Daubert Cromwell Laboratory – Research Internship

Rosa Mahmoud Abdelfattah

Saint Xavier University

Introduction: Daubert Cromwell is a company specializing in the manufacturing of corrosion prevention solutions. The company offers a wide range of packaging solutions designed to protect metal components from the damaging effects of corrosion, using volatile corrosion inhibitors (VCIs). VCIs are chemicals that vaporize and form a protective layer on the surface of the metal, preventing the onset of corrosion.

Gage/ Caliper Machine

TAPPI T411

The caliper machine is used to measure the thickness of the paper. The machine lowers a plate and measures the distance before it's stopped by the paper. The purpose of this test is to show how consistent the material is throughout the sample.

Steps:

- Clean the surface with a napkin and zero the machine
- Make sure the sample being tested has enough room for all the required readings
- For paper, a minimum of 20 readings are required
- Once all the 20 readings are finished, record the average, high, low, and standard deviation

Tear Machine

ASTM D1922 – ASTM D689

The tear machine is used to test the tearing resistance and measures the strength of various materials, including paper, plastic films, textiles, and other flexible materials. It provides valuable information about the material's durability and helps assess its suitability for customer-specific applications.

Steps:

- When testing cross direction, cut it at a length of 2.5" and have machine direction at 3"
- When testing the machine direction, cut it at a length of 2.5" and have a cross direction of 3"
- Place in testing position, create a tear with the blade and shut the clamps
- Manually release the weight and allow it to create a tear in the paper or film
- If the reading is below 20, then add ply and/ or more weight to the machine

Tensile Strength

ASTM D828 – ASTM D882

The tensile machine is used to measure the mechanical properties of paper and film. It's used to test their tensile strength and elongation. This is used to evaluate the performance of the materials under pulling forces.

Steps:

- Cut 10 samples of each material being tested
- Paper needs to be 1" wide and 9" long, and film needs to be 1" wide and 4" long
- Open the tank for the air
- When testing paper, set the clamps at a distance of 180mm
- Depending on the thickness when testing film, set the clamps at 25mm or 50mm
- Select the program that corresponds with what you're testing and run 10 valid tests

DAUBERT CROMWELL

The Leading Name in Corrosion Prevention®

This research is supported by a grant from the National Science Foundation (No. 1832511).

Ensuring the Confidentiality of Messages in Digital Communications

Yasmean Abdullah & Mentor: Dr. Imad Al Saeed

Saint Xavier University

Abstract

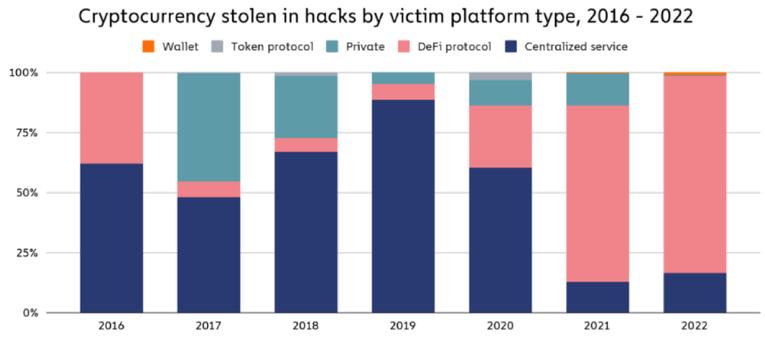
Cryptography is the practice and study of techniques for secure communication and data protection in the presence of adversaries or unauthorized parties. It involves the use of mathematical algorithms and principles to transform plain, readable information (referred to as plaintext) into unintelligible data (referred to as ciphertext) through a process called encryption. The main goal of cryptography is to ensure confidentiality, integrity, authenticity, and non-repudiation of information. The main goal of this research project is to investigate and compare various types of strong and modern algorithms derived from mathematical concepts and a set of rule-based calculations to be used to ensure the confidentiality of messages in digital communications.

Introduction

Cryptocurrency cybercrime can indeed occur due to weak cryptographic encryption algorithms. Cryptocurrencies rely heavily on cryptography to ensure security and privacy for transactions and user data. If weak encryption algorithms are used or if proper cryptographic practices are not followed, it can lead to vulnerabilities that cybercriminals can exploit. Here are a few ways in which weak cryptography can contribute to cryptocurrency-related cybercrime:

1.Private Key Vulnerabilities: Cryptocurrencies use private keys to sign transactions and prove ownership of assets. If weak encryption algorithms are used to generate private keys, attackers might be able to easily guess or brute-force these keys, gaining unauthorized access to users' funds.
2.Encryption of Sensitive Data: Cryptocurrency wallets and platforms often encrypt sensitive data like private keys, passwords, and user data. Weak encryption algorithms can be cracked by attackers, potentially exposing this sensitive information and giving them unauthorized access to users' accounts and funds.
3.Transaction Tampering: Weak encryption can lead to vulnerabilities in the cryptographic signatures that authenticate transactions. Attackers might be able to alter transactions or forge signatures, leading to unauthorized transfers of funds.
4.Blockchain Integrity: Cryptocurrencies rely on the integrity of their underlying blockchain. If weak encryption is used, it might compromise the integrity of the blockchain by enabling unauthorized modifications to transaction data.
5.Man-in-the-Middle Attacks: Weak encryption can make users vulnerable to man-in-the-middle attacks, where attackers intercept communications between users and cryptocurrency platforms, potentially stealing sensitive information.
6.Smart Contract Exploits: Many cryptocurrencies use smart contracts for automated and self-executing transactions. Weak cryptography in smart contracts can lead to vulnerabilities that attackers can exploit to steal funds or manipulate contract behavior.

To mitigate these risks, it's crucial for cryptocurrency developers, platforms, and users to follow best practices in cryptography:
•**Use Strong Encryption Algorithms:** Cryptocurrencies should use well-established and strong encryption algorithms for generating private keys, encrypting data, and signing transactions.
•**Regularly Update Software:** Developers should keep their software up to date to ensure that any vulnerabilities related to cryptography are patched promptly.
•**Follow Security Guidelines:** Cryptocurrency platforms and users should follow security guidelines provided by developers and industry experts to ensure the safe storage and usage of cryptographic keys and sensitive information.
•**Conduct Security Audits:** Regular security audits can help identify vulnerabilities in cryptocurrency systems, including those related to cryptography.
•**Stay Informed:** Cryptocurrency users should educate themselves about best practices for securely storing and using private keys and other sensitive information.
By following these practices and prioritizing strong cryptography, the risk of cryptocurrency cybercrime due to weak encryption algorithms can be significantly reduced.



Source: 2022 Biggest Year Ever For Crypto Hacking - Chainalysis

Methods

If "RAS" is indeed a specific cryptographic algorithm, it's important to evaluate its security, strengths, and weaknesses before considering its use in protecting against cryptocurrency crime or any other security-sensitive applications.
When selecting cryptographic algorithms to protect against cryptocurrency-related cybercrime, it's advisable to choose from well-established, widely reviewed, and trusted algorithms with proven security properties.
Examples of such algorithms include:
Cryptocurrencies often use public key cryptography for secure transactions and user authentication. Algorithms like RSA (Rivest-Shamir-Adleman) and ECC (Elliptic Curve Cryptography) are commonly used for this purpose. ECC is especially known for its ability to provide strong security with shorter key lengths compared to RSA.

Source: 2022 Cryptography in Blockchain - TechVidvan

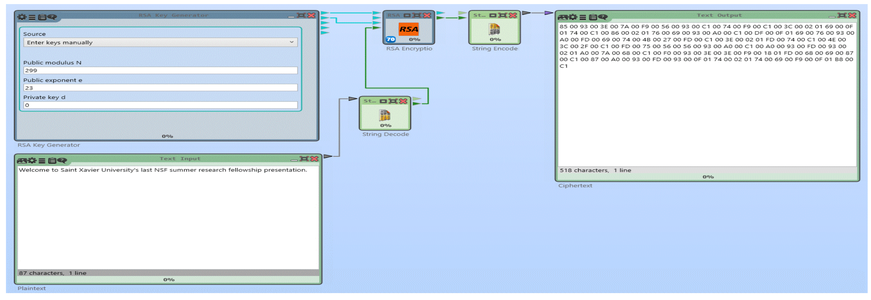
Procedure

The RSA encryption procedure involves using the recipient's public key to encrypt a plaintext message, resulting in a ciphertext that can be safely transmitted over an insecure channel. Here's a step-by-step guide to the RSA encryption process:

1. Key Setup:
- The recipient (receiver) generates an RSA key pair: a public key (consisting of the modulus "n" and the public exponent "e") and a private key (consisting of the modulus "n" and the private exponent "d").
- The recipient shares their public key with anyone who wants to send them encrypted messages.

2. Encryption:
Let's say the sender wants to send a message "M" to the recipient using RSA encryption.
- The sender obtains the recipient's public key, which includes the values of "n" (modulus) and "e" (public exponent).
- The sender converts the plaintext message "M" into a numerical value, usually by using a specific encoding scheme (such as ASCII or Unicode).
- The encryption formula is applied to the numerical value of the plaintext message using the recipient's public key: Ciphertext = (Plaintext^e) % n
- The result of this encryption process is the ciphertext "Ciphertext," which is a numerical representation of the encrypted message.

3. Sending the Ciphertext:
- The sender sends the ciphertext "Ciphertext" to the recipient over an insecure communication channel.



This research is supported by a grant from the National Science Foundation (No. 1832511).

Results

RSA algorithm is one of several cryptography algorithms, each with its own strengths and weaknesses. In comparing various types of strong and modern algorithms derived from mathematical concepts, we conclude the following:

1. **RSA vs. AES (Advanced Encryption Standard):**
   - **RSA:** Primarily used for asymmetric encryption, digital signatures, and key exchange. Key generation and encryption are slower compared to symmetric algorithms.
   - **AES:** A symmetric encryption algorithm known for its speed and efficiency in encrypting and decrypting large amounts of data. It's commonly used for securing data at rest and during transmission.
2. **RSA vs. ECC (Elliptic Curve Cryptography):**
   - **RSA:** Requires larger key sizes for equivalent security compared to ECC. Generally slower in key generation, encryption, and decryption.
   - **ECC:** Offers strong security with much smaller key sizes, making it more efficient in terms of computation and bandwidth. It's gaining popularity, especially in resource-constrained environments like IoT devices.
3. **RSA vs. Diffie-Hellman:**
   - **RSA:** Provides encryption, digital signatures, and key exchange. Primarily used in scenarios where data privacy, integrity, and authenticity are important.
   - **Diffie-Hellman:** A key exchange protocol used to establish a shared secret key between two parties. Often used in combination with symmetric encryption for secure communication.
4. **RSA vs. SHA (Secure Hash Algorithms):**
   - **RSA:** Focuses on encryption, authentication, and digital signatures. Used for both securing data and verifying the authenticity of digital messages.
   - **SHA:** Hash functions used for generating fixed-size hash values from input data. They are crucial for data integrity verification and password hashing.
5. **RSA vs. DSA (Digital Signature Algorithm):**
   - **RSA:** Offers both encryption and digital signatures. Popular for a wide range of cryptographic operations.
   - **DSA:** Primarily used for digital signatures. While efficient for signing, it's not suitable for encryption or key exchange.
6. **RSA vs. Symmetric Algorithms (e.g., DES, 3DES, Blowfish):**
   - **RSA:** Asymmetric encryption; slower but more secure for key exchange and digital signatures.
   - **Symmetric Algorithms:** Faster encryption and decryption, suitable for securing large amounts of data. Key exchange requires secure channels, making them less suitable for scenarios where key exchange between untrusted parties is needed.

In summary, RSA excels in scenarios that require secure key exchange, digital signatures, and asymmetric encryption. However, it's generally slower than symmetric encryption algorithms like AES and has larger key sizes for equivalent security. The choice of algorithm depends on the specific security requirements, efficiency constraints, and use cases of the application.

Conclusion

The RSA algorithm provides a foundation for secure digital communication by enabling encryption, authentication, digital signatures, and key exchange. Its applications span various domains, ensuring the confidentiality, integrity, and authenticity of data exchanged over networks and the internet. It is used for encrypting sensitive data such as messages, passwords, and credit card information before transmitting them over the internet. This prevents unauthorized parties from understanding the content of the data even if they intercept it.

RSA is used in key exchange protocols, like the Diffie-Hellman key exchange, which enables two parties to securely negotiate a shared encryption key over an insecure channel. This key can then be used for efficient symmetric encryption, which is more suitable for encrypting large amounts of data. It is widely used in SSL and TLS protocols to establish secure connections between web browsers and servers. It ensures that the data exchanged between them remains confidential and protected against eavesdropping.

Finally, it is used in email encryption protocols like Pretty Good Privacy (PGP) and S/MIME, allowing users to send encrypted emails that only the intended recipients can read.

Acknowledgement

I would like to thank my mentor, **Professor Al Saeed** for guiding me through this research project.
I would also love to thank the coordinators of this fellowship, Marina Martinez and Colleen Hanrahan.

Argonne National Laboratory: Water Reuse Database

CS Intern: Jose Aranda & Mentor: Dr. May Wu

Michigan:

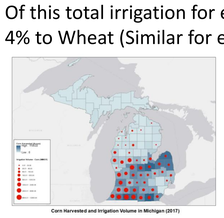
Major Agricultural Crops: Corn, Wheat, & Soybeans
Bioenergy Feedstock: Corn Stover & Wheat Straw

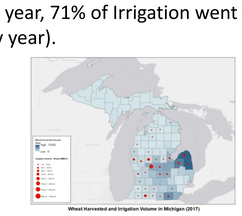
States Completed: **MI**, NJ, PA, IN, WI, MO, GA
- Preview of Michigan

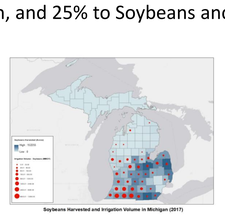
Total Irrigation Volume: County Irrigation x Acre Foot x 0.325851 (Acre Foot => Gallon)

2017: 72,247 Million Gallons
2019: 56,492 Million Gallons
2020: 63,105 Million Gallons
2021: 63,758 Million Gallons

Of this total irrigation for each year, 71% of Irrigation went to Corn, and 25% to Soybeans and 4% to Wheat (Similar for every year).


Corn Harvested and Irrigation Volume in Michigan (2017)

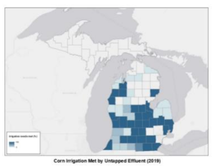

Wheat Harvested and Irrigation Volume in Michigan (2017)

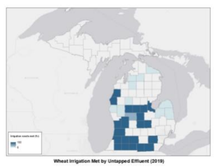

Soybeans Harvested and Irrigation Volume in Michigan (2017)

Total Harvest Acres: 2,168,204 | Total Harvest Acres: 487,011 | Total Harvest Acres: 2,487,343

Irrigation Needs Met: Agriculture Crop

Using Reclaimed Water & Crop Irrigation Volume (Similar for every other year)
Ex: If RW > County Irrigation Volume = 1 else do RW/County Irrigation Volume


Corn Irrigation Met by Untapped Effluent (2019)

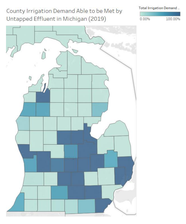

Wheat Irrigation Met by Untapped Effluent (2019)


Soybeans Irrigation Met by Untapped Effluent (2019)

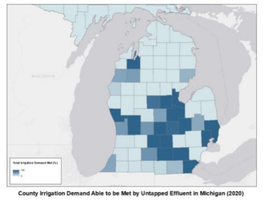
Irrigation Needs Met: Bioenergy Feedstock

351,106 MG of water is predicted to be needed for irrigation in 2040.

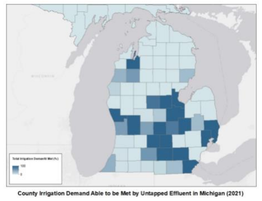
2019: 21%, could be satisfied by 2019 RW



2020: 19.86%, could be satisfied by 2020 RW


County Irrigation Demand Able to be Met by Untapped Effluent in Michigan (2020)

2021: 18.63%, could be satisfied by 2021 RW


County Irrigation Demand Able to be Met by Untapped Effluent in Michigan (2021)

Argonne NATIONAL LABORATORY

Equations: In this Internship I dealt with counties having missing data.
Ex:
- (D): Undisclosed data is prevalent within 2017 Harvest and Irrigation Acreage Data
- "Other Counties": Aggregated 2019-2021 harvest data that isn't dispersed properly.

Background:

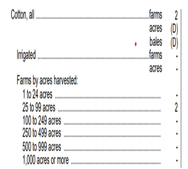
Argonne: Argonne National Laboratory is federally funded company that focuses on a variety of different topics. My internship duties were under the Energy System Infrastructure Assessment (ESIA) division. Meaning the project focused on water resource analysis such as examining freshwater availability/reusable water.

Internship Task: My mentor assigned me 7 states to complete by the end of the internship. In this internship I had to deal with agriculture crops (aka ag) data. The ag crop data that was used for each state was determined by identifying the top 3 crops with the highest harvest acreage using USDA NASS 2017 data. Once the ag crop was identified, I had to solve the harvest acreage and irrigation acreage for counties with missing values in order to match the state total (for the years 2017 & 2019-2021). After imputing all missing values, I had to identify the acreage that can be covered with reclaimed water (for the years 2019-2021). Lastly, I had to identify the amount of acreage that can be covered with reclaimed water for bioenergy feedstock (using 2019-2021 RW data to infer the potential acreage covered for year 2040).

Summary: This project focused on calculating the potential irrigation needs met for agriculture crops and bioenergy feedstock for all counties in each state using 2017 census data found in USDA NASS and 2040 KDF data. The purpose for this was so Argonne can update their water reuse database with my completed/calculated data.

Equations: (D)

Harvest Acreage 2017:
Step 1: Determine Max/Min Acres Harvested (Farms X Acres)
Step 2: Find Normalized Max for each county (Max – Min) & then sum up all
Step 3: Discrepancy (State total – sum w/missing data) – Sum of Min (step 1)
Step 4a: Discrepancy (step 3) / Sum Normalized Max (step 2)
Step 4b: Normalized max (step 2) * Decimal value (step 4a)
Step 4c: Value from 4b + Min Acres Harvested



Irrigation Acreage 2017:
Step 1: Discrepancy (State total – sum w/missing data)
Step 2: Add Harvest Acreage into counties with missing irrigation acres
Step 3: Discrepancy / total harvest acreage
Step 4: Harvest Acreage (step 2) * Decimal Value (step 3)

Equations: "Other Counties"

Harvest Acreage 2019-2021:
Step 1: Moving Average (add previous 3 years of harvest acres and then divide by 3)
Step 2: Moving Average * Decimal Value (Missing Data sum / sum of original data w/moving average)

Irrigation Acreage 2019-2021:
Step 1: Harvest Acres * Percent of Crop irrigated (2017 irrigation/2017 harvest)

Georgia:

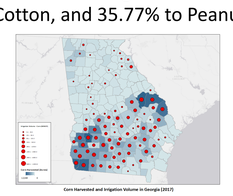
Major Agricultural Crops: Corn, Cotton, & Peanuts
Bioenergy Feedstock: Corn Stover

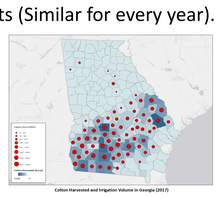
States Completed: MI, NJ, PA, IN, WI, MO, **GA**
- Preview of Georgia

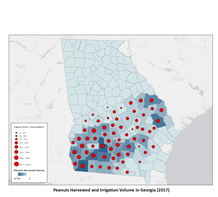
Total Irrigation Volume: County Irrigation x Acre Foot x 0.325851

2017: 199,166 Million Gallons
2019: 208,372 Million Gallons
2020: 213,896 Million Gallons
2021: 216,169 Million Gallons

Of this total irrigation for each year, 21.57% of Irrigation went to Corn, 42.66% to Cotton, and 35.77% to Peanuts (Similar for every year).


Corn Harvested and Irrigation Volume in Georgia (2017)

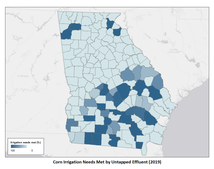

Cotton Harvested and Irrigation Volume in Georgia (2017)

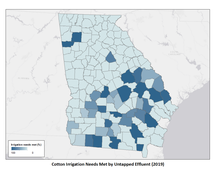

Peanuts Harvested and Irrigation Volume in Georgia (2017)

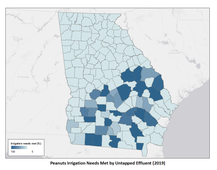
Total Harvest Acres: 259,315 | Total Harvest Acres: 1,270,652 | Total Harvest Acres: 827,627

Irrigation Needs Met: Agriculture Crop

Using Reclaimed Water & Crop Irrigation Volume (Similar for every other year)
Ex: If RW > County Irrigation Volume = 1 else do RW/County Irrigation Volume


Corn Irrigation Needs Met by Untapped Effluent (2019)

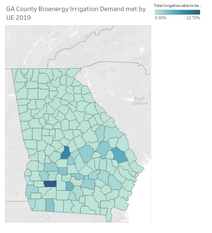

Cotton Irrigation Needs Met by Untapped Effluent (2019)


Peanuts Irrigation Needs Met by Untapped Effluent (2019)

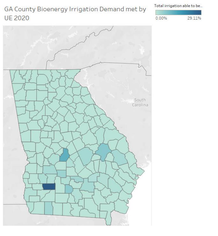
Irrigation Needs Met: Bioenergy Feedstock

1,925,009 MG of water is predicted to be needed for irrigation in 2040.

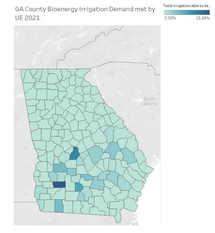
2019: 1.5%, could be satisfied by 2019 RW



2020: 1.9%, could be satisfied by 2020 RW



2021: 1.7%, could be satisfied by 2021 RW



This research is supported by a grant from the National Science Foundation (No. 1832511).

Artificial Intelligence (AI) Potential Political Threat

Daisy Diaz
Research Mentor: Dr. Mehta

INTRODUCTION

Our research focused on Chat Generative Pre-Trained Transformer (Chat GPT) and deepfakes. ChatGPT is a conversational format currently free to the public designed for users to continuously ask ChatGPT questions. Deepfakes can alter or make completely new audio, videos, and images of events that never actually happened in real life. Deepfakes, although not all high quality, can be generated by most people with a computer. Deepfakes utilize face mapping technology and the use of AI to swap faces. There is very limited information on the mechanisms ChatGPT uses for sources of information. This lack of knowledge prompted research on how ChatGPT may be possibly biased in its answers, how this bias may influence political elections, and deepfakes in politics.

PROCEDURE

- Research of AI in various fields of work was first assessed.
- We conducted a review of AI tools in current use prior to narrowing down the project to deepfakes and ChatGPT.
- The focus on AI as a potential political threat was of interest because of my double major in Political Science and because of the upcoming 2024 Presidential Election where we believe AI in politics is going to be widely seen as a mechanism of advantage.

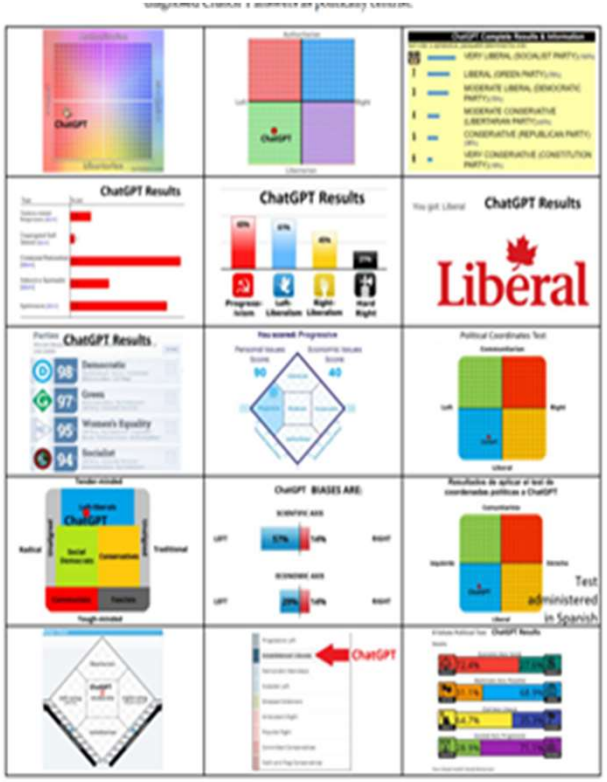


Figure 1. Results of applying 15 political orientation tests to ChatGPT. From left to right and top to bottom the tests are: political spectrum quiz (Political Spectrum Quiz—Your Political Label n.d.),

DISCUSSION

- ChatGPT has a strong political ideology bias present
- Based on fifteen political ideology orientation surveys, evidence has shown ChatGPT has a pro-environmental, left-libertarian orientation.
- ChatGPT's political ideology origin is unclear/not transparent to the public.
- ChatGPT having no political bias is extremely important.
- AI-generated images, audio, and videos (deepfakes) of political figures are being used to tarnish their reputations.
- Deepfakes are used for viral misinformation that could affect the public perception of the 2024 presidential election

LIMITATIONS

- More research is needed on how ChatGPT's bias directly affects users.
- Why ChatGPT has a strong political bias is unclear.
- Currently, there are no known solutions to ChatGPT being biased.
- Deepfake technology detection is relatively new, further research is needed as it becomes more advanced.
- As the 2024 presidential election draws near, the public influence of deepfakes will most likely be more present and can be assessed.

This research is supported by a grant from the National Science Foundation (No. 1832511).

Examining Areca Catechu's Inhibition of PTP1B

Chaniece Dobson Mentor: Dr. Sharada Buddha

Saint Xavier University

Abstract

Diabetes has become the eighth leading cause of death for Americans and there has been a steady increase in the number of Americans suffering with disease. Particularly, there has been an increase in the number of type II diabetes cases in recent years due to the epidemic of obesity in America. Type II diabetes involves the inability of the pancreas to produce enough insulin, making the body resistant to insulin and causing higher glucose levels in the blood. While many medications have been made to provide relief for those who suffer from type II diabetes, previous studies have looked at protein tyrosine phosphatase 1 beta, which is an enzyme that, when inhibited in the body, can lower the glucose levels of those with type II diabetes. Studies have shown that PTP1B can be inhibited in the body and lower glucose levels, however, more research needs to be done to find a way for PTP1B to be transferred into a viable medication for type II diabetes.

Introduction

Protein Tyrosine Phosphatase 1 Beta, or PTP1B, is an enzyme that has been shown to reduce insulin sensitivity, which in turn makes insulin more effective in the body of those with type 2 diabetes. In addition to being shown to improve type 2 diabetes symptoms, the enzyme has been linked to Alzheimer's disease by decreasing cognitive decline by interacting with cellular processes involved with the disease. In this current study, we aimed to find out if the Indian nut, *Areca Catechu*, could inhibit PTP1B in the body in hopes of there being evidence to include it onto the list of other natural remedies that treat hyperglycemia. This nut was the central point of interest alongside the plants *Gymnema Sylvestre* and *Azadirachta Indica*, which were also studied to examine their interactions with PTP1B, but were not focal points for this study due to their being enough present research showing their effectiveness in inhibiting PTP1B.

Methods

Extraction of Gymnema Sylvestre:

- 18 grams of powdered *Gymnema Sylvestre* was placed inside of an soxhlet thimble and was extracted continuously with ethanol until it was completely exhausted (took about 2 hours).
- The substance was then evaporated and weighed in at 0.1490 grams.
- This process was repeated once again with an additional 18 grams of *Gymnema Sylvestre.*

Extraction of Azadirachta Indica:

- 25 grams of powdered *Azadirachta Indica* was placed inside of an soxhlet thimble and was extracted continuously with ethanol until it was completely exhausted (took about 2 hours).
- The substance was then evaporated and weighed in at 0.1583 grams.
- This process was repeated once again with an additional 25 grams of *Azadirachta Indica*.

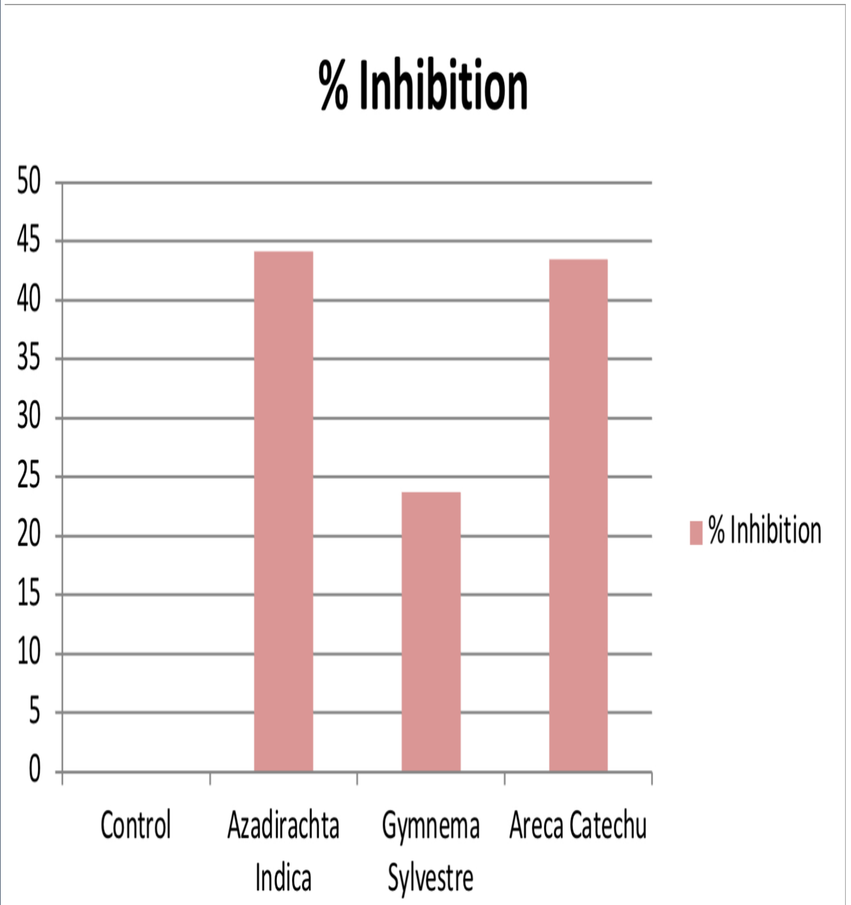
Extraction of Areca Catechu Nuts:

- Three *Areca Catechu* nuts were placed in a 200 mL beaker of water and remained in the breakers for a three day period to soften the nuts.
- The wet nuts were then crushed and placed into 30 mL beakers and each nut was extracted in 25 mL of acetone and were then sent for evaporation.
- During the evaporation process, two of my nut extracts were contaminated and only one remained for use.

Pipetting Materials into Microplate:

- All extractions where then tested to observe their interactions with the enzyme PTP1B and a mixture of the extract, the enzyme, an assay buffer (composed of Tris HCl, NaCl, and DTT), and an enzyme substrate (composed of dissolved para-Nitrophenyl Phosphate in the assay buffer).
- A 12x12 microplate was obtained with the first row including 3 wells 10 microliters of the assay buffer combined with 50 microliters of the PTP1B enzyme, 3 wells with 10 microliters of DMSO with 50 microliters of the enzyme.
- The 3rd row had 3 wells of 10 microliters of *Azadirachta Indica* from the first extraction of the plant combined with PTP1B and 3 wells of the second extract from the plant with 50 microliters of the enzyme.
- The 5th row had 3 wells of 50 microliters of PTP1B and 10 microliters of *Gymnema Sylvestre* from the first extraction and 3 wells of 50 microliters of the enzyme and 10 microliters of the second plant extract.
- The 7th row has three wells of 50 microliters of PTP1B and 10 microliters of the only remaining extract of the *Areca Catechu* nut.
- The microplate was then incubated for 30 minutes and after the removal of the microplate, 40 microliters of the enzyme substrate was added to to each well.
- The microplate was then brought to the microplate reader and data was then obtained.

This research is supported by a grant from the National Science Foundation (No. 1832511).



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Results

- After obtaining the data from the microplate reading, it was found that the *Areca Catechu* nut inhibited PTP1B by 43.5%, which *Azadirachta Indica* barely beating it out at 44.1%.
- *Gymnema Sylvestre*, however, inhibited PTP1B significantly less, at 23.7%, which shows that it possible doesn't specifically target PTP1B and specialized in targeting others enzymes in the body

Future Findings

While the results gathered regarding *Areca Catechu's* inhibition of PTP1B seems promising, future studies will have to be conducted and replicated in order to confirm these results.

Determination of an Interaction Between Zinc and Common Artificial Food Colorings

Noreen Dominguez & Mentor: Professor Steven McComis

Saint Xavier University

Introduction

Although there is no established cause of attention-deficit hyperactivity disorder (ADHD), some subgroups tend to show symptom improvement when avoiding artificial food colorings (AFC) in their diets [1]. Similarly, low levels of essential metals have been shown to correlate with an increased severity of symptoms in behavioral disorders such as ADHD [2]. It has also been proposed that essential metals, such as zinc, chelate with AFCs, leading to an increased excretion from the body and rendering them inactive [3].

This project utilizes UV-VIS spectroscopy to determine if an interaction exists between zinc and artificial food colorings: Allura red, indigo carmine and tartrazine. These AFCs are regularly found in a multitude of processed foods, like sodas, candies and jellies [4].

Research Questions

1. Does an interaction exist between AFC and essential metals, such as zinc?
2. What type of interaction, if existent, occurs?

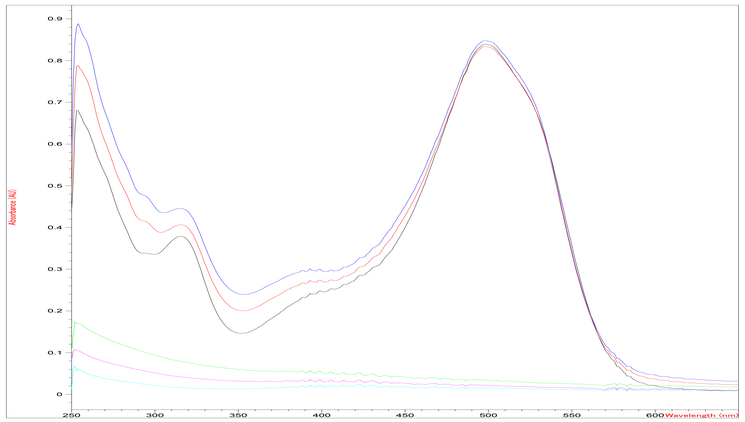


Figure 1. UV-VIS spectra of Allura red-ZnCl solutions (Black, Blue, Red) and ZnCl solutions (Green, Purple, Teal).

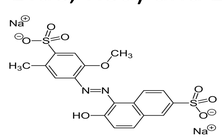
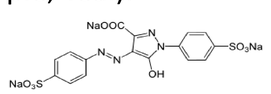
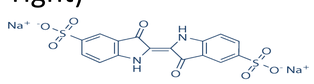


Figure 2,3 and 4.
Tartrazine (upper right)
Indigo carmine (lower right)
Allura red (left)





Methods and Results

Solution Preparation: 0.1mg/mL stock solutions of Allura red, tartrazine and indigo carmine were prepared. A 3mg/mL stock solution of zinc chloride was prepared.

Absorbance Wavelength Selection: UV-VIS spectra of test samples consisting of zinc chloride and an AFC were obtained. Prominent peaks and valleys were recorded and are listed in table 1.. Absorption spectra were collected on an Agilent 8453 UV-VIS spectrophotometer.

Test Samples: Absorbance of test samples consisting of 0.017mg/mL of an AFC and varying concentration of zinc chloride (0.25,0.5,0.75,1.0,1.25 mg/mL) were measured at the peaks listed in table 1. Absorption data was collected on a Biotek Synergy 2 microplate reader.

Additivity: Determination of additivity was calculated by comparing the sum of the individual absorbances of AFC and ZnCl solutions to the combined solution.

Results

Artificial Food Coloring	Wavelength (nm)	Additivity Observed?
Allura red	291	No
	317	No
	350	No
	500	Yes
Indigo carmine	287	Additional Testing
	487	Yes
	612	Additional Testing
Tartrazine	256	Additional Testing
	340	Yes
	415	Yes

Table 1. Occurrence of additivity in solutions of AFC and zinc chloride

Discussion

Additivity calculations suggest an interaction between Allura red and zinc chloride is occurring; However,
there is inconclusive results regarding indigo carmine and tartrazine. While a chelation interaction was proposed, this data is not able to determine the type or extent of the interaction.
Some limitations to this project include the disproportionally high concentrations of ZnCl and AFC as compared to the levels found in the body. Future research would benefit from working with concentrations closer to those found in the body.

Future Research

- Exploration of Blue No.1.
- Exploration of known chelators of zinc.
- Determination of the specific interaction occurring.
- Explore possible interactions with varying essential metals (magnesium, iron, etc.).
- Additional sample testing for indigo blue and tartrazine in search of possible interactions.

Acknowledgments

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Exploring Cheaper Alternatives to Glucose Monitoring

Gabrielle Escobedo & Mentor: Sharada Buddha, Ph.D.

Saint Xavier University

Introduction

Glucose monitoring is a crucial method for patients with type II diabetes to keep track of their blood sugar levels. However, this process can cost up to $300 per month[1] , that can cause financial burden on families of low income and third-world countries. In glucose monitor kits, glucose oxidase is the enzyme that helps detect glucose in the blood via oxidation. An enzyme is a protein that functions as a catalyst in a biochemical reaction. Different various glucose assays are conducted to find a possible cheaper alternative to the costly glucose monitors using Trinder reagent.

Methods and Materials

Creating the Buffers: Phosphate Buffered Saline (PBS): 800ml of distilled H_2O was poured into an 800ml beaker and transferred to a 1000ml clear storage glass bottle. 8.131g of NaCl, 1.421g of sodium phosphate monobasic, 0.224g of potassium chloride and 0.246g potassium phosphate dibasic were all weighed out and added into the bottle. Distilled H_2O was added to fill up the bottle to the 1000ml line. The pH was adjusted to about 7.4 and 0.372g of EDTA was added into the buffer (AAT Bioquest, 2023).

Due to a misreading of the scale during synthesis, the color reagent was created at 10x concentration of the ingredients (Color Reagent): In a 150ml beaker, 100ml of H_2O was added and 4g of disodium hydrogen phosphate was added and dissolved into the water to create a 4% concentration for the reagent. For the reagent synthesis, 75ml of the 4% Na_2HPO_4 was added into a 400ml beaker. On the scale: 2.5293g sodium azide, 1.6582g 4-aminoantipyrine, 0.223g glucose oxidase, and 0.0063g peroxidase were weighed and added into the beaker. Later in the experiment, 0.0271g of phenol was added due to an accidental misread. After dissolving, the beaker was transferred into a 300ml brown glass bottle (Trinder, 1969).

Finding the Right Dilutions: Stock "A" was created by adding 5g of glucose into 50ml of water in a 100ml beaker and diluting it into different concentrations:

Glucose Conc.	Stock A	H_2O
0 mg/ml	0	10ml
50 mg/ml	1ml	9ml
100mg/ml	2ml	8ml
150mg/ml	3ml	7ml
200mg/ml	4ml	6ml
250mg/ml	5ml	5ml

Table 1. Volume of stock A and H_2O added to create each glucose concentration.

To find the right dilution of color reagent, a few experimental tests are trialed. First, 5.0ml color reagent is added into 50ml PBS buffer in a 100ml beaker. Secondly, using a pipette, 2700µL of color reagent and 300µL of each glucose concentration is put into test tubes. Using a UV-VIS spectrophotometer, the glucose concentrations are read at a fixed wavelength of 507nm to test the efficiency of the color reagent. This results in inconsistent absorbances. A new dilution of 5.0ml color reagent in 20ml PBS buffer in a 50ml beaker is created and the above process is repeated with the dilution. The absorbance is read at 508nm due to the readings of the 100mg/ml glucose conc. and a colorimeter app, "Color Harmony", is used to determine further accuracy by reading RGB values. Due to the results, another dilution of the color reagent is made; 7.5ml color reagent is added into 25ml PBS buffer in a 50ml beaker. Absorbances are read at 508nm as the wavelength constant and the colorimeter app is used to read each concentration. The previous steps are once again recreated with the same dilution concentration except there is a 10-minute wait period before the absorbances and colorimeter app are read.

These results are successful, and the 50mg/ml glucose concentration is further diluted to test the continued accuracy of the color reagent:

Glucose Conc.	Amount of 50mg/ml	Amount of H_2O
0.5mg/ml	10uL	990uL
1.0mg/ml	20uL	980uL
1.5mg/ml	30uL	970uL
2.0mg/ml	40uL	960uL
2.5mg/ml	50uL	950uL
3.0mg/ml	60uL	940uL

Table 2. Amount of the 50mg/ml concentration and water for the smaller dilutions.

The same process with the 7.5ml color reagent is performed again except using the concentrations from table 2. The absorbances are read at 507nm alongside with the RGB values taken from the colorimeter app.

Finding the Best Materials: Using wax paper on top of chromatography paper, 10µL of the glucose conc., and 70µL 7.5ml color reagent in 25ml PBS is added on top of white hole punch stickers and the RGB values are taken via colorimeter app:

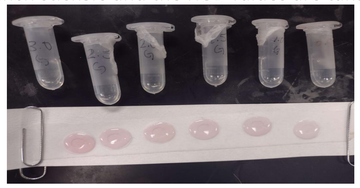


Figure 1. 0.5mg/ml to 3.0mg/ml concentrations with color reagent on wax paper on top of chromatography paper.

Instead of wax paper, orthodontic wax was purchased from Walgreens in order to prevent cross-contamination of the liquids. Three of the wax strips were mushed together and used to record the RGB values of the glucose. While this was done multiple times, a common issue was spillage of the liquids. Therefore, the wax paper was flattened, and a test tube was used to create circular indents. This prevented any spillage and mixing of the liquids. To increase accurate results, the wait minute doubled due to the smaller concentrations. In order to further determine accuracy, a glucose meter was purchased from Glucocard Expression to read the glucose concentration of the dilutions to determine any errors of the procedure. In each dental wax, 45µL of 7.5ml color reagent in 25ml PBS buffer is added with 5µL of glucose concentrations with a wait time of 20 minutes.

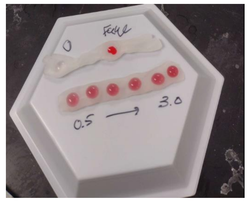
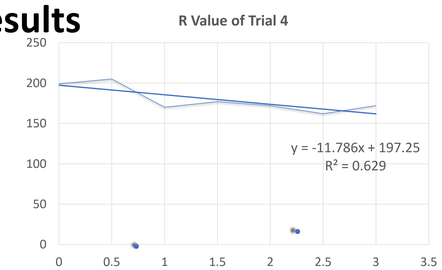


Figure 2. 0mg/ml – 3.0mg/ml glucose conc. & fake blood from Glucocard Expression with color reagent on dental wax after 20 minutes.

Results

Trials	Fake Blood RGB Values
4	R: 199 G: 13 B: 16
5	R: 186 G: 20 B: 20
7	R: 167 G: 50 B: 30

Table 3. Red/Green/Blue values of fake blood found in the glucometer package.



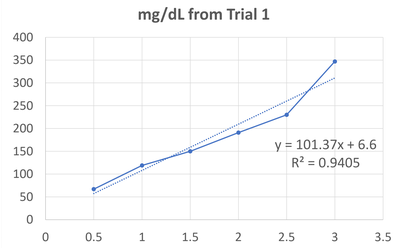
Graph 1. Graph of Trial 4's Red Value of different Glucose concentrations.

Trials	0.5 Glucose Conc. + RGB Values	1.0 Glucose Conc. + RGB Values	1.5 Glucose Conc. + RGB Values	2.0 Glucose Conc. + RGB Values	2.5 Glucose Conc. + RGB Values	3.0 Glucose Conc. + RGB Values
1	R: 218 G: 118 B: 130	R: 178 G: 93 B: 98	R: 173 G: 41 B: 54	R: 178 G: 40 B: 53	R: 167 G: 31 B: 41	R: 178 G: 43 B: 50
2	R: 169 G: 92 B: 50	R: 170 G: 52 B: 66	R: 169 G: 54 B: 61	R: 173 G: 37 B: 49	R: 174 G: 32 B: 44	R: 172 G: 35 B: 45
3	R: 165 G: 61 B: 72	R: 159 G: 41 B: 53	R: 170 G: 46 B: 57	R: 181 G: 78 B: 82	R: 172 G: 44 B: 57	R: 175 G: 30 B: 43
4	R: 205 G: 166 B: 161	R: 170 G: 55 B: 70	R: 177 G: 53 B: 64	R: 172 G: 44 B: 57	R: 162 G: 30 B: 43	R: 177 G: 32 B: 49
5	R: 170 G: 91 B: 94	R: 164 G: 63 B: 69	R: 173 G: 68 B: 73	R: 173 G: 64 B: 69	R: 176 G: 56 B: 65	R: 172 G: 41 B: 49
6	R: 169 G: 68 B: 76	R: 174 G: 69 B: 74	R: 169 G: 69 B: 74	R: 165 G: 55 B: 58	R: 169 G: 53 B: 56	R: 169 G: 56 B: 58
7	R: 154 G: 94 B: 94	R: 146 G: 58 B: 56	R: 144 G: 66 B: 56	R: 154 G: 65 B: 51	R: 135 G: 66 B: 51	R: 147 G: 64 B: 50

Table 4. Red/Green/Blue values of each glucose concentrations in each trial.

Glucose Meter Reading (mg/dL)			
Glucose Conc.	Trial 1	Trial 2	Trial 5
0.5	67 mg/dL	23 mg/dL	77 mg/dL
1	119 mg/dL	103 mg/dL	121 mg/dL
1.5	150 mg/dL	163 mg/dL	153 mg/dL
2	191 mg/dL	222 mg/dL	193 mg/dL
2.5	230 mg/dL	263 mg/dL	235 mg/dL
3	347 mg/dL	336 mg/dL	328 mg/dL

Table 5. Glucometer readings of different glucose concentrations.



Graph 2. Glucometer readings from trial 1.

Discussion

Based on the evidence presented, the dental wax method is not as accurate compared to the glucometer readings. Errors include mistakes in pipetting techniques, mistakes in preparing the glucose concentrations, and buffer making errors. One noticeable discovery is as the glucose concentrations go up, the green and blue values tend to decrease while the red value slowly decreases.

Conclusion

The dental wax method can be used to indicate low, normal, and high ranges of glucose in biological samples.

Future Research

Optimize the method to improve the accuracy, ease of use and affordability of the test method

Acknowledgments

I would like to thank Dr. Sharada Buddha for her knowledge and teaching me useful skills in the chemistry laboratory and overall being a great support system. I would also like to thank Mark Westerhoff for supplies and shipment of any chemicals needed for this research.

National Science Foundation Grant to Saint Xavier University (#1832511)

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Ensure the non-repudiation of a message in digital communications

By Saralynn Figueroa Research Mentor Dr. Imad Al Saeed

ABSTRACT

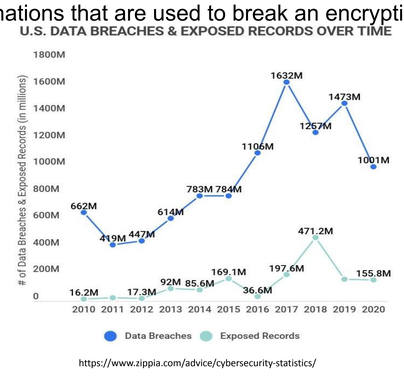
Cryptography is the study of secure communication. Hashing plays a significant role in cryptography because it provides a way to verify digital signatures in a secure way for the receiver that will authenticate the senders message. There are multiple methods of encryption like DES, DSA, RSA, ETC… In this research study we focus on RSA which is a type of method in securing communication between two parties. We do this by using the software Krypto 2.0 to secure online communication.

INTRODUCTION

Online communication is a common way many communicate. It is important to secure the messages being sent between both parties.
Cryptography has two methods symmetric and asymmetric. Symmetric uses a private key that is the same for encryption and decryption. Asymmetric encryption uses a private key for encryption and public key for decryption. the advantage asymmetric has over symmetric is the security. Since it has two different keys and both users have different decryption keys this prevents from the keys being at risk to be shared with someone. This helps individuals feel secure and have trust.

METHODS

For the experiment RSA(Rivest-Shamir-Adleman) asymmetric cryptographic was used. RSA is widely known to be used to secure online communication and sensitive data. The asymmetric experiment was done by using a public key for decryption and private key for encryption. During the experiment we learned that RSA was able to sign the senders letter and be verified by the receiver.
In the experiment there are options in Kryptos like what algorithm to use. An algorithm in encryption is important because it is what protects the information. It protects sensitive data that is used. It will also ask how will you like the key size, which affects the strength because it determines the amount of combinations that are used to break an encryption.



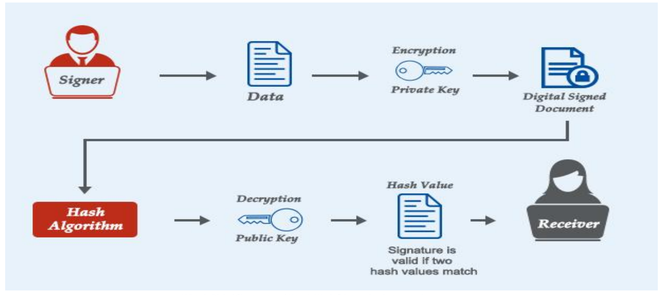
https://www.zippia.com/advice/cybersecurity-statistics/

PROCEDURE

The research project is mainly for students with no prior knowledge of Cryptography. They only need to understand the general concept of Hash Function Cryptography concepts as solutions for ensuring the integrity of the message being sent. Below is the general procedure used to create and verify a digital signature of a message.
Step 1: Key generation
Both partners (sender and receiver) should generate public and private keys. They need to share public keys only with each other.

Step 2: Signature creation
After creating a message as a text file. Both partners should use the Kryptos software to create a signature for their text files and save them in their computers. Finally, both partners should send their message and their signature files to each other.

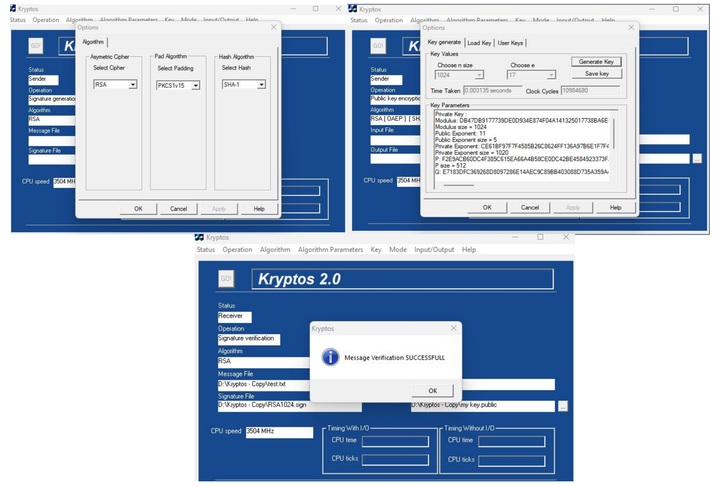
Step 3: Signature verification
The partners should download the files they received from each other and save them in their appropriate folder on their computers. After that their partner should verify the signatures on the files that he/she received using Kryptos software.



What is Digital Signature and How It Works? (comodosslstore.com)

RESULTS

In the experiment we noticed that using RSA was a great method to signing and verifying the message. Using RSA with hash function SHA-1 we were able to get the sender to sign their message for the receiver to be able to verify the message. SHA-1 helps keep communications between parties secure. This will make it authenticated.
In one of the tests we did as seen below it shows how the message will show verification successful if it is the correct one. Changing anything in the message will make the verification fail. The smallest change like taking off a space will not be verified.



CONCLUSIONS

The research experiment focuses on securing information between two parties. Digital signing and verifying the messages being sent. We used RSA for this because it is the most secure for online communications. I learned that when signing a message if it is breached the receiver will not be able to verify the message. No matter what is changed in the message it can be a period, it will still continue to fail.
RSA is a widely used encryption technique because it has been around for a long time. It is popularly used in cryptography. There are many strengths to it like it being confidential, having authenticity, and integrity. Message verification is crucial because it adds another layer of protection.

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- Explore STEM Summer Research

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Behavioral Responses of Avian Species to Monk Parakeet Calls in Areas With and Without Parakeets

Ashley Gamero and Stephanie Silva Gutierrez
Mentor: Christopher W. Appelt, PhD

Introduction

Many vertebrates, including birds, are able to get information about danger by eavesdropping on other species' alarm calls (Magrath et. al 2015). By learning to recognize these calls, birds can become more informed about their surroundings (Caro 2005). Vigilance in birds can be indicated by a "heads up" posture (i.e., scanning their surroundings) versus a non-alert "heads down" posture (Beauchamp 2002). The opportunity to learn new alarm calls occurs when exotic species are introduced to an area. Monk parakeets (*Myiopsitta monachus*) are native to South America (Speyer and Bucher 1998), but were introduced to the Chicagoland area in 1973 and soon began breeding in 1979 (Hymen and Pruett-Jones 1995). They are known to have loud alarm calls to alert of danger (Speyer and Bucher 1998). Therefore, we hypothesized that resident birds in areas where monk parakeets have colonized (MOPA sites) will recognize and respond to their alarm call resulting in stronger behavioral responses to the call than birds in areas unfamiliar with monk parakeets (Non-MOPA sites). We tested whether birds will behave differently to a neutral northern cardinal (*Cardinalis cardinalis*) call and monk parakeet calls in MOPA and Non-MOPA sites to see if resident birds have learned to eavesdrop on parakeet auditory cues indicating predation risk. We expected bird species at MOPA sites to be most alert in response to the monk parakeets' alarm call, while avian communities in Non-MOPA sites to be most alert to the monk parakeets' calls in general.

Methods

We collected data over four weeks from a total of 12 study sites, six in locations with confirmed monk parakeet activity within a kilometer and six without known monk parakeet activity within two kilometers. Once arriving at a site, we located a bird flock (4 or more individuals within 15 m of one another), identified the species, and recorded total number of individuals. We placed a speaker on the ground approximately 20 m from the flock and waited five minutes before collecting data to allow the birds to be accustomed to our presence. We played three different calls: a northern cardinal call as a control, a monk parakeet contact call (indicates presence of monk parakeets but no immediate threat), and a monk parakeet alarm call. We played the cardinal call first as we considered it the least threatening call with the weakest response. We recorded the maximum number of individuals being alert (heads up) or changing positions (moving spots) during the 7s prior to playing the call ("pre" data), the 7s as the call played ("during" data), and the 7s after the call ended ("post" data). After waiting one minute, we repeated these steps for the contact and alarm calls, respectively. Considering group sizes fluctuated between trials and time periods (i.e., flying away), data were analyzed based on the percent of birds present at each time period. We compared the responses of flocks between MOPA and Non-MOPA sites based on individual species when they were observed at both site types and analyzing data based on mixed flocks of any species.

This research is supported by a grant from the National Science Foundation (No. 1832511).

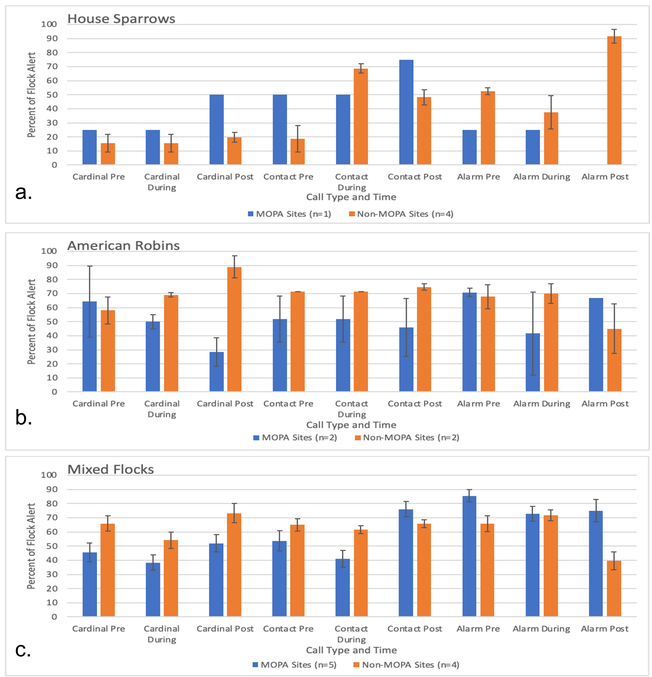

Figure 1. Percent of birds alert in flocks of various bird species in response to cardinal call, monk parakeet contact call, and monk parakeet alarm call.

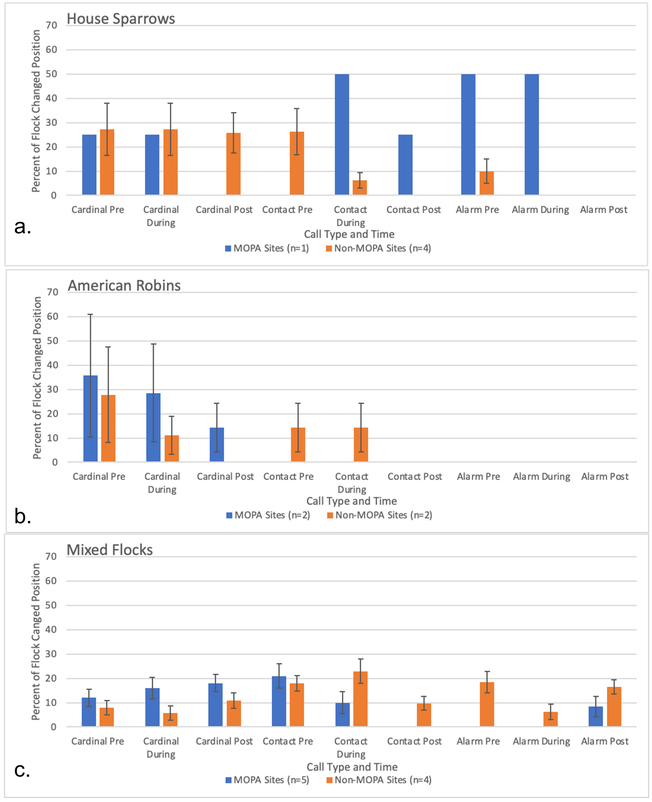

Figure 2. Percent of birds changing position in flocks of various bird species in response to cardinal call, monk parakeet contact call, and monk parakeet alarm call.

Results

House sparrows (*Passer domesticus*) and American robins (*Turdus migratorius*) were the only species with at least one flock at each site type. European starlings (*Sturnus vulgaris*) were only present in Non-MOPA areas and mourning doves (*Zenaida macroura*) were only present in MOPA areas; therefore, they were excluded from comparisons unless they were a part of a mixed flock. The house sparrows in MOPA sites were most alert after the contact call, but this was based on one flock (Fig 1a). House sparrow flocks in Non-MOPA sites had a spike in alertness from the contact call through the post alarm call (Fig 1a). In American robins, the Non-MOPA flocks were 3x as alert as those in MOPA sites after the cardinal call (Fig 1b). Besides this data point, both site types appeared to be relatively stable throughout all three calls (Fig 1b). In mixed flocks, both MOPA and Non-MOPA sites seemed to fluctuate at similar rates at each point (Fig 1c) with no apparent pattern. House sparrows in Non-MOPA sites, American robins in both site types, and mixed flocks in MOPA sites appeared to not change position once they heard the parakeets' contact call through the alarm call (Fig 2a, 2b, & 2c). The single house sparrow flock at a MOPA site had the opposite reaction and had the highest percentage of position changes after the contact call (Fig 2a). As for mixed flocks in Non-MOPA sites, position changes appeared to fluctuate without pattern (Fig 2c).

Discussion

While it is challenging to make strong conclusions, we found little difference between species alertness at MOPA and Non-MOPA sites to all three calls played. A previous study showed that monk parakeets have no effect on the evenness or diversity of avian species in both site types (Appelt et. al 2016). Small sample sizes make analyzing data difficult, but monk parakeets seem to have little effect on the behavioral responses of birds in both areas as well. Future work should include more species and flocks from both site types. One thing to possibly consider in the future is the amount of time between the calls to allow for the birds to fully recover as there were slight spikes in the "Alarm Pre" for mixed flocks and American robins. It would also be beneficial to collect more data throughout the year to observe migratory species' responses as they have a lower chance of having been exposed to monk parakeet calls.

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Daubert Cromwell Testing

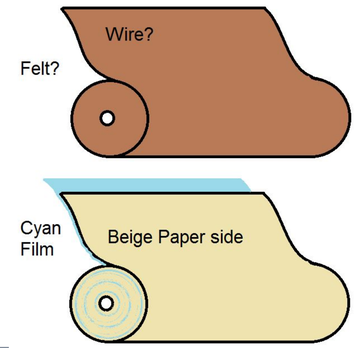
Xavier Garcilazo

Daubert Cromwell is a global manufacturer of Volatile Corrosion Inhibitor (VCI) protection for metals. For more than 80 years, quality manufacturers have trusted their VCI products to protect valuable metal parts against corrosion. Through proven quality and years of exemplary service, the company earned its reputation as "The leading name in corrosion prevention®."

ASTM- American Society for Testing and Materials

TAPPI- Technical Association of the Pulp & Paper Industry

Process Terms
Felt Side- side exposed to air
Wire Side- Side in contact with drying wire.
Print Side can be either side for paper. Also common at Daubert is multi layered materials. Examples include paper and woven kraft or film.

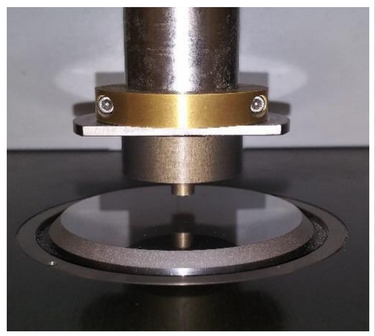


Burst *TAPPI T403*

Burst is typically used for paper materials. TAPPI T403 is a standard procedure for testing as follows: A strip of paper is placed inside the clamp and the motor applies constant pressure through a bladder until the paper bursts. The motor stops at the highest pressure measured, this value is recorded and the average of multiple tests is taken.
The manufacturing process leaves the paper with two sides that result in different pressures. There are 10 tests on each side of the paper.
In the packaging industry, customers look for materials that can withstand sharp edges or a point of failure.

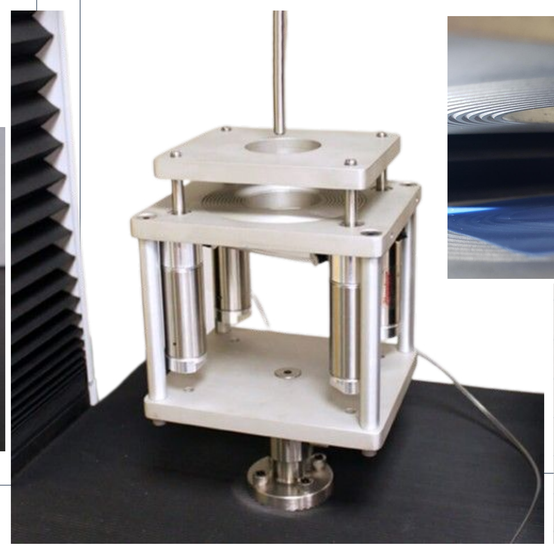
Film Caliper *ASTM D6988*

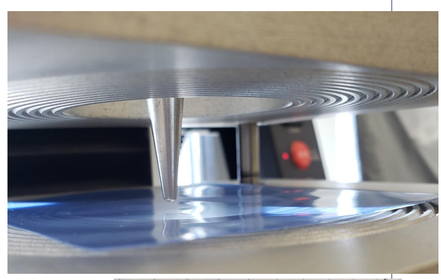
To start, the caliper is zeroed by measuring the plate to the bottom. The machine lowers a plate and measures the distance before it's stopped by the film. A single piece of film is moved around for at least 3 readings.
Once testing is done, the caliper shows the lowest & highest point, average thickness, standard deviation, and number of tests.
The purpose of this test shows how consistent every following test of the material will be. A wide range of thicknesses means a wide range of other results as a thinner sample will fail faster than a thicker one.

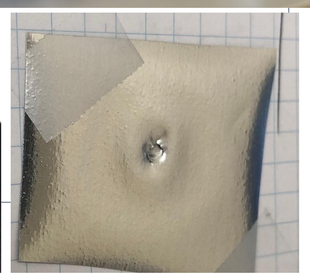


Puncture *MIL -STD-3010 Method 2065*

Puncture is the stronger version of burst and is meant for film and reinforced paper. This test is done on a computer and is mostly automated. Film is cut into squares to fit and is clamped down. A metal rod is forced through the sample until it is punctured. This is repeated for at least 10 readings.
Measurements are taken by computer and include force applied, deformation, etc. As mentioned, an object can puncture the material, so Cromwell sells a range of materials with tolerances to withstand holding most objects.







This research is supported by a grant from the National Science Foundation (No. 1832511).

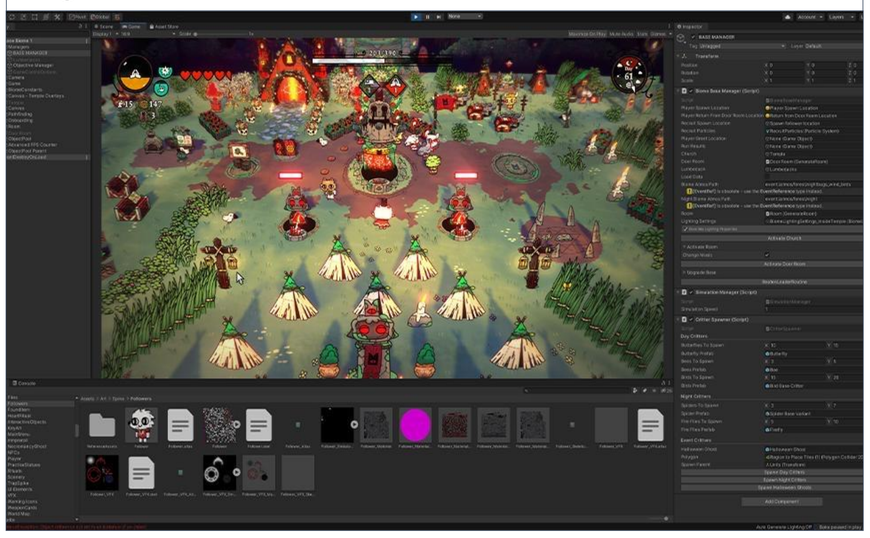
Creating a Learning Program With Unity

Michael Guzaitis
Mentor: Dr. Vanderhyde

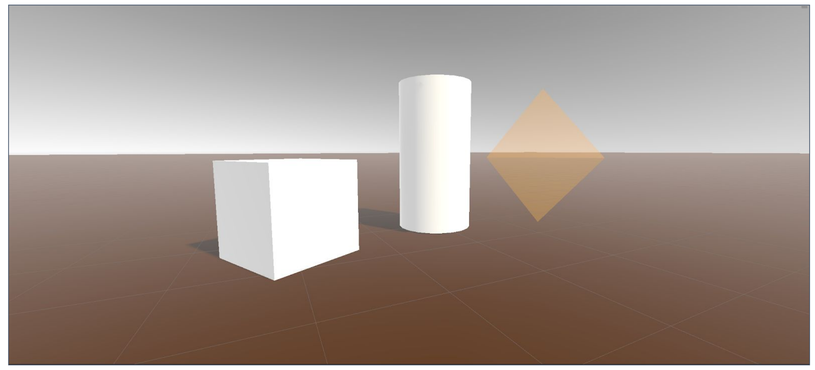
Saint Xavier University

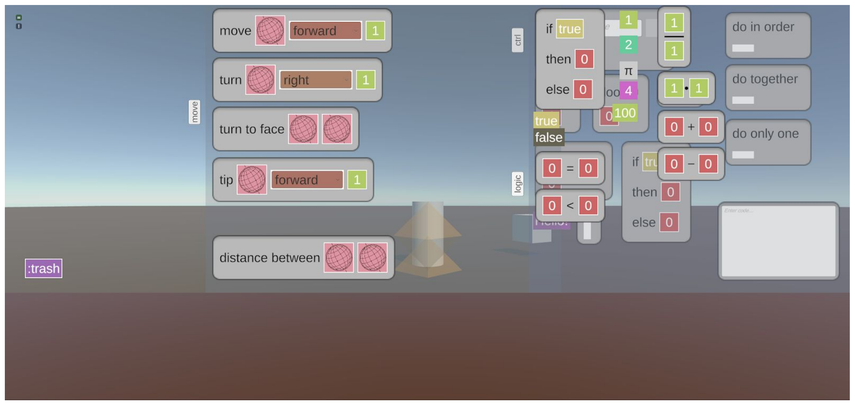
Unity

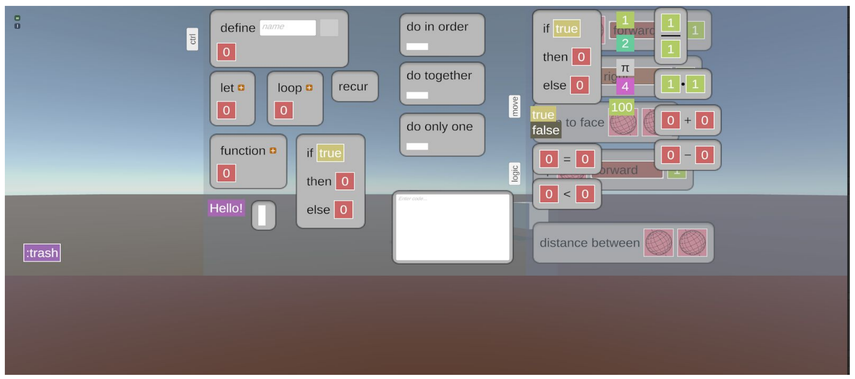
Unity is a programming software that allows you to create basically anything you can think of. Unity has mainly been used for creating games, which some of those games have been published as popular console or PC games. Some of those popular games include Fall Guys, Among Us, and Pokémon Go along with many others. A lot of times developers will just make games for fun on it that people can play but they don't expect it to become extremely popular where it gets published by bigger companies. Below is a picture of the 2022 game Cult of The Lamb being made in Unity. Cult of The Lamb is one of the newer released popular console and PC games.

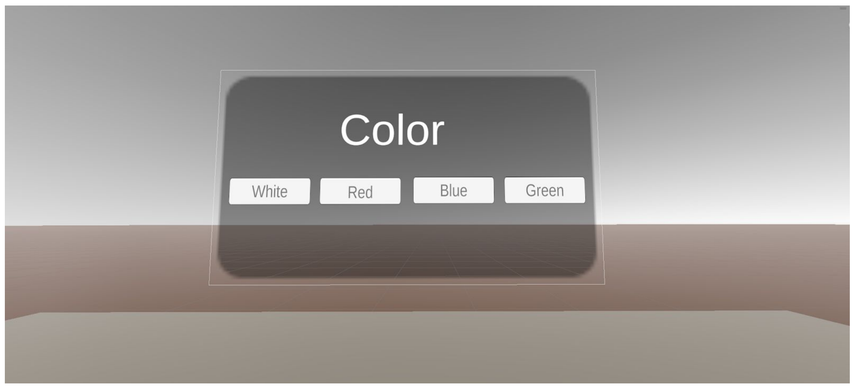


Unity isn't just for making games, it can also be used to learn or to teach people. We created a way to make drag and drop coding easier for younger students. Drag and drop coding is what most students use when starting to learn how to code. We tried to make our program be as close to the program called Alice 3, which is a drag and drop program.









When making our program we looked at other small programs and we found what we saw was the best part of those programs to make an interactive drag and drop menu. We also wanted to make it in VR and lean it towards teaching younger students not just to teach them how to code but how to code in VR to get them used to using VR. Unity also has really good VR support and pretty much everything you can do in regular Unity you can do make it in VR. So I added movement within the program so you can walk around in the VR world to get an up close feeling to the objects as your coding them within the interactive world. Another thing that I added to the world is a UI that allows you to change the objects color to four different colors. We wanted our program to feel like a VR version of Alice 3 but not too advanced where it would get students confused. We found with other programs that having too many objects within the the virtual world distracts students from the main objective, so having less objects to get distracted by keep their attention to the main objective of coding.

This research is supported by a grant from the National Science Foundation (No. 1832511).

Efficacy of Lead Detecting Methods

Sean Harris & Mentor: Professor Steven McComis

Introduction

Lead pipes have been a hidden danger to our water. Despite their use, they pose a serious health risk to people who consume tap water. The process of corrosion and dissolution leads to the dispersion of lead ions, a potent neurotoxin in the water stream [1]. Water filtration is an indispensable component of modern society's efforts to ensure the availability of safe and potable water [2].

This project sought to determine the efficacy of household water filter's ability to filter lead. However, the lead testing proved to be difficult. In addition to a qualitative testing of water filters, this project compares lead water testing methods.

Quantitative Methods

ICP/AA: Inductively Coupled Plasma and Atomic Absorption are instruments that can determine the amount of lead in a sample. However, their use requires a professional chemist and large upkeep cost. For these reasons, this method was not utilized.

Dithizone: It utilizes a molecule, dithizone, which turns a red color when chelated with iron. A modified version of this method was attempted. Shown in figure 2.

EDTA: Ethylenediaminetetraacetic is a molecule that can be used to determine the concentration of metals in water. A methodology using EDTA was developed to determine the amount of lead in drinking water. However, the experiment proved ineffective as the titration was time consuming and the endpoint was difficult to determine. Shown in figure 1.

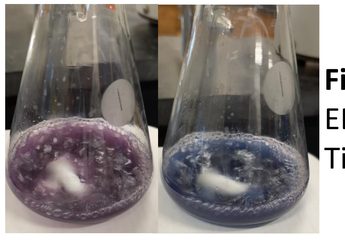


Figure 1. EDTA Titration

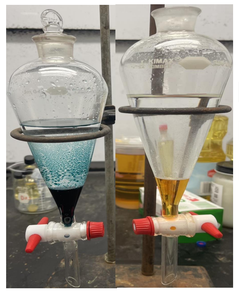


Figure 2. Dithizone Method

Qualitative Water Filter Results

Due to the difficulties associated with quantitative testing. A qualitative lead testing strip method was used to determine if lead was present in filtered water. Two common household pitcher filters advertised as lead reducing were purchased.

Lead solutions were prepared using lead(II) nitrate and lead(II) acetate trihydrate. Solutions were made in lead concentrations of 500, 4.5, 3.0 and 1.5 ppb for lead (II) nitrate and 5000, 45, 30, and 15 ppb for lead(II) acetate trihydrate. The lead(II) acetate trihydrate solutions were used to test the filters shown in figure 5. The filters were prepared following manufacturer instructions. 300mL of 45ppb lead solution was filtered through each pitcher filter. The filtered solution's results are shown in figure 6.

Figure 3. Color comparison for lead test strips.

Figure 4. Lead test strips Pb concentration: (left to right): 0, 500 0.5, 1.5, 3.0, 4.5 ppb

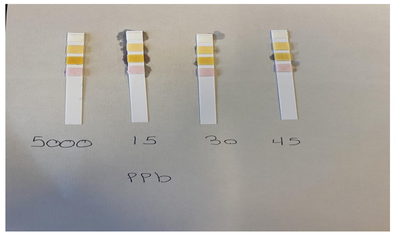


Figure 5: Lead testing strip Concentrations (left to right): 5000,15,30,45 ppb

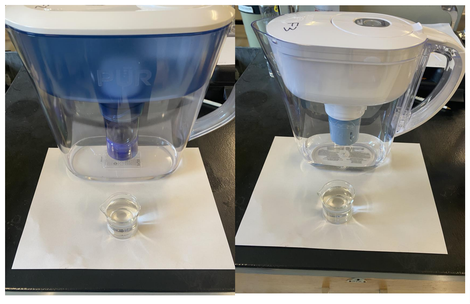


Figure 6 (above): Test strip results of filtered water (left to right): Deionized water, Brita, Pur)

Figure 7. (left): Water filters: Pur(left), Brita (right)

Discussion

Conducting lead testing within the lab setting proved to be more difficult than expected. While multiple quantitative methods were tested, none proved to be effective with the materials and equipment available.

The lead testing strips offered limited accuracy in detecting lead in water. They often didn't change to their intended color when presented with high traces of lead in the water undermining their reliability and making them ineffective for testing lead.

Future work

- Other heavy metals by analyzing other common heavy metals found in water and filtering.
- Testing heavy metals using the AA and ICP method despite drawbacks.
- Total Dissolved Solids (TDS) tests to measure the post filtration sample of water for effective removal. [3]

Acknowledgement

A special thank you to Saint Xavier University, Professor Steven McComis and the National Science Foundation (No.1832511) for making this research possible.

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2. Water Treatment. https://www.cdc.gov/healthywater/drinking/public/water_treatment.html (accessed 2023-08-24).
3. Hancock, N. TDS and Ph. https://www.safewater.org/fact-sheets-1/2017/1/23/tds-and-ph(accessed 2023-08-23).

This research is supported by a grant from the National Science Foundation (No. 1832511).

Symmetry Explored: Investigating Left and Right-Handed Differences in Men's Volleyball

Mason Nafziger & Mentor: Alak Chakravorty, PhD

Saint Xavier University

Introduction

This project delves into the realm of physics of volleyball, specifically examining the intriguing asymmetry between left-handed and right-handed men's volleyball players. We've cast our investigative net wide, encompassing the diverse landscape of collegiate volleyball across three distinct divisions: NAIA, D1, and D3. Our study uses a comprehensive process that begins with the meticulous compilation of teams within these divisions, in order to identify the handedness of players (not commonly listed). Utilizing film analysis to gain insights into the playing styles and techniques of individual athletes, we identified a set of players in order to analyze statistical metrics that can be used to distinguish between left-handed and right-handed players. The ultimate aim of the study would be to gain a deeper understanding of the differences that can be advantageous in the highly competitive collegiate volleyball world.Where science and athleticism intersect on the court, this study offers a fresh perspective on this captivating sport.

Gathering the List of Teams

We compiled a list of teams using the "Productive Recruit" website, known for its extensive data on teams across divisions. However, challenges arose as not all teams could be included due to missing data or discontinued programs.

Name	Location	Division	Conference
Adrian College	Adrian, Michigan	NCAA Division 3	Michigan (MIAA)
Alderson Broaddus University	Philippi, West Virginia	NCAA Division 2	GMAC
American International College	Springfield, Massachusetts	NCAA Division 2	Northeast-10
Aquinas College	Grand Rapids, Michigan	NAIA	Wolverine-Hoosier
Arcadia University	Glenside, Pennsylvania	NCAA Division 3	Middle Atlantic Freedom
Arizona Christian University	Glendale, Arizona	NAIA	Golden State (GSAC)
Augustana College	Rock Island, Illinois	NCAA Division 3	CCIW
Aurora University	Aurora, Illinois	NCAA Division 3	Northern (NACC)
Baldwin Wallace University	Berea, Ohio	NCAA Division 3	Ohio (OAC)
Ball State University	Muncie, Indiana	NCAA Division 1	MAC (Mid-American)
Bard College	Annandale-On-Hudson, New York	NCAA Division 3	Liberty
Barton College	Wilson, North Carolina	NCAA Division 2	Conference Carolinas
Belmont Abbey College	Belmont, North Carolina	NCAA Division 2	Conference Carolinas
Benedict College	Columbia, South Carolina	NCAA Division 2	SIAC
Benedictine University	Lisle, Illinois	NCAA Division 3	Northern (NACC)
Bethel University	Mishawaka, Indiana	NAIA	Crossroads
Bluefield University	Bluefield, Virginia	NAIA	Appalachian (AAC)
Brigham Young University	Provo, Utah	NCAA Division 1	Big 12
Bryn Athyn College of the New Church	Bryn Athyn, Pennsylvania	NCAA Division 3	Colonial States

Figure 1. An example of the list provided (other teams not pictured were included)

Film Analysis

We dedicated significant time to reviewing game footage of each team. Our goal was to observe and analyze individual players, paying close attention to their hitting hand preference. This initial step was crucial to lay the foundation for our study's data.

RESOURCES: **HUDL, YOUTUBE, VOLLEYMETRICS, and ATHLETIC WEBSITE LIVESTREAMS**

Determining Hand Preference

Through careful observation of arm-swing and ball-placement,we determined whether a player was left-handed or right-handed. This process forms the bedrock of our scientific inquiry, enabling us to explore the fascinating world of player asymmetry and physics of volleyball.

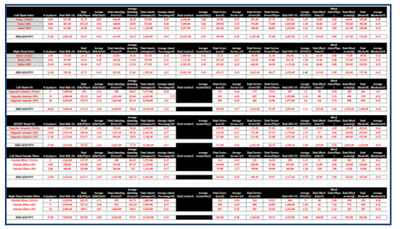


Figure 2. The sheet breakdown of each position for every division, and their respective statistics that range from their offensive to defensive numbers.

Collecting Player Statistics

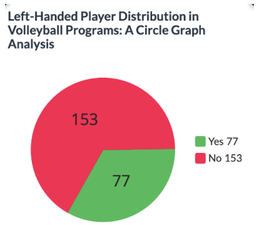


Figure 3: a circle graph showing the difference between programs that have and do not have left-handed players.

Total Volleyball Programs: comprises a total of 246 volleyball programs across the United States.

Participation in the Study: 230 teams were analyzed in our study. (79 Left-Handed Players)

Yes: 77 out of the 230 teams were shown to have left-handed volleyball players, demonstrating their presence in a significant portion of the teams.

No: The remaining 153 teams indicated not having left-handed volleyball players.

Left-handed players often favor attacking from the right side of the court, capitalizing on their unique angle of approach. This strategic choice aims to exploit less common trajectories and potentially result in successful kills Conversely, right-handed attackers frequently opt for the left side, harnessing their dominant hand for powerful and precise shots.

Data Science In Volleyball

Previous studies [1] have examined different aspects of volleyball data but to our knowledge this work comparing left and right handed players is unique.

Reference

[1] Cantú-González JR, Hueyotl-Zahuantitla F, Castorena-Peña JA, Aguirre-López MA. The Attack-Block-Court Defense Algorithm: A New Volleyball Index Supported by Data Science. *Symmetry*. 2022; 14(8):1499. and references therein

Comparing Player Metrics

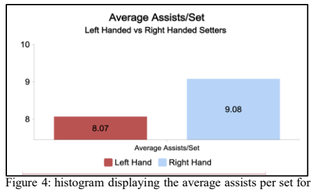


Figure 4: histogram displaying the average assists per set for left and right handed setter (blue right handed)

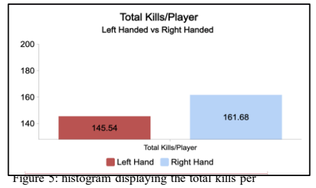


Figure 5: histogram displaying the total kills per player for left and right-handed players

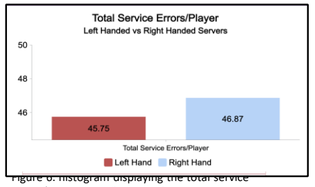


Figure 6: histogram displaying the total service errors/player for left and right handed players

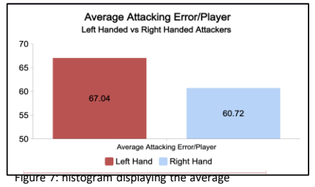


Figure 7: histogram displaying the average attacking errors per player

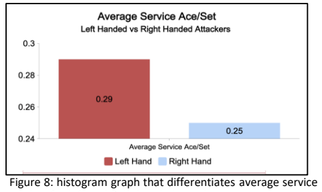


Figure 8: histogram graph that differentiates average service ace/set for left and right handed attackers

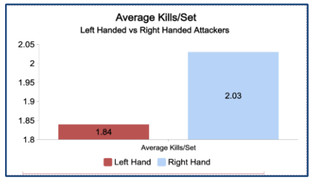


Figure 9: histogram graph displaying the average kills per set among left and right handed players

Attack Tendencies of Left and Right Handed Attacker

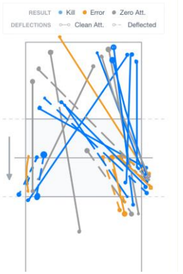


Figure 10: Left-handed Player (Player A)

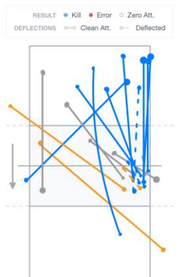


Figure 11: Right Handed Player (Player B)

Left-Handed Player (Player A): Player A exhibits a distinctive left-handed attack style. As seen in the image on the left, Player A typically positions their body differently when approaching the net, favoring the right side of the court for attack opportunities.

Right-Handed Player (Player B): Player B is a right-handed player known for their traditional right-handed attack style. In the image on the right, Player B aligns their body differently, favoring the left side of the court for attack opportunities.

Conclusions and Future Work

Patterns in the Data: Initial dataset reveals intriguing handedness patterns in men's volleyball players. There is to be further research needed for definitive conclusions.

Comparing Player Metrics: Left and Right Handed Players exhibit different strengths and weaknesses

The Need for Larger Data Sets: More future work should encompass a broader spectrum, including international, club, junior college, and professional levels, while also considering both gender-specific factors

Conclusion: Our initial findings offer a glimpse into the fascinating realm of handedness among volleyball players.While these insights are promising, they underscore the need for more comprehensive observations.

This research is supported by a grant from the National Science Foundation (No. 1832511).

Synergy of Technologies

Eliel Najera & Mentor: Robert Mahoney

Three Technologies are currently converging to create a synergy and corresponding paradigm shift**:** **Artificial Intelligence** (AI), microelectronics and the **Internet of Things** (IoT), and **3-D Printing**.

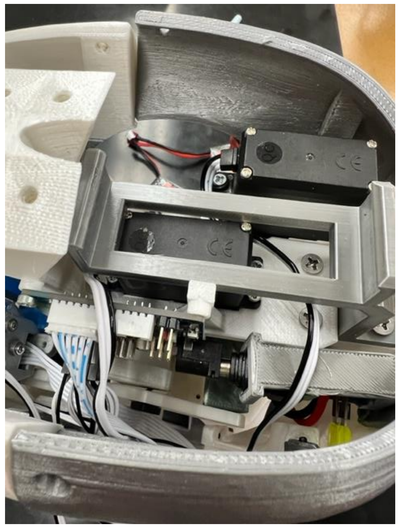
In this project, we 3-D printed **two animatronic robot heads** that can talk (when prompted), speaking with AI synthesized voices, both when interrogated by a human, and when speaking to each other.

Prompting was achieved using AI powered **speech recognition technology**.

The robot head movements were in turn controlled by an autopositions "frame and action" skill embodied in a PC based program called **ARC by Synthiam** (developed by EZ-Robot of Calgary, Canada).

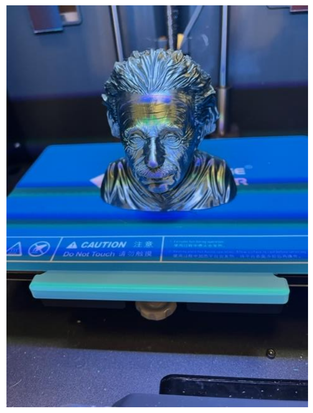
Each robot head's servo motor movements were controlled as separate instances of the ARC program running on a single PC that was wifi connected to **an IPhone hotspot**.

Audio in (mic) was achieved with a USB connected lavalier mic, and audio out was achieved via a **Bluetooth connected echo dot speaker**.



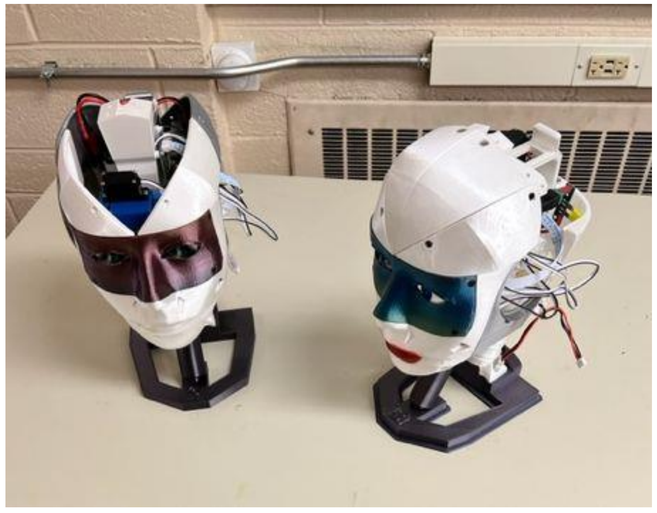
Each robot head's movements are run by a microcontroller board called Tiny I/O.

Each Robot's control board connects back to a PC that is connected to an Iphone "hotspot" network.



All "plastic" parts were printed with PLA filament on two 3-D printers.

"Creator Pro 2" 3-D Printer shown on left. "Creality CR-6" 3-D Printer shown on right.



Left Robot Head is **FDR or Reginald (Romeo)**.

Right Robot Head is **Zelda the Magnificent**.

This research is supported by a grant from the National Science Foundation (No. 1832511).

Assessment of growth inhibitory properties of garlic, Allium Sativum, extracts on gram-positive and gram-negative bacteria

Ahmad Nakhleh and Dr. Ricardo Monzon
Department of Biological Sciences, Saint Xavier University, Chicago IL

Abstract

The research is centered around studying the properties of natural extracts, particularly garlic against bacteria's Escherichia coli, Staphylococcus epidermidis and Staphylococcus aureus. I am conducting experiments using various concentrations of a garlic/H2O mixture on liquid bacterial cultures to observe the extent of inhibition. The goal is to gain insights into the mechanisms of inhibition which could potentially aid in drug development and preventative measures against resistance. I also acknowledge the complexities of such interactions, in instances such as biofilms. Aim to explore how natural remedies can contribute to promoting good health.

Background

Zhu and Zheng demonstrate within their research that garlic is a naturally occurring compound that has a plethora of benefits: it contains antifungal, antiviral, antibacterial, and antiparasitic properties (2020). There are two main of active components of garlic, the first being allicin as it has antimicrobial, antifungal, and antibiofilm properties (2020). As an antifungal agent, garlic extract is able to penetrate the cell membrane, destroy cell structure and alter gene expression of microorganisms (2020). It is also important to note that garlic is volatile and breaks down very quickly. suggesting a difficulty of use in clinical settings (2020). The second component is ajoene which has the ability to inhibit quorum sensing systems, which as we know are essential to the development of biofilms and in turn certain infections (2020).

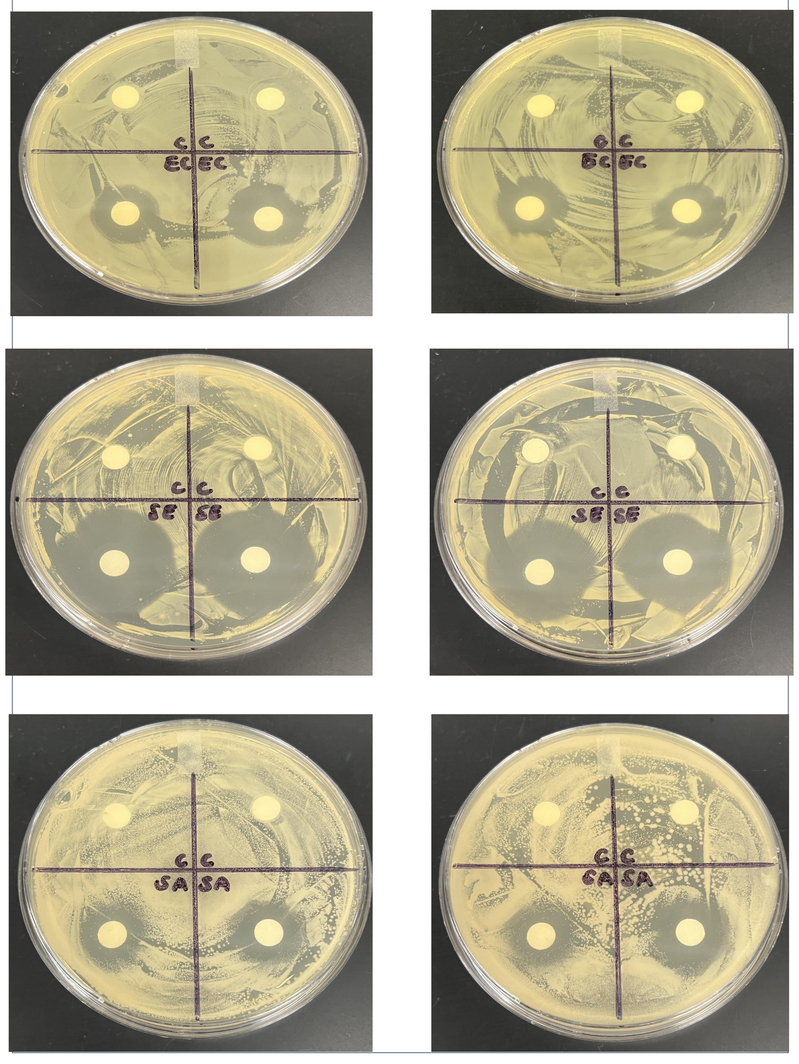
Method

Inhibition assay: This procedure required us to spread 0.2 ML of each bacteria on each plate. The plate was split into 4 quadrants, A, B, C, D. As shown in Figure 1. Control disks were placed in quadrant A and B. Disks soaked in a 50% garlic solution was placed in quadrants C and D. Plates were stored in a 37 degree C incubator for approximately 24 hours. Zone of inhibition was observed of each plate.

Method (continued)

Liquid Cultures: 5 ML of Tryptic Soy Broth (TSB) was prepared with different concentrations of garlic inoculated in different tubes. 0.2ml or 200ul of bacteria was added in each tube and left to grow for ~ 24 hours. Optical density was measured at a wavelength of 600 nanometers using a spectrophotometer. Data reflected in Figure 2.

Figure 1.



Conclusions

- Garlic has clear inhibitory effects on gram positive and gram negative bacteria.
- Future plan is to extract RNA from Liquid culture samples and amplify via PCR.
- Research Primers to utilize in PCR

Figure 2. OD of Liquid Cultures 6/29/23

Garlic-OD	control	1:500	1:200	1:100	1:50	1:10
E. coli	0.026	0.018	0.021	0.031	0.020	0.010
S. aureus	0.020	0.024	0.023	0.014	0.009	-0.003

OD of Liquid Cultures 7/14/23

Garlic-OD	control	1:500	1:200	1:100	1:50	1:10
E.coli	0.080	0.068	0.053	0.087	0.088	0.013
S. aureus	0.076	0.068	0.068	0.055	0.011	0.007
S. epidermidis	0.081	0.082	0.081	0.051	0.070	0.004

OD of Liquid Cultures 7/21/23

Garlic-OD	control	1:100	1:50	1:10
E.coli	0.065	0.085	0.082	0.009
S. aureus	0.064	0.085	0.070	0.008
s. epidermidis	0.083	0.087	0.060	0.008

This research is supported by a grant from the National Science Foundation (No. 1832511).

Virtual Reality Experience using Alice 3

Gabriela Olivares-Diaz Mentor: James Vanderhyde

Background

- Virtual reality (VR) is used in many industries in the workforce, mainly for entertainment and education purposes. Alice 3 is a block-based program that allows users to write scripts and narratives that can be transferred to computer coding. The word coding doesn't need to be overwhelming to hear because it can be a new language, but the internet provides many resources that can come in handy. For some, Alice 3 can be old-school because educators use it less. New programs have more features that

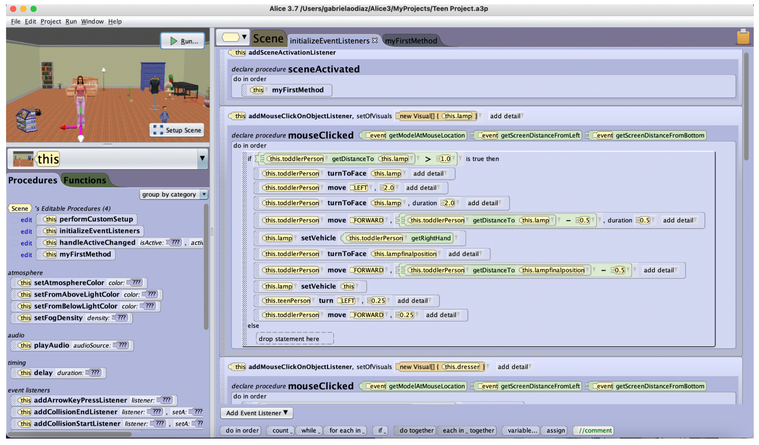
Overview

Alice's drag-and-drop feature can be a hassle when dragging from left to right. If a user wants to add a code, they must hold it precisely and drop it carefully. Without a doubt, Alice 3 is beginner-friendly.
The characters (Teen and Toddler) interact with the props randomly placed in a room to create a code allowing characters to go towards a prop and move together to a designated destination. Because most of the codes will follow a When transitioning from the computer coding of Alice 3 to the 3D world using the Oculus headset, a user can become eager to become more creative codings to use in VR. The 3D world is an adventure.

Alice 3 and VR

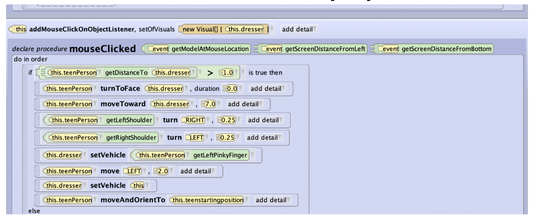
- This project aims to create an animated world that allows a user (with no computer science experience) to run the Teen and Toddler project, which allows by a single click for a character to go towards an object and lead it to a specific destination. A challenge we face is that the arm and leg movements are unrealistic because much deep coding and references are needed. The characters look like they slide or spontaneously get from point A to point B. The set vehicle code allowed a character to reach the prop and the prop's final destination and return to the character's initial location/position. The lamp moves to one destination when the toddler is clicked once—the dresses and rack move when clicked, as it looks like the character moves them.

Alice 3: Computer screen/ View



Codes: Mouse Object Listener

-The mouse object listener code allows a new visual responsible for the interactions between the characters and props.



Alice 3: Strengths

- Beginner-friendly and FREE
- It allows room for error and learning. Once the program runs, a user can notice where they went wrong and can learn and correct from their mistakes.
- Making codes that will make the character look realistic can be challenging. Many features in the Alice program are available for first-time users.
- alice.org provides free lessons for users.
- Interactive, immersive, and choice of scene, character, and prop set up.
- Great for animations in the 3D world.
- Users can grasp basic knowledge about coding using the drag-and-drop feature.

Alice 3: Weaknesses

- There are limited resources to reference, such as tutorials, because many resources are outdated or refer to older versions of Alice.
- Newer programs have taken over with advanced technology that allows users to advance their skills and creativity.
- Alice 3 is an older program that does not have frequent maintenance.
- Basic gaming creations.

Location: Target

This research is supported by a grant from the National Science Foundation (No. 1832511).

Oculus Headset & VR

- A user should use an Oculus with two hands, be in a clear space to avoid underage accidents and be monitored by an adult.
- A headset is like a blindfold that interrupts the real world with virtual reality. Therefore, no multitasking!
- VR headsets are adjustable and range in different prices with various accommodation options.

How can we make VR more effective?

- Implementing VR can be effective if Oculus headsets are provided to students at little or no cost.
- A person should remember that using an Oculus headset is fun but risky. A person can experience health difficulties if used for long periods.
- Beginner-friendly programs can be available for free for users to use virtual reality.

Future Action

- If we had additional time, we would spend more time learning how to implement realistic features into Alice 3. New software is pricier and requires advanced skills because it provides new technology. On the other hand, Alice 3 is free and beginner-friendly. Having more material for Alice 3 to advance our skills would be great. Creating a code for characters to walk or move their arms/ hands (upper and lower body) is challenging because characters slide. We recommend that users use Alice 3 as their go-to. Alice has so many cool coding features that a simple drag-and-drop can quickly improve the virtual reality experience. Once a user learns how to give basic instructions to a computer, a user can explore the VR field. Unity is a program that we would like to explore in VR as the language and creations grow. It would be great to compare and contrast other Oculus headsets to see how the experience differs.

Thanks, Explore STEM and Professor Vanderhyde, for this fantastic opportunity.

ICL Group R&D Laboratory Testing Standards

Rene Peralta; Yvette Gomes; Tanya Hunter

Saint Xavier University

For over 50 years in the paint corrosion inhibitor industry, ICL group has been one of the trusted sources where leading companies send their paint to be tested. They also make their own paint formulas and paint inhibitors in house in Hammond, Indiana. In addition, the company has countless manufacturing plants around the world.

Figure 1: Salt Spray – ASTM B117

Figure 2: Prohesion – ASTM G85 5A

Salt sprays and Prohesion test: Salt sprays and Prohesion tests are used in order to replicate long-term natural cycling weather exposure. Salt sprays uses a 5% Sodium Chloride solution at temperature of 34°c. Prohesion spray uses a combination of 0.05% sodium Chloride and 0.35% Ammonium Sulfate. It sprays for 1 hour at 35°C and then it's left to dry for 1 hour at a temperature of 40°C

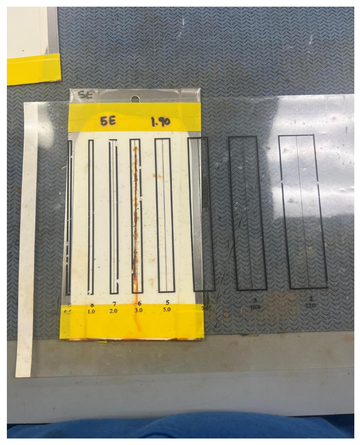


Figure 3: Scribe Creep Test

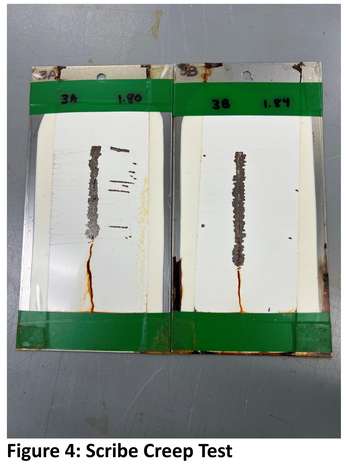


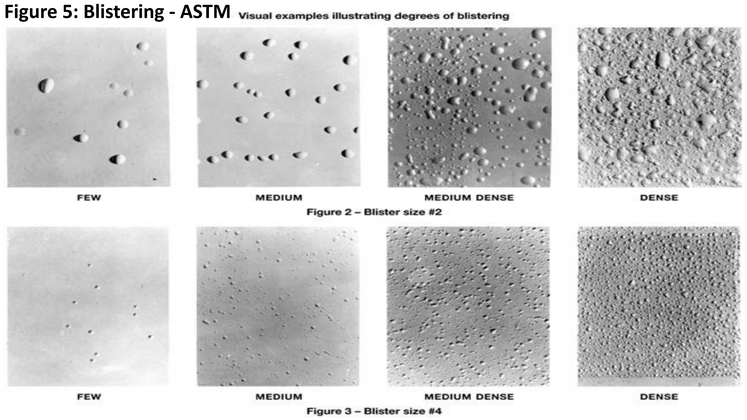
Figure 4: Scribe Creep Test

Scribe Creep Test: After the concluding salt spray or prohesion test the panels are removed from the machine. The panels are rinsed off and then the scribe creep test begins. We first begin by getting an initial rating of the thickness of the damage in the center line. After, we grab a spatula and scrape along the centerline. This causes for any loose paint to peel off. After another rise, we then measure the distance of 5 different points along the centerline. We then add all the values and average it out.

Blistering and Field Corrosion:

During these tests, we observe the surrounding edges of the panel. Some of the things we look for are is the panel has any form of rust spot or if it has any pin holes or bubbles.

Figure 5: Blistering - ASTM Visual examples illustrating degrees of blistering



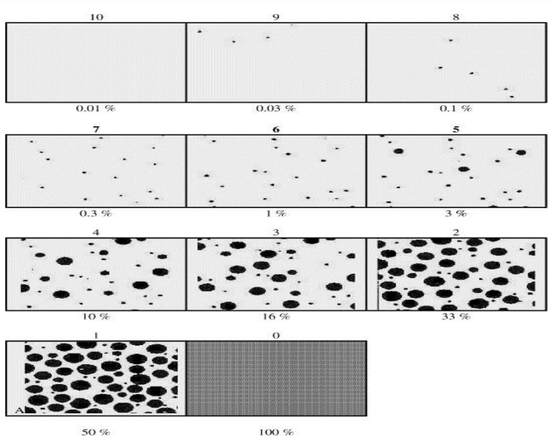


Figure 6: Field Corrosion – ASTM

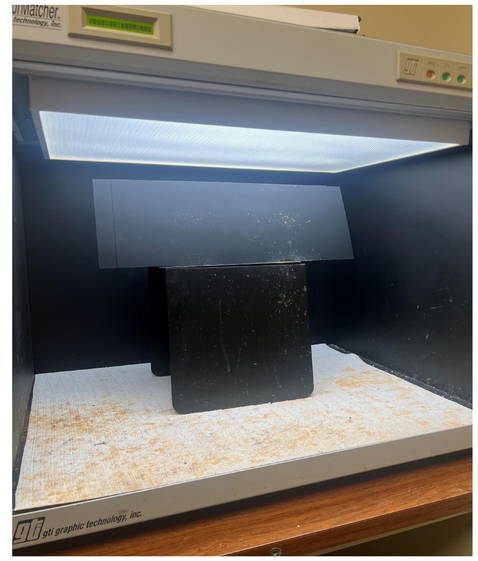


Figure 7: Picture Booth

After performing the numerous amount of test on the different metal panels we then add all of our data onto a spreadsheet. The finished panels are then gathered and taken to the picture booth. In the picture booth we take pictures of every single panel. We then transfer the picture into a folder where we could send the final result to the companies.

Paint testing is important because we need it to help protect infrastructure from premature wear that could be caused by exposure to the natural elements. One way we use paint to protect infrastructure is when we build a bridge we add paint to protected it from rusting.

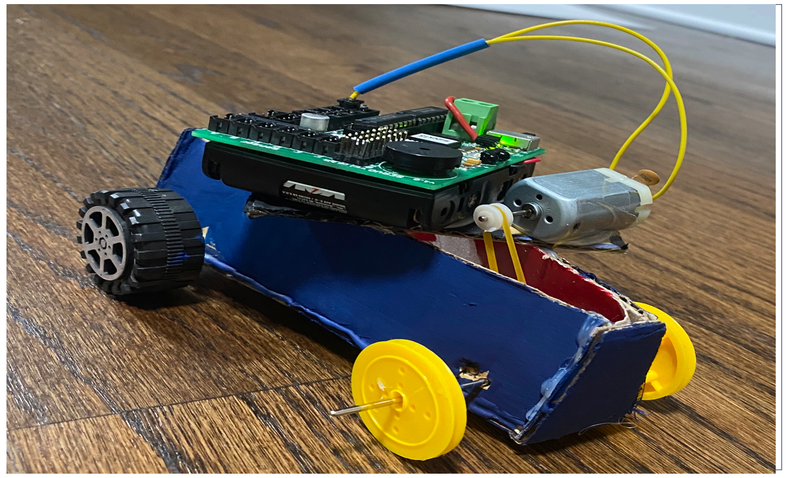
This research is supported by a grant from the National Science Foundation (No. 1832511).

Title: Explore STEM Summer Research Fellowship (Artbotics)

Name: Perla Rodriguez

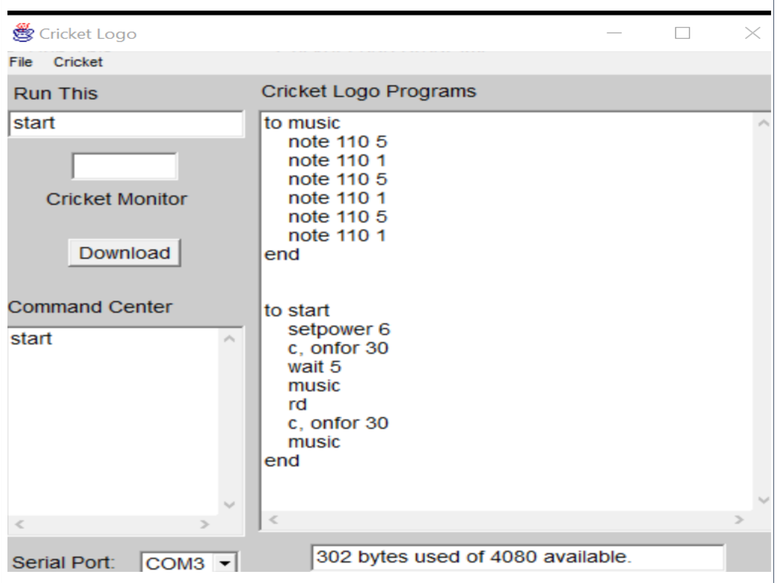
Mentor: Dr.Jean Mehta; Department of Computer Science, Saint Xavier University

The central objective of the fellowship was to study Artbotics and apply the studies to create my own piece of art where I will use the Cricket Logo Program to add motion, sound, or light. In my art project, I used cardboard as the primary building medium. Guided by mentorship, the project culminated in the successful development of a captivating cardboard vehicle, brought to life by the integration of motor and light modules facilitated by the Cricket Logo program. Through this endeavor, the robot demonstrated an ability to comprehend its environment and respond dynamically, marking a working final product.



The results of the project yielded a compelling and interactive art robot car that seamlessly combined technological prowess, artistic craftsmanship, and programmed intelligence. The successful implementation of command structures within the Cricket Logo program, coupled with the strategic integration of cardboard and technology, resulted in a cohesive and captivating embodiment of art and robotics. The final result of the vehicle is to drive forward while playing music and drive backward playing music as well. It includes music notes and setting the motor power higher so the wheels can spin better. Timing had to be calculated so the music and the motor can be ran smoothly

This vehicle was created as part of a summer research fellowship, with a primary focus on leveraging cardboard as the foundational material and the Cricket Logo program for programming. The construction process began by studying the language of the Cricket Logo and conceptualizing the design of the robotic vehicle, taking into consideration functional aspects. Cardboard was chosen for its accessibility to function correctly with the motor. The motor is mounted onto the vehicle so the wheels are able to spin, with precise alignment to enable seamless forward movement. I had to revise the pulley alley movement so it would be precise to add the motion to the wheels as I was only provided with only one motor. Additionally, music was added as the vehicle moved forward. Using the logo language I was able to create a command structure to program the vehicle to move forward as it plays a note for each movement. Testing was conducted to validate the accuracy of the command structures, ensuring that the robot vehicle responded appropriately .



In conclusion, the creation of the art robot car stands as a testament to the successful convergence of creativity, technology, and perseverance. The journey of learning a new programming language, combined with the intricacies of mastering command structures, posed significant challenges. The challenges extended beyond programming, with the task of designing the pulley wheel and belt proving to be an engineering puzzle. Ensuring the proper alignment and attachment of these components to the motor was essential for enabling accurate and consistent movement. This fellowship was characterized by dedication, mentorship, and the willingness to confront challenges head-on. This project not only underscores the potential of art robotics but also serves as a learning experience I wish to continue on further in the journey of becoming a software programmer.

This research is supported by a grant from the National Science Foundation (No. 1832511).

Analysis of Fatty Acids in Commercial Olive Oils Through Gas Chromatography

Javier Romero and Mark Westerhoff
Department of Chemistry Saint Xavier University, Chicago, IL

Introduction

Olea europaea, the olive, is known to have various health benefits such as monosaturated fatty acids, antioxidants, vitamin E, etc. However, since commercial products vary greatly in price there could be confusion/curiosity about the purity or any adulterations of the extra virgin olive oil (EVOO). Exploring the components within the EVOO would be interesting to observe. Fatty Acids such as Oleic acid (cis-9-Ocatadecenoic acid) is the most common compound (55-83% of fatty acid content) within EVOO. Identifying the compounds that make up the EVOO is vital since the oil is made up of several organic compounds. However, some are not found in EVOO naturally such as Behenic acid, found in canola, peanut, behen oil, etc., and may be an indicator of adulteration. Fatty acids were chosen to be the compounds to observe due to oils having characteristic profiles. EVOO being predominantly Oleic acid, Linoleic acid, and Palmitic acid. Gas Chromatography/Mass Spec (GCMS) can be used to identify the compounds within a sample. With this data we can relate the molecules observed to those expected in EVOO.

Method

To prepare the EVOO for GC analysis the fatty acids needed to become fatty acid methyl esters (FAME). An Esterification procedure was done for each commercial EVOO and the reference standard material. First 0.5 g of EVOO was measured on an electronic scale then mixed with 6 mL of 2% Methanolic Sodium Hydroxide. It was then brought up to a heat of 100°C and a vortex mixer at 400 rpm. After 10 minutes of refluxing the solution, 7 mL of 14% Boron Trifluoride in methanol was added and refluxed for another 3 minutes. Then 5 mL of n-heptane was added with another 2 minutes of refluxing. After the last reflux it was left to cool and then mixed with 15 mL of Saturated Sodium Chloride. They were both poured into a separatory funnel and vigorously shaken. Once the solution was left to separate the light green product of FAME was left floating above the resulting solution.

Results

Sodium Sulfate was added to the FAME product to dry. Additional n-heptane was added to the product for more solubility and reducing sample size. Samples would solidify in the vials so reducing the contents of the sample would yield it to be volatile for a longer period.

Figure 1: (Left) Product of FAME esterification inside separatory funnel.

Figure 2: (Right) Close up of separatory funnel with FAME after draining separated solution.

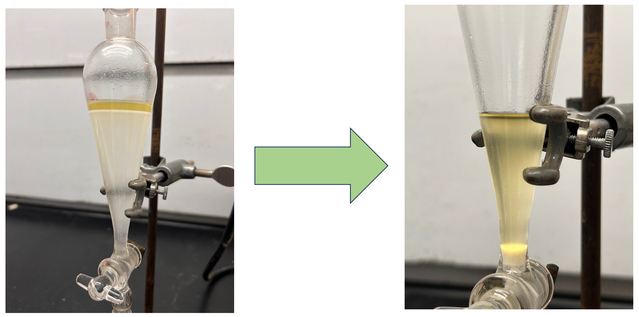


Table 1: (Below) Compounds detected from the Gas Chromatography instrument. The EVOO are listed in order of increasing cost (left to right) and on the first column all the compounds detected throughout the eight EVOO and reference standard material.

Brand of Olive Oil	Olive Oil 1	Olive Oil 2	Olive Oil 3	Olive Oil 4	Olive Oil 5	Olive Oil 6	Olive Oil 7	Oilive Oil 8	Olive Oil 9
Compound Name	Essential Everyday	Bertolli Dal 1865	Iberia	Saro Taormina	Goya	Thalysia	Bono Olio Dal 1934	California Olive Ranch	STANDARD
9-Octadecenoic acid (Z)-,methyl ester	Present	Present	Present	Present	Present	Present	Present	Present	Present
Hexadecanoic acid, methyl ester	Present	Present	Present	Present	Present	Present	Present	Present	Present
cis-13-Octadecenoic acid, methyl ester	Present	Present	Not Present	Not Present	Not Present	Not Present	Not Present	Not Present	Present
trans-13-Octadecenoic acid	Present	Present	Not Present	Present	Not Present	Not Present	Not Present	Present	Present
9,12,-Octadecadienoic acid (Z,Z)-, methyl ester	Present	Present	Present	Present	Present	Present	Present	Present	Present
7-Hexadecenoic acid, methyl ester, (Z)-	Present	Not Present	Not Present	Not Present	Not Present	Present	Not Present	Not Present	Present
Methyl stearate	Present	Present	Present	Present	Present	Present	Present	Present	Present
Squalene	Present	Present	Present	Present	Present	Present	Present	Not Present	Present
n-Hexadecanoic acid	Present	Present	Present	Present	Not Present	Present	Present	Present	Present
9-Hexadenoic acid, methyl ester, (Z)-	Present	Present	Present	Present	Present	Not Present	Present	Present	Not Present
Methyl 18-methylnonadecanoate	Not Present	Present	Present	Present	Present	Present	Present	Present	Present
cis-Methyl 11-eicosenoate	Present	Present	Present	Present	Present	Present	Present	Present	Present
cis-13-Octadecenoic acid	Not Present	Present	Present	Present	Present	Present	Present	Present	Not Present
trans-13-Octadecenoic acid, methyl ester	Present	Present	Not Present	Not Present	Present	Present	Present	Present	Not Present
cis-10-Heptadecenoic acid, methyl ester	Not Present	Not Present	Present	Not Present	Present	Not Present	Present	Present	Not Present
Docosanoic acid, methyl ester	Not Present	Not Present	Present	Present	Not Present	Not Present	Not Present	Present	Not Present
Benzene, 1,3-bis(3-phenoxyphenoxy)-	Not Present	Not Present	Not Present	Present	Not Present	Not Present	Not Present	Not Present	Not Present
Cyclodecasiloxane, eicosamethyl-	Not Present	Not Present	Not Present	Present	Not Present	Not Present	Not Present	Not Present	Not Present
Cyclononasiloxane, octadecamethyl-	Not Present	Not Present	Not Present	Present	Not Present	Not Present	Not Present	Not Present	Not Present
cis-Vaccenic acid	Not Present	Not Present	Not Present	Not Present	Not Present	Present	Present	Not Present	Present
Heptadecanoic acid, methyl ester	Not Present	Not Present	Not Present	Not Present	Not Present	Not Present	Not Present	Present	Not Present

Discussion and Conclusion

- All EVOO samples did undergo an esterification reaction and formed 9-Octadecenoic acid (Z)-, methyl ester (breaking the –OH bond and forming –OCH3) in Oleic Acid.
- A trend of the more costly EVOO having less variation in compounds while the cheaper EVOO having more compounds detected.
- Detection of Docosanoic acid, methyl ester, naturally found in canola, peanut, and marine animal oils.
- Detection of Cyclodecasiloxane, eicosamethyl- and Cyclononasiloxane, octadecamethyl-, these are from the column in the GC.
- Detection of cis-Vaccenic acid, possible contamination in the GC or through lab procedure.
- Lab procedures do have human errors and instrumentation is also a possible source of error.

Future Work

- Iodine value titration for each EVOO to measure the degree of unsaturated oils and fats.
- Acidity titrations would be interesting information to observe over an increasing price range.
- Use of a GCMS column specific to identification mono and polyunsaturated FAMEs will produce definitive results.

Acknowledgements

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Comparing Volatile Organic Compounds Found In the Air at Different Locations

Daniah Salameh and Prof. Mark Westerhoff

Background

Ever wondered what is in the air we breathe? There are many different compounds in the air depending on the environment we are in. Volatile organic compounds (VOC) are compounds made from carbon that can occur under normal air conditions as well as release from air pollution in indoor or outdoor settings. There are also chemicals found in the air that can never decompose, therefore named the "forever chemicals." These chemicals include halogenated molecules that can be harmful to humans and the environment. Additionally, while gathering samples for this project, the air quality had to be considered along with other variables such as weather, setting, wind, etc. This air quality is important to note because of the amount of air pollution in may ultimately reveal the types of compounds that reside in the air.

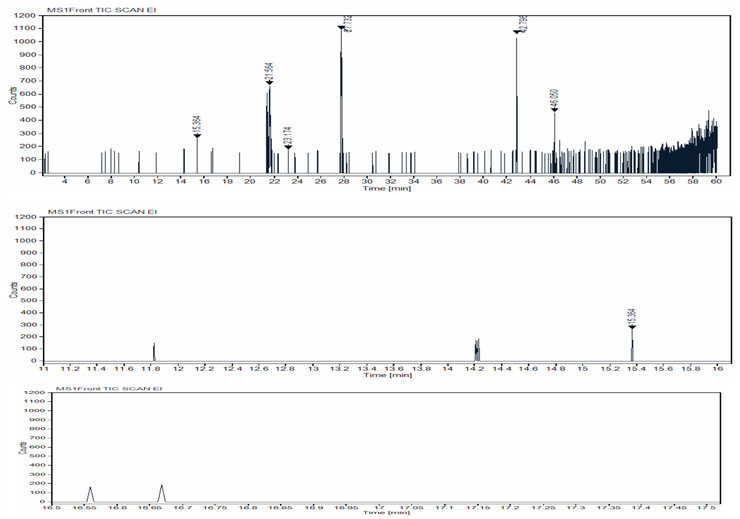
Methodology

To begin, the use of a vacuum pump, activated carbon, and a syringe were used for each individual sample as a way to capture the various compounds in the air at the time of sampling. The vacuum pump acted as a means of moving air through activated carbon. The activated carbon was used to collect the volatile organic compounds by absorbing it for later analysis. The syringe was used to store the activated carbon and is easily compact enough to take it from one place to another. Similarly to the syringes used, the vacuum pump and activated carbon were small and compact for the purpose of being able to travel to numerous environments to take samples in. Furthermore, samples were taken in 1 hour increments for each location starting from 1 hour up until 3 hours. This was to optimize the absorption, as we had little idea of the best sampling rate. Some things taken into account each hour were: the weather, air quality, temperature, barometric pressure, an humidity

After obtaining each sample, the technique used to read and identify the compounds was gas chromatography/ mass spec (GCMS). In gas chromatography, the liquid samples prepared are dissolved using a solvent and then vaporized within the GC to create a gas. From here, the MS can detect the names of compounds and the amount of each compound in a given sample. For this project, each sample was ran twice; once for a "short run" and another for a "long run." It was found that having a sample run for a longer period of time exposed more compounds that were hidden in the shorter time.

Results and discussion

As recalled, each sample ran a "short run" and again for a "long run." This was done to find any hidden compounds that were not found during the first run. When comparing the runs with their compounds, it was revealed that newer compounds came up for the "long runs" that were not shown in their "short runs." For example, the sample named BY June 30 4-7pm ran a "short run" which resulted in compounds such as sulphuric acid dibutyl ester, while the "long run" revealed compounds such as 1-undecanol. Not only did each run in the GC exhibit have differences in compounds for each sample, but the difference in sample hours also showed varying results. When taking a look at the results of the sample from hour 1 to hour 3, we can see a gradual increase and variety as the hours increased.



RT	Compound Name	Score	Rev. Score	Prob. %	Library Name	CAS #	Library Id
15.364	DL-2,3-Butanediol	999	999	14.42	mainlib	6982-25-8	18303
23.174	Methyl 10,11-tetradecadienoate	999	999	1	mainlib		35584
46.05	Acetaldehyde ethyl trans-2-hexenyl acetal	652	652	35.42	mainlib		44570

Acknowledgements

I would like to acknowledge Professor Mark Westerhoff for being my mentor through my first research project and guiding me in new laboratory techniques and methods.
I would like to acknowledge Professor Mahoney for the use of his weather measuring device to be able to successfully obtain each sample.
I would like to acknowledge the Chemistry department and Explore Stem for their support.

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Conclusion

In brief, I was able to obtain samples in numerous environments such as my home yard, a pond, a beach, etc., as well taking samples in different weathers including thunderstorms, cloudy days, and sunny days. What was found while reviewing all of the samples was that there were some reoccurring compounds. One of these compounds being Methyl 10,11-tetra decadienoate. This compound is found in plant seeds and common in many fungi which can be the reason for this compound to be ubiquitous throughout. Another compound that was repeatedly seen was DL-2,3-Butanediol. This compound naturally occurs from a bacteria called Bacillus subtilis which is commonly found in soil and plants. Because soil and plants are all around us outside, DL-2,3-Butanediol had shown up in almost all of the samples taken in both the "slow run" and "long run" while also being consistent in appearing for all 3 hours of each sample. While some compounds were found regularly among each sample, there were other compounds that were unique to certain locations. One compound was Gadoleic acid. This compound is a fatty acid, found near lakes/ponds/etc., and is released from decomposed fish that feed on crustaceans. This compound was only found in the samples taken from the pond and beach. To conclude, it is important to be aware of volatile organic compounds in various environments as some compounds are beneficial and natural whereas other compounds are not.

Vigilance Behavior of Avian Species in Areas With and Without Monk Parakeets

Stephanie Silva Gutierrez and Ashley Gamero
Mentor: Christopher W. Appelt, PhD

Introduction

Vigilance (i.e., awareness of surroundings) is important for the survival of most vertebrates. Many birds gather visual information about various threats while vigilant (Fernandez-Juricic, E. 2012). Avian vigilance behavior (often a “heads up” posture) can be influenced by flock size, other avian species, weather, locations, or other environmental variables (Griesser, 2009). Bird species may change vigilance behaviors in the presence of non-native species (Peck, 2014). Usually, birds use vigilance to be aware of predators’ presence but vigilance decreases with flock size; the bigger the flock, the less vigilant they are (Pravosudov and Grubb, 1999). Monk Parakeets *(Myiopsitta monachus)* are native to South America, (Speyer and Bucher 1998). They were introduced to the Chicagoland area in 1973 and began breeding in 1979 (Van Bael & Pruett-Jones 1995). Monk Parakeets have loud calls that might help other bird species to recognize threats. We hypothesized that avian species in areas colonized by Monk Parakeets may learn their calls resulting in avian species being less vigilant than their counterparts in non-parakeet areas.

Methods

We had a total of 12 study areas, six with confirmed Monk Parakeet activity within a kilometer (MOPA) as well as six without known Monk Parakeet activity within two kilometers (Non-MOPA). Each week, we visited three MOPA and three Non-MOPA locations and collected data during a four-week period. We considered a bird to be vigilant if the head was up in an elevated position or moving side-to-side (Fernandez-Juricic, E. 2012). After arriving at a site, we located a flock of birds (4 or more individuals within 15m of one another) and recorded species and flock size. We waited two minutes before collecting data to allow the birds to become accustomed to our presence. After two minutes, we recorded the flock size and number of vigilant individuals as well as the number that flew away (out of sight) every 30s for three minutes (0s-180s). Considering the group sizes fluctuated between trials and time periods, data were analyzed based on the percentage of birds present at each time period. We compared the responses of flocks between MOPA and Non-MOPA areas analyzing data based on individual species when they were observed at both site types and analyzing data based on mixed flocks of any species. We used a t-test to compare the percentage of flock alertness between Non-MOPA and MOPA sites using the mean value for alertness across all time period observation values.

This research is supported by a grant from the National Science Foundation (No. 1832511).

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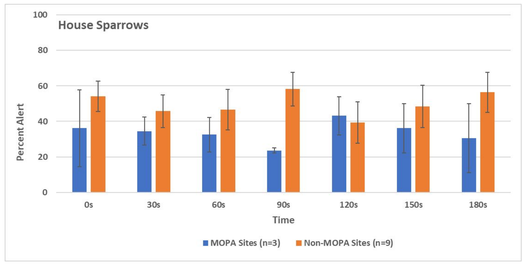

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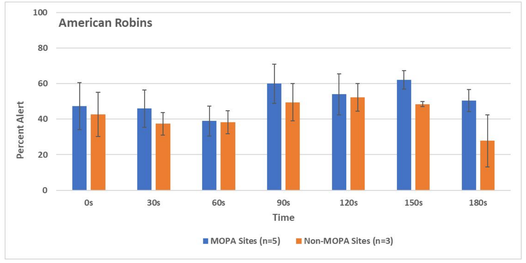

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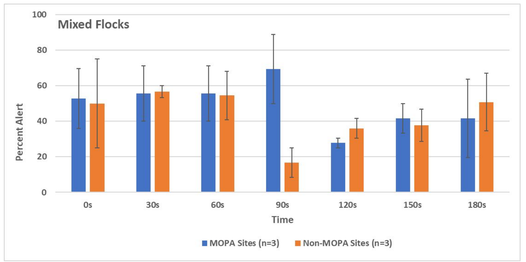
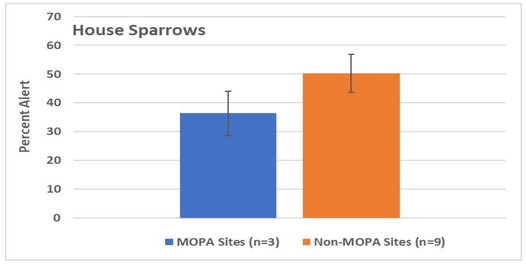


Figure 1. Vigilance responses of various species at MOPA and non-MOPA sites

a.



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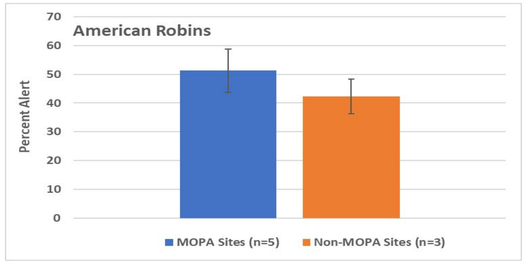

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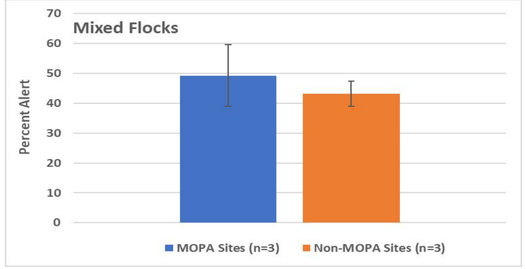

Figure 2. T-test of vigilance responses measured across various species at MOPA and non-MOPA sites.

Results

We found vigilance of each flock type to be relatively constant across time periods at both MOPA and Non-MOPA sites. American Robins (*Turdus migratorius)* and House Sparrows (*Passer domesticus*) were the only species to have at least a single flock at both site types. We observed European Starlings (*Sturnus vulgaris*) at Non-MOPA sites only and Mourning Doves (*Zenaida macroura*) at MOPA sites only. Thus, they were excluded from the single species analyses but were included in Mixed flocks analyses. We noticed an unusual increase in alertness at the 90s mark for both American Robins and Mixed flocks at MOPA sites (Figure 1a & b). Statistical analysis of percent alertness showed no significant difference between site types for any flock type (Figure 2). Interestingly, House Sparrows were non-significantly more alert at Non-MOPA sites, while American Robins and Mixed flocks were non-significantly more alert at MOPA sites (Figure 2).

Discussion

In this study, we found no evidence that avian species are more or less vigilant at Non-MOPA sites than at MOPA sites. However, the results could be affected by the broad “Mixed flocks” category, the low number of species, and the small flock sizes. In the future, our study should examine more species with larger flock sizes. Furthermore, we should, find flocks near parakeet flocks for a comparison between MOPA and Non-MOPA sites. Finally, we should collect more data throughout the year in part to observe species that migrate through this area.

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Examining the Radical Reaction of Common E-Cigarette Flavorings with Calcium Phosphate

Nicole Vilcamiche and James Kiddle

Introduction

Electronic Nicotine Delivery Systems (ENDS) have become increasingly popular since being commercially introduced in 2006.[2] Evidence suggests that aerosols in vapor from e-cigarettes can contain toxic or potentially carcinogenic chemicals such as: flavorants, glycerin, metals, silicate beads, propylene glycol and carbonyls (formaldehyde and acetaldehyde), which upon passive exposure might be harmful.[4]

The oral tissues are the first locus of direct interaction with the components of the inhaled vapor.[4] Furthermore, a study in 2018 found that e-cigarette users showed an increase in plaque index, probing depths, bone loss, volume of gingival crevicular fluid and localized inflammatory markers.[2] Additionally, previous research indicated that the flavoring agents played a role in either inhibiting or increasing radical production.[1] For this reason, this research focuses on how different types of e-cigarettes flavorings influence oral health. To further understand this concept, it was decided to examine the reactions of two common e-cigarette flavoring. Ethyl Vanillin (compound that inhibits radical production) and Ethyl Maltol (compound that increases radical production).[3] Ethyl Vanillin and Ethyl Maltol were separately mixed with Calcium Phosphate, the main chemical component of teeth and bone. (Figure 1).[4] Calcium Phosphate was used in determining their reactivity with the hydroxyl radical (·OH). The hydroxyl radical acts as a mimic for the commonly encountered **R**eactive **O**xygen **S**pecies (ROS) found in biochemical systems.

Figure 1. Flavoring compounds

ethyl vanillin | ethyl maltol

Results and Discussions

Generation of Hydroxyl Radicals

The primary radiolysis of water produces the suit of species shown in Figure 2. To isolate the hydroxyl radical the solution is presaturated with N_2O (nitrous oxide) also converting the hydrated electron and hydrogen atom to hydroxyl radical. The bracketed values are the G-value and indicate the number of radicals formed per 100eV of energy deposited in the water.

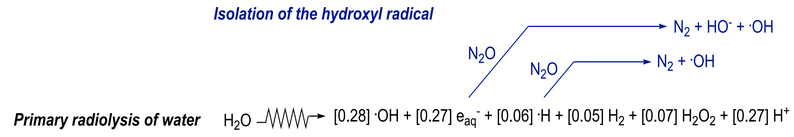
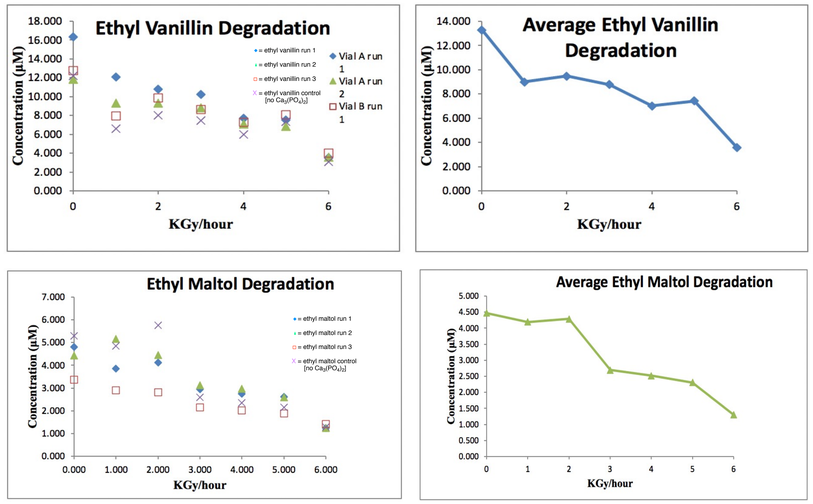


Figure 2. Primary radiolysis of water and effect of presaturation with nitric oxide

The determination of hydroxyl radical reaction degradation involves the quantitative measurement of the absolute change in contaminant concentration with absorbed radiation dose. The data for ethyl vanillin and ethyl maltol, as determined by ESIMS, are shown in Figure 3.

Figure 3. Degradation of flavorings in the presence of calcium phosphate.



Overall, each flavoring was degraded by the hydroxyl radical regardless of concentration. For ethyl vanillin the hydroxyl radical reactivity shown in figure 3 indicates that the rate of radical reaction is slowed in the presence of calcium phosphate when compared to water. A similar trend is observed for ethyl maltol. However, the degradation data for ethyl maltol suggests that at higher concentrations ethyl maltol degrades more rapidly than at lower concentrations when compared to water. Although, the average degradation for both flavorings shows an expected trend suggesting a more rapid reaction with the flavoring with increasing concentrations of ROS.

Conclusions

In conclusion, these data suggest that the e-cigarette flavoring compounds readily react with reactive oxygen species, and are impacted by the primary component of saliva, calcium phosphate

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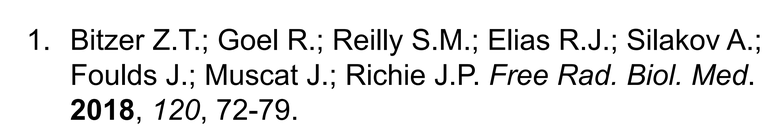

The reactivity shows a slower decreases of the two flavoring compounds in the presence of calcium phosphate compared to the flavoring in water. These data represent a clear indication that the environment of the oral cavity needs to be considered in detail to fully elucidate the adverse health effects associated with e-cigarettes.

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Saint Xavier University Chemistry Department

Collaborators

Dr. Stephen P. Mezyk

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