply that a mass of 475mg of curcuminoids should be present. If curcumin were the only curcuminoid in the pill, the data suggests that this claim is off by an order of magnitude.

Lab Notebook

Objective: Prepare a calibration curve for curcumin UV-Vis and use it to determine the purity of a commercial sample

Procedure: From a 0.100mg/mL stock solution, prepare 6 10mL standard solutions shown to the right. →

Part A Use 2.0mL of Sodium phosphate as a buffer in each. Use ethanol as solvent.

Part B obtain UV-Vis measurement in a similar fashion from a commercially available sample — compare with Part A to determine purity

10mL standard solutions
Stock solution: 100mg/100mL = 0.100 mg/mL

Volume Stock Soln. (mL)	(calculated) Conc. (mg/mL) = Volume/10mL * 0.100mg/mL	Observed Absorbance (AU) at 429 nm
0.1mL	0.00100	433 0.094
0.2mL	0.00200	0.283
0.3mL	0.00300	0.304
0.4mL	0.00400	0.409
0.5mL	0.00500	0.529
0.6mL	0.00600	433 429m 0.611

0.0131g curcumin
44%

Sundown Natural
Turmeric
500mg, 450mg turmeric
50mg t. extract
(standardized)
for 95%
curcuminous

mass: 0.4587g
Sampled: 0.0145g

UV-Vis Part B
Same λ_{max}
0.9 0.094, 0.162, 0.108