IDENTIFICATION OF THE ARTIFICIAL SYNTHESIS OF AROMATIC AMINO ACID TYROSINE, BASED ON Π Π* ABSORBANCE PEAKS

Jordyn Begay

Navajo Preparatory School, Farmington, NM

Abstract

- The aromatic amino acid Tyrosine was synthesized using three types of clays, water, heat, and a few common compounds. However, initial efforts to identify Tyrosine were stymied by the sole use of the Pearson Correlation Coefficient to statistically compare synthesized compounds with laboratory grade amino acids, without any understanding of the underlying chemistry.
- This synthesis was successfully revisited with the aid of quantitative chemistry, to understand the actual chemical bonding and thus the amino acid synthesized.
- The Beer-Lambert equation, Plank's equation, and two dominant spectroscopic absorbance peaks at λ1 = 287nm and λ2 = 294nm were critical to this study. The dominant spectroscopic peaks represented πèπ* electron transitions, as these peaks were significantly higher than all other absorbance data in the absorbance versus wavelength graph. These two dominant peaks became an UV/Vis "signature" which led to identifying the aromatic amino acid Tyrosine as having been created by all three types of clays.
- The Beer-Lambert equation was applied to show that Moroccan Clay produced a higher concentration of Tyrosine than Talc, and Talc produced a higher concentration than Sepiolite.

RESEARCH QUESTION

Can one or more amino acids be synthesized by exposing clay to common chemicals and heat, and subsequently be identified to a high statistical correlation and confidence?

HYPOTHESIS

If these specific clays are found with the other reactants utilized in the experiment, then spontaneous generation could have occurred and given rise to extraterrestrial biomolecules. Furthermore, a better understanding as to the origin of life can be attained.

VARIABLES

Independent	Dependent	Controlled Variables
Three types of clay used to catalyze synthesis of amino acid(s).	Types of amino acids synthesized. Concentrations of amino acids synthesized.	Heat Duration of time in which heat applied Pressure Chemicals used in the reaction

BACKGROUND RESEARCH

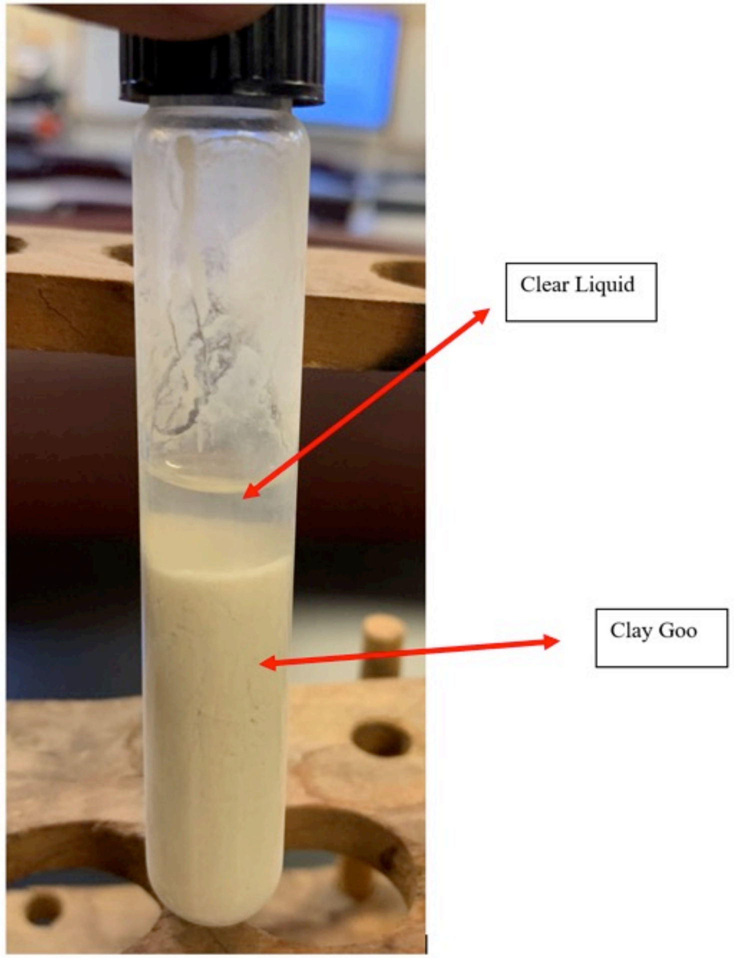
- Life on earth arose from coincidental chemical reactions, in which various organic molecules combined and interacted. There are many theories as to how this happened; one theory that scientists speculate is abiogenesis. This meant that inorganic molecules reacted with other inorganic molecules to create biomolecules. A few years later, this theory was refined and came to be known as Oparin's Hypothesis; where it was suggested that life was created from nonliving matter.
- In the 1800's, many believed that a "vital source" was within all organic molecules. This became known as Vitalism and challenged the Oparin's Hypothesis. Vitalism meant that organic molecules came from an organic source, while other inorganic molecules came from other inorganic sources. But in 1828, Friedrich Wohler, a chemist, in an attempt to create ammonium
- cyanate, synthesized urea. Urea is an organic molecule, and this discovery falsified Vitalism, and reinforced abiogenesis.
- Since this discovery, many organic molecules have been artificially synthesized from non-organic compounds. In 1953, Stanley Miller and Urey, his mentor, created amino acids. These two scientists had created the perfect apparatus simulate the primordial Earth's atmosphere-ocean system. They subjected this environment to electric discharges for a week and produced amino acids. After the publication of results from Miller's experiment, numerous variations of the experiment emerged. For example, using other gas mixtures were performed to explore the possibility of producing organic compounds important for life under a variety of possible primordial Earth conditions.
- Throughout these numerous experiments, most scientists agreed on an idea of a "primordial soup." Inorganic molecules collected in one area, and reactions took place to synthesize biomolecules, which then reacted to form cells. One compound, that has been speculated to catalyze chemical reactions in this soup mixture, is clay.
- Earth, as we presently know it, is the only planet to harbor life. But there has been evidence to suggest that there may have been forms of life in space, due to the presence of biomolecules within meteorites. This would mean that spontaneous generation is continuing to occur throughout the universe.

MATERIALS AND EQUIPMENT

- **MATERIALS AND EQUIPMENT**
- The following are the materials and equipment and experimental procedures used.
- Test Tubes with seal (5)
- Ammonia Water (0.20 Molar)
- Sodium Carbonate (1.0 Molar)
- Sodium Phosphate (0.050 Molar)
- 3
- Hydrogen Peroxide (1.0 molar) Ø Powdered Clay

1. Sepiolite
2. Moroccan
3. Talc

- UNICO Spectrophotometer model S2150UV Ø "Blanked" cuvettes for use in the S2150UV Ø UNICO K3 Analyst Software
- -



Photos taken by researcher

EXPERIMENTAL PROCEDURE

- **Safety Precautions**
- *Before experimentation can be conducted, be sure to follow proper lab safety requirements. Furthermore, for this experiment, hair must be tied back, any loose clothing or jewelry must be removed. Any metal on your person must be removed, and wear latex gloves, and goggles.*
- **Experimental Procedure**
- Gather all required materials and keep organized, making sure to avoid contamination.
- Measure 0.400g of autoclaved clay specimen and place in a 16mL test tube.
- Measure 3mL of Sodium Phosphate and add to 16mL test tube.
- Repeat step 3 with Sodium Carbonate, Hydrogen Peroxide, and Ammonia Water.
- Heat 250mL of water in a 400mL beaker until 100 degrees Celsius with a hot plate.
- Seal test tube with clay specimen and NaPO4, Na2CO3, H2O2, and NH3 + H2O.
- Shake test tube vigorously for 10 seconds. Place test tube in hot water and subject to
- water bath.
- Let mixture stay in bath for 20 minutes.
- After 20 minutes pass, turn off hot plate and let specimen cool for 10 minutes.
- Remove test tube and set-in test-tube rack. Remove seal.
- “Blank” cuvette utilizing S2150UV spectrophotometer and K3 Analyst Software to create
- the signature of an empty cuvette for subtraction from the sample in the cuvette.
- 4
- Take 3mL of clear liquid collected at the top of the test tube, and place in “blanked” cuvette.
- Analyze utilizing S2150UV spectrophotometer and K3 Analyst Software.
- Record absorbance “A” of each specimen against wavelength in nanometers.
- Graph and analyze absorbance data versus wavelength.

DATA, DIAGRAMS, AND OBSERVATIONS

Infrared (longest wavelength: heat)	740 – 1100 nm
Red **Orange** **Yellow** **Green** **Blue** **Violet** (visible to the human eye)	625 – 740 nm 590 – 625 nm 565 – 590 nm 500 – 565 nm 450 – 500 nm 400 – 450 nm
Ultraviolet-A **Ultraviolet-B** **Ultraviolet-C** (shortest wavelength)	315 – 400 nm 280 – 315 nm 190 – 280 nm

Table 2: Unico S2150 Series UV/Vis Spectrophotometer Optical Spectrum Ranges

Clay Used	Sepiolite	Moroccan	Talc
Chemical Formula	$Mg_4H_4O_{15}Si_6$	$NaCa_3Al_2O_{10}Si_4$	$Mg_3Si_4O_{10}(OH)_2$
λ1 (empirical peak)	287 nm	287 nm	287 nm
λ2 (empirical peak)	294 nm	294 nm	294 nm
λ2 – λ1 (empirical)	7 nm	7 nm	7 nm
λ2 – λ1 (Tyrosine)	7 nm	7 nm	7 nm

Table 3: Peak-Peak Wavelength Separation of 7 nm Identifies Aromatic Amino Acid Tyrosine

DATA, DIAGRAMS, AND OBSERVATIONS

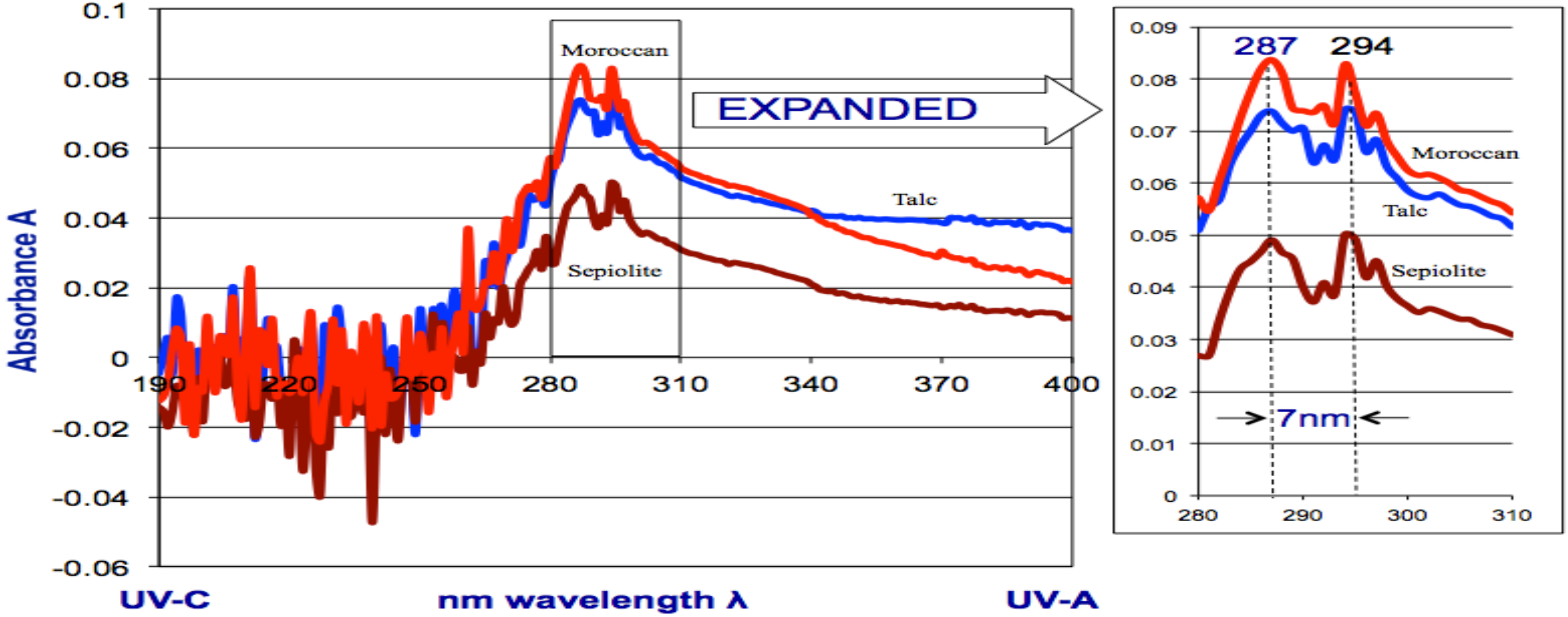


Figure 2. Absorbance "A" versus Wavelength "λ" for Three Clays

DATA, DIAGRAMS, AND OBSERVATIONS

Wavelength	λ1 (empirical) = 287nm	λ2 (empirical) = 294nm
Path Length L (S2150 cuvettes)	10 mm (1 cm)	10 mm (1 cm)
Absorbance A(Talc) Absorbance A(Moroccan)	0.0738 0.0837	0.0741 0.0828
Concentration of Tyrosine Talc versus Moroccan: C(Talc) / C(Moroccan)	0.0738 / 0.0837 = 88.2% (Average	0.0741 / 0.0828 = 89.5% = 88.8%)
Absorbance A(Sepiolite) Absorbance A(Moroccan)	0.0491 0.0837	0.0501 0.0828
Concentration of Tyrosine Sepiolite versus Moroccan: C(Sepiolite) / C(Moroccan)	0.0491 / 0.0837 = 58.7% (Average	0.0501 / 0.0828 = 60.5% = 59.6%)
Absorbance A(Sepiolite) Absorbance A(Talc)	0.0491 0.0738	0.0501 0.0741
Concentration of Tyrosine Sepiolite versus Talc: C(Sepiolite) / C(Talc)	0.0491 / 0.0738 = 66.5% (Average	0.0501 / 0.0741 = 67.6% = 67.0%)

Table 4. Application of Beer-Lambert Law A = εLC

DATA, DIAGRAMS, AND OBSERVATIONS

Wavelength	$\lambda 1$ (empirical) = 287nm	$\lambda 2$ (empirical) = 294nm
E = hc/λ in Joules	6.92E-19 Joules	6.76E-19 Joules
E = hc/λ in electron-volts	4.32 eV	4.22 eV

Table 5. Application of Plank's Law E = hc/λ

Tyrosine Created By	Sepiolite vs Moroccan	Sepiolite vs Talc	Talc vs Moroccan
Pearson Correlation Coefficient "R"	R = 94.2%	R = 95.8%	R = 97.7%
Sample Size N (280-310nm)	31	31	31
Degrees of Freedom (N-2)	29	29	29
T_value for 99.95% confidence and N-2 = 29	3.659	3.659	3.659
T_calculated versus T_value	17.995 > 3.659	15.104 > 3.659	24.613 > 3.659

Table 6. Pearson Correlation Coefficients over 280-310 nm Wavelength

DATA, DIAGRAMS, AND OBSERVATIONS

Tyrosine Created By	Sepiolite	Talc	Moroccan
Sepiolite	100%	95.8%	94.2%
Talc	95.8%	100%	97.7%
Moroccan	94.2%	97.7%	100%

Table 7. Correlation Matrix [R]

- The main diagonal has values of 100%, representing the autocorrelation between each clay with itself, which is essentially the algebraic identity of y=x.
- The off-diagonal elements represent the cross-correlation values in Table 6.
- Note that the correlation matrix is symmetric because the Pearson Correlation Coefficient function is symmetric, meaning that =PEARSON(B3:B33,C3:C33) and =PEARSON(C3:C33,B3:B33) have the same numerical value.

CONCLUSION

- My project showed that I was able to create and identify Tyrosine, an aromatic amino acid, using three different clays. One clay,
- Moroccan, was better at creating Tyrosine than Talc, and much better at creating Tyrosine than Sepiolite.
- I created a correlation matrix [R] between the three clays used to create Tyrosine and obtained pairwise cross-correlations between 94.2% and 97.7%, with a confidence level exceeding 99.95% in all pairwise cross-correlations.
- Thus, my hypothesis of creating at least one amino acid was accepted.

FUTURE DIRECTION

In the future, I would like to try to synthesize simple proteins from the amino acids that I synthesize.
I would also like to try applying heat for longer periods of time, and use other chemicals, to see of other amino acids could be created.

REFERENCES

- [1] “Spectrophotometry,” https://en.wikipedia.org/wiki/Spectrophotometry, January 8, 2021.
- [2] “UNICO Productivity UV-VIS Spectrophotometer,”
- https://www.unicosci.com/productpdf/download/file/id/193/name/Productivity_UV-VIS_Spectrophotometer.pdf/, downloaded January 8, 2021.
- [3] “UV-difference and CD spectroscopy studies on juvenile hormone binding to its carrier protein.” D. Krzyzanowska, M. Lisowski, M. Kochman, Journal of Peptide Research, 1998 Feb; 51(2): 96-102. https://pubmed.ncbi.nlm.nih.gov/9516043/, downloaded January 7, 2021.
- [4] “Tyrosine,” https://en.wikipedia.org/wiki/Tyrosine, downloaded January 7, 2021.
  [5] “Beer-Lambert law,” https://en.wikipedia.org/wiki/Beer–Lambert_law, downloaded January
- 8, 2021.
- [6] “Plank’s Constant,” https://en.wikipedia.org/wiki/Planck_constant, downloaded January 8, 2021.
- [7] “Pearson’s *R*, Chi-Square, *T*-Test, And Anova,” page 123. https://www.sagepub.com/sites/default/files/upm-binaries/33663_Chapter4.pdf, downloaded
- January 9, 2021.
  [8] CRC Standard Mathematical Tables, 20th Edition, CRC Press, 1972, page 588.