Control and monitoring of vital signs. Development of an insulin pump.

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1. INTRODUCTION

Diabetic patients need to inject a dose of insulin every few hours to maintain their sugar levels. Insulin pumps were invented to make their life easier. I became interested in studying this issue and tried to create my own model of a working insulin pump.

2. AIMS

The aim of the project was to study the intricacies of the disease and develop a device that would receive and process blood glucose data. Also to come up with a mechanism to administer insulin.

3. METHODS AND MATERIALS

Glucose reading: I used the Freestyle Libre device to monitor my glucose levels. It allows you to continuously measure your glucose levels without the need for constant piercing. The device fits on your arm and then transmits data via NFC.

Data transmission: It was not possible to get the data from the glucometer directly as it was encrypted. So I used the Xdrip app as an intermediary. And through it the readings from the glucometer are transferred to the Nightscout database.

Data processing and visualization: I used Nightscout to take the data from Xdrip and visualize it. It allows real-time viewing of the readings on any electronic device such as laptops, smartphones or fitness bracelets.

Control and data transfer to Wemos: For insulin delivery, I chose the Wemos mini microcontroller. It differs from the Arduino in its compactness and internet connectivity. The board receives glucose data from Nightscout via API and controls the stepper motor.

Input system: According to predefined algorithms, the microcontroller rotates the stepper motor. It enters the thread and injects insulin.

To calculate the insulin dose, I consulted with an endocrinologist. We determined the following formula.

Insulin calculation formula:

$$B = (HU * UK) + ((HC - CG)/FCHI - AI)) \quad (1)$$

where **Bolus(B)** - a single dose of insulin for a meal or to lower blood glucose.

BU - bread unit

CR - carbohydrate coefficient

BG - blood glucose (mmol/L)

TG - target glycemia (mmol/L)

ISF - insulin sensitivity factor

AI - active insulin - the part of the previous bolus dose that has not yet finished its effect (units).

4. RESULTS

As a result, I developed a prototype of an insulin pump. I have successfully implemented a data acquisition system and an insulin injection system. On the front side, I placed a display that shows all the readings. For notification I have provided an LED and a beeper. You can set all the parameters through the web page, and control the device through the button on the body. The device turned out to be quite compact, light and cute.

Figure 1. Photo of the device.

5. CONCLUSIONS

In conclusion, the topic of developing affordable insulin pumps is very relevant. And we hope that our findings will help someone in the future to create a full-fledged insulin pump.

6. ACKNOWLEDGEMENT

I thank Daria Aleksandrovna Tyrtova from St. Petersburg State Pediatric University Hospital for consulting me on all medical issues.

Meropenem stability increasing with a range of β-cyclodextrin derivatives as an approach to highly efficient drug design for airway therapy of coronavirus infection.

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1. INTRODUCTION

Currently, bacteria develop antibiotic resistance indeed quickly, so there is a need to find new antibiotics that have been introduced into clinical practice relatively recently, and improve their characteristics. Antibiotic Meropenem(MP) is poorly soluble in water and gets destroyed in short times, because it's susceptible to hydrolysis. In my research project I am developing a targeted delivery system for the antibiotic Meropenem, which will prevent its destruction and promote uniform release.

2. AIMS

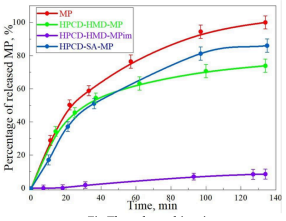
In my research project I aim to develop delivery systems based on hydroxypropyl-β-cyclodextrins(HPCD) polymers with variable linkers, namely, 1,6-hexamethylene diisocyanate(HMD) and succinic anhydride(SA) that will increase the stability of MP and to conduct a series of cellular tests that are necessary to verify the effectiveness of my drug and its introduction into clinical practice.

3. METHODS AND MATERIALS

Firstly, I synthesized polymers of HPCD with linkers HMD and SA. It is possible by two different variations: make a polymer and then add MP there or make a complex MP-HPCD(encapsulated MP) and polymerize it. Unfortunately, polymerization with Succinic anhydride(SA) requires high temperature and complex with MP gets destroyed, so only the first version is possible, while the use of HMD allows both versions. I confirmed the structure of polymers and their complexes with MP by NMR and FTIR spectroscopy. After that I investigated the kinetics of drug's release from complexes by using the equilibrium dialysis method(see **Figure 1**) and UV spectroscopy. UV also showed that fresh MP has a peak at 297 nm and the stored MP doesn't(see **Figure 2)**, which means I can monitor the stability of MP and its complexes by UV-spectra. I conducted hemolysis to test the effect of my drug on red blood cells. Further I carried out antibacterial experiments to see how polymers can affect antibacterial cells and their growth. To research how the drug can be transported in the human body I calculated binding constants of MP with HSA(Human Serum Albumin)(see **Table 1** in Results). Constants range between 10^(4) and 10^(5).

4. RESULTS AND DISCUSSION

The synthesis of polymers was successful, it was proven by IR and NMR spectroscopy.



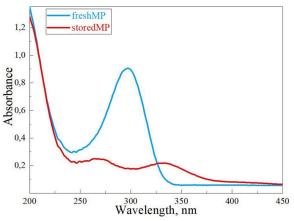


Figure 1. The release kinetics. **Figure 2.** UV-spectra.

There is a relative scale on **Figure 1**, and 100% on the graph corresponds to 50% in the dialysis bag, because there is equilibrium between internal and external solute.

Sample	Ka	Ksv
HPCD	$3.6*10^4$	$0.85*10^4$
HPCD-SA	$4.9*10^5$	$2.4*10^4$
HPCD-HMD	$9.3*10^5$	$1.3*10^4$

It shows that the speed of release of MP depends on the polymer.

Table 1. KA AND KSV VALUES. The UV spectrum of fresh and stored meropenem was compared, providing a new method for monitoring the stability of meropenem. The diagram of release shows that the stability of meropenem increases depending on the carriers used, and it's interesting that there's no the best or the worst carriers, they are just for different cases of delivery with different antibiotic duration and delivery point, which allows to use this system for transport of drug in various parts of human body. The results of hemolysis proved that the drug does not have a detrimental effect on red blood cells, antibacterial tests also showed the absence of a negative effect on antibacterial cells. The range of constant values shows that antibiotic has a strong bond with HSA.

6. CONCLUSIONS

✓The synthesis scheme with encapsulation of MP turned out to be the most effective.
✓The delivery system developed by me is biocompatible with the human body.
✓The calculation of constants showed that the drug can be successfully transported within the human body.

Autinosis: Artificial Intelligence applied to autism spectrum disorder screening.

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1. INTRODUCTION

The number of people with autism spectrum disorder (ASD) has significantly increased in over the last decades and now affects about 1% of the global population[1], which reveals the need for better and cheaper diagnosis. With the help of modern Artificial Intelligence (AI) technologies, project Autinosis is changing the way that medical professionals and parents can identify autism. This study will be very helpful for early and universally accessible autism diagnosis, diminishing costs with diagnosis and treatment as well as advancing our understanding of the symptoms and potential treatments for ASD.

2. AIMS

This research aims to:

1. Gain comprehensive insights into the manifestations of autism across all age groups.

2. Introduce an accessible, cost-effective, and reliable autism screening method for all ages.

3. Lay the groundwork for utilizing contemporary AI techniques in neurological disorder research, ultimately enhancing the quality of life for individuals with ASD.

Most of all, the most important goal is to improve the life quality of underprivileged who would otherwise not be aware of ASD, due to the lack of clinics nearby and the high costs of a medical consultation.

3. METHODS AND MATERIALS

The AI model was trained on three distinct databases representing different age groups, utilizing Python, and employing logistic regressions and Decision Trees[2]. Results underwent analysis and refinement using explainable AI to elucidate the model's decisions. Precision (proportion of correct answers), sensitivity (proportion of true positives), and specificity (proportion of true negatives). were evaluated for each age group to ensure accuracy.

To give people access to the technology, a website was created to gather insights on the first impressions of the public and professionals about the product.

The datasets are made from many answers to a 10-question long form that was filled by people and all the data is labelled as characterizing ASD or not.

Figure 1. A print of the homepage of our platform.

4. RESULTS

Testing against a validation dataset demonstrated high accuracy across all age groups, particularly noteworthy given the limited publicly available data.[3]

Table 1. Precision, sensitivity, and specificity of the Autinosis AI for each age group

	Adults	Adolescents	Children
Accuracy	0.91	0.71	0.90
Sensitivity	0.87	0.85	0.91
Specificity	0.94	0.50	0.87

Moreover, the following diagram shows the decision-making process of the adult AI model as an example:

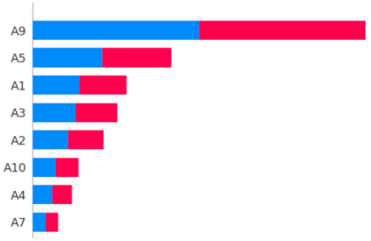

Figure 2. The decision making of the AI for adults.

The larger the difference between the red and blue bars the more decisive that feature is on deciding whether a person has or not ASD, the model uses this data to create a logistic regression and make predictions.

5. DISCUSSION

The results show the Autinosis AI model is very capable very precise results, even with scarce data. That shows how this study can positively impact the lives of many people who do not have access to a nearby specialized clinic but can use the platform to get a results and directions on how to proceed caring for a family member with ASD or themselves.

These capabilities will allow Autinosis to deliver good autism results for anyone with an internet connection, which will allow many families to care for their members that have ASD, improving their overall life quality while diminishing the burocratic work to get an official diagnosis.

6. CONCLUSIONS

AI systems offer a potent tool for screening neurological disorders, as demonstrated by Autinosis. Its ability to deliver reliable results at minimal cost holds promise for expanding access to diagnosis for families and individuals, increasing the life quality by raising awareness and making ASD screening universally available. That will not only help people be aware of their condition but also significantly lowering the costs of treatment by up to two thirds with early diagnosis.[4]

7. ACKNOWLEDGEMENT

It is important to acknowledge the challenge posed by limited dataset sizes, particularly affecting adolescent outcomes, the smallest of the three datasets and recognize the need for further data acquisition in this domain, which the project aims to do by partnering with research clinics to gain insight on how to perfect our technical performance and deliver better results to more people.

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Bromelain and papain - possible therapy for coeliac disease?

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Introduction

Coeliac disease is an autoimmune enteropathy induced by gluten. The autoimmune reaction is caused by partially degraded gluten peptides including a 33-residue fragment of gliadin (33-mer). This leads to mucosal inflammation and atrophy of the small intestine followed by chronic malabsorption of nutrients. Currently, there is no established therapy besides a strict gluten free diet. This can lead to various problems in the patients‘ everyday life [1].

Aims

Our first project‘s goal was to investigate whether gluten can be digested by the proteases bromelain (pineapple) and papain (papaya). We examined how much protease is needed for the digestion and how fast gluten is hydrolyzed. In a second step, we investigated the important question whether bromelain and papain can also support the digestion of gluten under the conditions of the human gastrointestinal tract and therefore be potentially suitable for an enzyme therapy promoting further digestion of gliadin peptides. To achieve this, we established a model to simulate the conditions of the digestion of gluten in the stomach and small intestine considering the pH-value, temperature, incubation time and the relevant digestive enzymes pepsin and trypsin.

Methods and materials

First, we incubated gluten with bromelain and papain using different incubation times (5-30 min) and concentration ratios (40:40; 40:10; 40:1; 40:0.5; 40:0.1; 40:0.01). Next, we simulated the digestion of gluten in the gastrointestinal tract following the conditions shown in figure 1. For the analysis of the experiments, the SDS-polyacrylamidgelelectrophoresis was used.

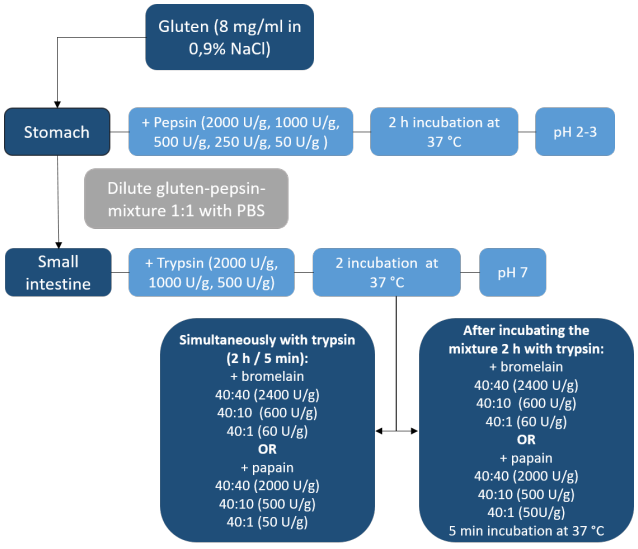

Figure 1: Established model simulating the digestion in the gastrointestinal tract

Results

In the first part of our project, we found out that gluten can indeed be digested by bromelain and papain. The hydrolysis works with a concentration ratio of 40:1 and within 5 minutes. Knowing this, we investigated if bromelain/papain can also support the digestion in the human gastrointestinal tract. The disappearance of charateristic gluten bands is interpreted as the digestion of gluten. In the experiments using our simulation model (figure 2), we observed that the additional digestion with bromelain/papain (lanes 8/9 and 11/12) is much better even after 5 minutes (lanes 10-12) than with pepsin and trypsin alone (lanes 7 + 10). Furthermore, we showed that the concentration ratio 40:1 (60 U/g bromelain or 50 U/g papain) is sufficient to digest the remaining gliadin fragments.

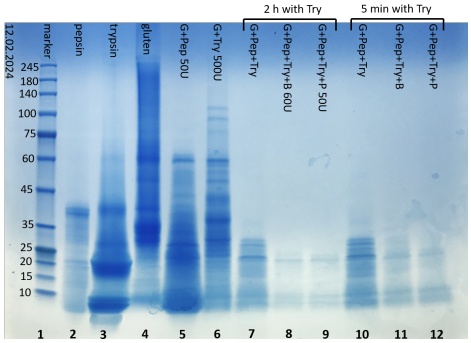

Figure 2: Gel: incubation of gluten (G, lane 4) with pepsin (Pep, lane 5) or trypsin (Try, lane 6) only. Incubation of gluten with pepsin and trypsin in succession for 2 h (lane 7) or 5 min (lane 10). Incubation with bromelain (B, lane 8 + 11) or papain (P, lane 9 + 12) simultaneously with trypsin.

Discussion and conclusion

Gluten can be digested by bromelain and papain. By developing a model to simulate the human gastrointestinal tract we were able to demonstrate that bromelain and papain additionally hydrolyze the gliadin fragments that are left after the digestion with pepsin and trypsin. This process is nearly complete in 5 minutes using a concentration ratio of 40:1. That means that the required amount of protease needed is low enough that it fits into a capsule resistant to stomach acid and makes oral administration possible. Considering all this, an enzyme therapy seems to be possible. However, there are some important peptides (33-mer) we couldn‘t scrutinize with our method. To do this and to gain more certainty, further research is necessary.

Acknowlegdement

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Unraveling Mysteries: A Comprehensive Study of the Second Alternative Oxidase Gene in *Aspergillus niger*

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1. INTRODUCTION

Terminal oxidation, the final step in aerobic respiration, occurs in the mitochondria or cell membrane, involving the electron transport chain (ETC) and resulting in ATP synthesis. The alternative oxidase (AOX) bypasses the ETC's proton gradient, accepting electrons without contributing to ATP production. AOX plays diverse roles, including stress management, cellular regulation, and redox balance, particularly in organisms like plants. In *Aspergillus niger*, AOX is crucial for citric acid production, and while literature mainly focuses on one *aox* gene, a less-discussed second copy (*aox2* gene) prompts research on its unclear biochemical function and necessity.

2. AIMS

This study seeks to address the limited information on the *aox2* gene in *A. niger*. We were curious whether through bioinformatics and molecular biological methods, we could better understand the gene, and provide an answer to what causes the potential loss of function of the gene. This knowledge could serve as a basis for the treatment of certain human disorders and diseases

3. METHODS AND MATERIALS

In our study, we investigated alternative oxidases in various *A. niger* strains. To analyze these genes, we utilized the NCBI database, employing the *A. niger* ATCC 1015 strain's protein sequence as a reference in a Blast search. After identifying 70 genome sequences, we conducted multiple alignments, followed by phylogenetic analysis using the BMGE program. Mutations were validated in our laboratory, with each mutation corresponding to a specific strain. Verification involved DNA isolation, PCR amplification, and gel electrophoresis. For sequencing, we ligated the gene into a plasmid and sent it to the Eurofins Scientific laboratory. Additionally, we assessed gene expression in the ATCC 1015 strain using RT-PCR, providing insights into the expression levels of the genes.

4. RESULTS AND DISCUSSION

In my investigation about alleles of the second alternative oxidase (*aox2*) in *A. niger* strains, the first crucial step to construct a gene-tree. This tree served to categorize strains into a wild-type group (I), and five mutated groups exhibiting various mutations affecting protein formation and function. The identified mutations included deletions (II), where specific gene sections were missing, transposon insertions (III), missense mutations (IV) altering start codons, and frameshift mutations (V) leading to reading-frame shifts. As I mentioned earlier we found a transposon which is a mobile genetic element that can change its position within a genome and altering it, which we found we named Anita2. The study concludes the examination of ATCC 1015 strain *aox2* gene expression wild type among citric acid overproducing strains. Through RT-PCR, we confirmed the expression of *aox* genes in this strain

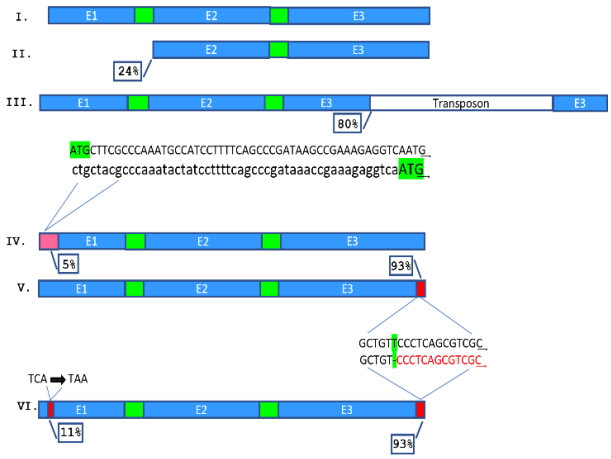

Figure 1 Schematic representation of detected aox2 mutations

5. CONCLUSIONS

AOX is vital for citric acid production in *Aspergillus niger*. While literature concentrates on one *aox* gene, a neglected second copy (*aox2*) was investigated bioinformatically in the current study. Six *aox2* alleles were found, with mutations in 70% of strains. Confirming *aox2* expression in citric acid-producing strains underscores its role in fermentation and strain development.

6. ACKNOWLEDGEMENT

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Antibacterial impact assessment of cyanobacteria

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1. INTRODUCTION

Cyanobacteria (blue-green algae) are ancient microorganisms found worldwide. Cyanobacteria may be able to produce secondary metabolites of different structures and effects. *Nostoc* species [Figure 1.] belong to the group of heterocystic filamentous cyanobacteria. *Nostoc* species have long been known to produce metabolites with a wide variety of biological effects. One group of biotechnological and therapeutic significance is the group of metabolites with antimicrobial effects, especially those with antibacterial effects.

Figure 1. *Nostoc* species

2. AIMS

During our work, the antibacterial effect of *Nostoc* isolates was investigated on *Escherichia coli* (*E. coli*) cultures. Our aim was to find cyanobacterial strains with antibacterial effects and to increase the number of new antibiotics in the future. But what motivated me to start this research? Childhood illnesses sparked my interest in medicines, growing into a passion. My research not only broadened my knowledge but also moved me closer to my dream of advancing in pharmacy.

3. METHODS AND MATERIALS

During our research, extracts were prepared with 96 *V/V*% ethanol from the reserved *Nostoc* species and the effect of these extracts on *E. coli* cell growth was investigated using a conventional disk test and a more modern microplate-based photometric method. During the disc tests, the samples were pipetted onto filter paper discs, and these were placed on an *E. coli* lawn and left in a thermostat. After 24 hours, we examined the inhibition zones. (Positive control: solutions of chloramphenicol of different concentrations). In microplate experiments, ethanol extracts were pipetted onto the microplate wells. Subsequently, LB medium and *E. coli* liquid culture was added to the wells. (Controls: *E. coli*, LB medium, solvent control). The microplate assembled in this way was placed in a microplate reader.

4. RESULTS

During the disc tests, we assumed that we would see nice characteristic zones of inhibition, and in a few cases, we experienced such an effect, but relatively small. [Figure 2A] We found the results interesting, especially after re-examining the petri dishes after 48 and 72 hours. In the case of many extracts, we found that the cells grew back in the inhibition zones. Therefore, we also conducted a microplate experiment where we found that some extracts inhibited *E. coli* growth, some stimulated culture growth and some had no effect on *E. coli*. [Figure 2B] Analysing the growth data, it seemed as if these effects were often intermittent: the differences we observed at the beginning of the experiment would sooner or later disappear and the growth curves would adjust to the level of control.

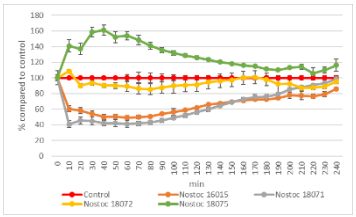

Figure 2A. Optical density (showing cell density) of cultures treated with different *Nostoc* extracts, as a percentage of *E. coli* control data.

Figure 2B. Disc test showing the effect of a *Nostoc* extract.

5. DISCUSSION

This study would further help the development of natural medicines and would later contribute to the development of new antibiotics.

6. CONCLUSIONS

Based on literature sources, we assumed that these isolates might have antibacterial properties, so we selected a basic test. The extent of the effects was difficult to see on the disc tests. Therefore, we switched to another, more modern and easily quantifiable test system, which showed the transient antimicrobial effect in several selected isolates.

7. ACKNOWLEDGEMENT

I would like to thank my teachers, Katalin Konczné Jámbrik PhD, Gábor Koncz PhD and my mentor Milán Riba PhD for all their help!

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An enhanced deep learning model for Alzheimer's disease detection and subtype identification based on FDG-PET brain scans

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1. Introduction

Alzheimer's disease (AD) is a neurodegenerative condition characterized by abnormal protein accumulation, neuronal death, and memory loss. It is often diagnosed in advanced stages due to late symptom manifestation. While structural imaging techniques, MRI, have limitations in early detection, functional neuroimaging, especially FDG-PET, offer new avenues for early and differential diagnosis by examining brain metabolic activity changes that precede symptomatic onset. However, AD's heterogeneity challenges precise diagnosis and treatment, underscoring the need for improved diagnostic frameworks.

2. Aims

To develop a deep learning framework that can predict disease stages and cognitive performance (CDR-SB) based on FDG-PET data and determine clinical subgroups linked to variations in neural activity and cognitive impairment.

3. Methods and materials

FDG-PET brain scans from patients at different AD stages were collected from the ADNI database, totaling 4,662 samples. These images underwent pre-processing and augmentation to improve model robustness [Figure 1a.]. A deep learning model featuring an InceptionV3-based encoder with dual classification heads was developed for disease stage and CDR-SB scores prediction [Figure 1b.]. The encoder was pre-trained using a self-supervised SimSiam approach, allowing the model to learn to capture intrinsic patterns from the unlabeled data [Figure 1c.].

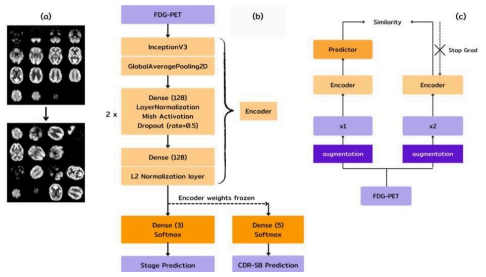

Figure 1. (a) Pre-processed FDG-PET brain image. (b) Proposed network architecture. (c) SimSiam self-supervised pre-training.

Four model variants: (i) a baseline InceptionV3 (-/-), (ii) with SimSiam pre-training (S/-), (iii) with ImageNet pre-trained weights (-/I), and (iv) a combination of both (S/I) were trained across 500 epochs and evaluated their performance on accuracy, AUC-ROC and AUC-PR. Finally, K-Means clustering was applied to the encoded latent vectors to distinguish patient subgroups, visualized through UMAP, and qualitatively compared the differences between the subgroups.

4. Results and Discussion

Our results [Table 1.] highlighted three main findings: (I) Transfer learning from ImageNet reduced model performance, likely due to the mismatch between medical and non-medical domains, while the SimSiam self-supervised learning improved the performance. (II) Among tested architectures, InceptionV3 coupled with SimSiam pre-training offered the best performance for AD stage classification. (III) Cluster analysis with k-means successfully grouped the FDG-PET brain scans into clusters aligning with AD's clinical stages. These clusters, visualized through UMAP and analyzed with Grad-CAM, revealed the brain areas most associated with each AD stage, demonstrating the model's effectiveness in distinguishing stages and subtypes [Figure 2.].

Table 1. Model classification performance.

Model variations	Disease stage				Cognitive score			
	Loss	Accuracy	AU_ROC	AU_PRC	Loss	Accuracy	AU_ROC	AU_PRC
-/-	1.0126	0.5175	0.7735	0.6322	1.5083	0.6999	0.7723	0.4112
S/-	0.8973	0.6181	0.8061	0.6725	1.4007	0.7408	0.7849	0.4214
-/I	0.9839	0.5955	0.7772	0.6345	1.4280	0.7222	0.7718	0.4076
S/I	0.9676	0.5807	0.7903	0.6562	1.456	0.6927	0.7546	0.3932

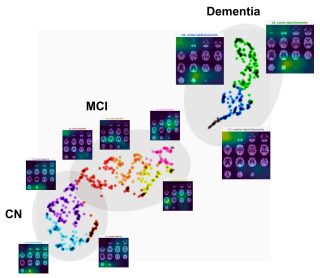

Figure 2. A UMAP visualization of 128-dimensional vectors with Grad-CAM visualization on the cluster-center FDG-PET samples.

5. Conclusions

A deep learning model that utilizes self-supervised learning techniques is developed for early detection and subtype identification of AD using FDG-PET. Experimental results demonstrate that the SimSiam self-supervised approach significantly enhances model accuracy, overcoming the challenges posed by the scarcity of annotated medical datasets. Furthermore, the disease subgroups could be identified based on neural activity and cognitive impairment levels. These findings show the model's capability in accurately distinguishing AD stages and subtypes, highlighting the potential of integrating self-supervised and supervised learning methods to advance diagnostic tools, offering promising avenues for future research and improved clinical diagnosis of AD.

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Effect of *Centella asiatica* extract on associative memory in *Caenorhabditis elegans*

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1. INTRODUCTION

Memory is the process of storing information. There is a study found that short-term memory can last only 30 seconds in humans. To find out whether associative memory can be extended, this study uses *Caenorhabditis elegans*, a small invertebrate which has simple nervous system and short lifespan, as a model for testing associative memory retention after treatment with *Centella asiatica* (CA). Additionally, *Centella asiatica* (CA), a local herb of Thailand, is known for its ability to be used in healing wounds, improving cognition, and treating anxiety in human. The result of this study may be useful for future research in human associative memory as the memory is crucial for every day life.

2. AIMS

The aim of this study is to examine the potential of *Centella asiatica* extract to retain associative memory in *Caenorhabditis elegans*.

3. METHODS AND MATERIALS

Centella asiatica Extraction and treatment

CA leave powder was submerged with 95% ethanol to 0.1 g/ml and placed in 50 °C bathtub for 24 hours. After that, it was concentrated in rotary evaporate and dissolved to 1 mg/ml with 2% DMSO. CA extract was dissolved with *E. coli* by 1:6 and seeded on NGM (Nematode growth medium) plate as a food resource for treated L1 *C. elegans* into adults stage.

Associative learning assay

5% 1-propanol was streaked in the lids of NGM plate. 0.1 mM of HCl is spread on NGM agar. Then, *C. elegans* were placed into learning assay plate closed with a streaked lid and waited for 10 minutes.

Chemotaxis assay

NGM plate, which was divided into quarters, is dropped with test attractant (5% 1-propanol or 0.1 mM of HCl) in diagonally opposite quarters and other with water (control solution). Then, *C. elegans* were placed into the center of plate and wait for 30 minutes. *C. elegans* in test and control quarters were counted and calculated with following equation.

$$\text{Chemotaxis index (C.I.)} = \frac{\text{Test} - \text{Control}}{\text{Total}} \quad (1)$$

$$\text{Learning index (L.I.)} = \text{C.I.}_{\text{positive control}} - \text{C.I.}_{\text{learned}} \quad (2)$$

Data analysis

The significance of differences in Chemotaxis index for each experimental group was evaluated by one-way ANOVA and Bonferroni post hoc test.

4. RESULTS

The results showed the significant differences between C.I. of 0 hour and 2 hours after learning in both control and CA treated *C. elegans* (from Figure 1). The C.I. value can imply the preferences of the *C. elegans*. In addition, Figure 2 showed the declining of L.I. in both control *C. elegans* and CA treated *C. elegans*. This means *C. elegans* has memory decline as time passes. However, the slope of the CA treated *C. elegans* was higher than the control which can indicate the positive effect of CA on memory retention of *C. elegans*.

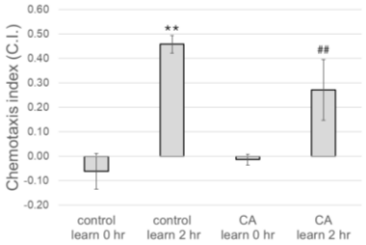

Figure 1. C.I. of control and CA treated *C. elegans* after 0 hr and 2 hr of associative learning assay. $^{**}p < 0.01$ compared with the control *C. elegans* 0 hr after learning and $^{\#\#}p < 0.01$ compared with the CA treated *C. elegans* 0 hr after learning

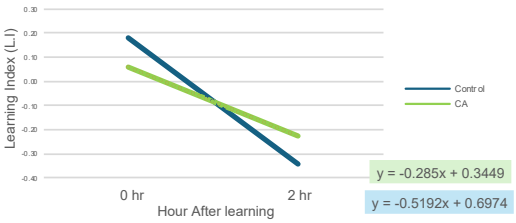

Figure 2. L.I. comparison between CA treated *C. elegans* and control *C. elegans*

5. DISCUSSION AND CONCLUSIONS

From the results, it can be concluded that CA ethanolic extract with concentration of 1 mg/ml solution in DMSO has the potential to retain associative memory in *C. elegans*.

6. ACKNOWLEDGEMENT

This study is financial supported by Kamnoetvidya Science Academy.

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Senior in Sync: Development and Study of an Application to Promote Learning and Social Opportunities in the Third Age, with a User-Centered Approach

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1. INTRODUCTION

In Guarulhos, São Paulo, Brazil, there are 178,723 elderly individuals [1], with a projected 56% increase by 2030, according to the United Nations [2].

Given this demographic shift, it is vital to develop strategies to promote a healthy aging, focusing on maintaining functional capacity for well-being in the third age [3].

Encouraging educational activities in later life improves brain function, reduces age-related risks [4], and shields against depression, anxiety, and loneliness [5]. Integrating these activities hold promises to promoting longevity with quality of life.

Likewise, as the elderly population grows, facilitating their use of technology is also crucial for enhancing their satisfaction and inclusivity.

2. AIMS

It is aimed to develop an accessible application for seniors, promoting both virtual and in-person learning and social activities, while also examining their significance in the elderly community.

3. METHODS AND MATERIALS

A literature review via Google Scholar established the foundation of the study, followed by a field research with fifty elderly volunteers in Guarulhos. After testing the application, participants completed two questionnaires: one to understand respondents' characteristics, and another to assess its usability, using the System Usability Scale (SUS) method.

4. RESULTS

98% of participants had a positive experience with the application, and 84% felt motivated to engage in social and educational activities afterward. The application also scored 75.8 on the SUS questionnaire, indicating a favorable assessment.

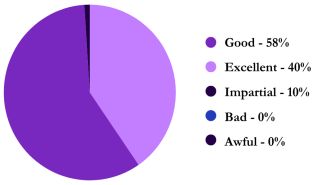

Figure 2. General experience with the application

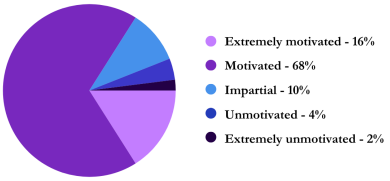

Figure 3. Motivation to participate in activities after using the application.

5. CONCLUSIONS

With the increasing elderly population and the widespread use of cell phones and applications, integrating these elements is crucial for promoting elderly inclusion. The proposed app, tailored for this purpose, shows promise for both in-person and virtual inclusion, and the promotion of health and well-being. The results indicate that the target audience approved the tool, acknowledging its accessibility and potential.

6. ACKNOWLEDGEMENT

To my parents João Oliveira and Maria Aparecida, my mentor João Armani, my advisor Marcia Pereira, my friends Juliana Oliveira, Rayssa Gondim and Kauan Pires, and every individual who contributed to my journey: I express my deepest gratitude.

And to myself, for never giving up.

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Impact of Blood Glucose Levels on Cortisol Reactivity in Social Stress Situations

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1. INTRODUCTION

The connection between blood glucose and cortisol in social stress is studied in psychoneuroendocrinology, emphasizing key terms: cortisol, glucose, and the HPA (Hypothalamic-Pituitary-Adrenal) axis—a crucial link between perceived stress and physiological reactions.

2. AIMS AND HYPOTHESES

Using available information, we conducted a pilot study to examine glucose's impact on cortisol reactivity. The study manipulated blood glucose levels in an experimental design. Two hypotheses were formed regarding the experimental intervention: 1. anticipating harm raises cortisol levels; 2. ample energy leads to HPA Axis negative feedback.

3. METHODS AND MATERIALS

The study itself had two steps: selecting the study lot, testing the participants, including collecting samples.

3.1. Selecting the Study Lot

We promoted the study with a school poster, receiving 23 applicants. Each student got a unique code for data privacy and an envelope with study materials: Preface of the Study, Informed Consent, Bio-Medical Questionnaire and STAI Questionnaire. Parental consent was obtained through Informed Consent, and the study, done in a certified lab, excluded participants with stress related medical conditions, hormonal treatments, or high anxiety scores (top 10% on STAI scale). The final group was N=8, with 4 men and 4 women, evenly distributed between GLUCO and CTRL groups.

3.2. Testing Procedure

For the testing, we gave the CTRL Group 400ml H2O and the GLUCO Group 400ml H2O with 100g of dissolved glucose. Acute stress was induced using the TSST (Trier Social Stress Test), involving a 5-minute job interview and 5-minute mental arithmetic. Samples were collected at four intervals: baseline, pre-stress, post-stress and rest. Glycemia levels were measured in mg/dL using a glucometer, and salivary cortisol was measured in µg/dL through the ELISA method. Participants received a set of rules (SoR) 24 hours before the test, and upon arrival at the lab, they completed a questionnaire about the rules. All tests were conducted individually.

4. RESULTS

Analyses were conducted in SPSS using three data sets: baseline, pre-stress, and post-stress. However, due to insufficient saliva secretion, data for one participant (F, CTRL) in S1 and S3 is undefined. Belonging to a certain group had a significant effect on glycemia ($F[1, 4] = 20.87$, $p = 0.010$). Group x Time interaction for glycemia also was significant ($F[2, 8] = 29.38$, $p < 0.001$), not at T1 ($t[6] = 0.19$, $p = 0.853$), but at T2 ($t[6] = 4.46$, $p = 0.004$) şi T3 ($t[6] = 5.03$, $p = 0.002$) **[Figure 1]**. Belonging to a certain group influenced the cortisol level as follows: ($F[1, 3] = 5.21$, $p = 0.107$), and time: ($F[2, 6] = 0.40$, $p = 0.684$). The interaction between group and time wasn't significant for cortisol ($F[2, 6] = 0.76$, $p = 0.506$) **[Figure 2].** We found a significant correlation between blood sugar and cortisol at T3 **[Table 1].**

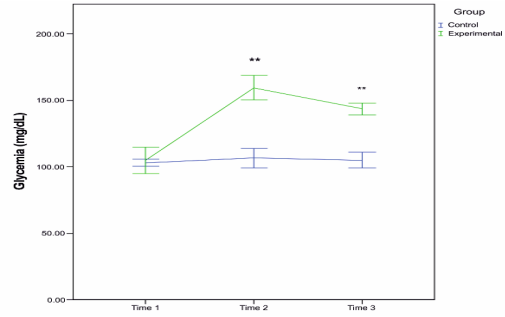

Figure 1. Glycemia x Time Graph

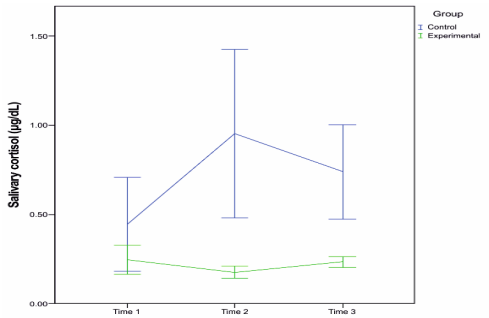

Figure 2. Cortisol x Time Graph

Table 1. Correlations between glycemia and cortisol

	Glycemia time 1	Glycemia time 2	Glycemia time 3	Cortisol time 1	Cortisol time 2	Cortisol time 3
Glycemia time 1		.01	.04	.35	.01	.11
Glycemia time 2			.85**	-.20	-.55	-.55
Glycemia time 3				-.55	-.58	-.82*
Cortisol time 1					.35	.74
Cortisol time 2						.81*
Cortisol time 3						

* $p < 0.05$; ** $p < 0.01$

5. DISCUSSION

Body mass and sex didn't significantly affect glycemia and cortisol levels. In the GLUCO group, higher glycemia and lower cortisol were noted, indicating interesting HPA axis feedback. Participants reported no secondary effects, and G*Power suggested a promising study size of 28 for future research.

6. CONCLUSIONS

The study concludes the procedure's efficiency for potential adaptation in a fully-powered study. Successful glycemia manipulation occurred in the GLUCO group, while a difference in the cortisol levels.

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Development Of A Nanobiotechnology-Based Controlled Drug Release System To Increase Therapeutic Effect In Neurological Diseases

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1. INTRODUCTION

Nanotechnology-based drug carrier and controlled release systems attract great attention due to their advantages such as nanosizes, controlled surface properties and high surface areas, long-term retention in the circulatory system, high bioavailability, and increased release of therapeutic active ingredients at a certain speed and duration. There is a need to develop nanobiotechnology-based drug delivery systems that will eliminate the side effects caused by the need for continuous and high dose drug delivery in the current drug delivery systems used in the clinic in neurological diseases, and provide long-term drug release with a single intake.

2. AIMS

Within the scope of the project, it was aimed to develop a nanopolymer-based controlled release system for the release of the model drug pregabalin, used in the treatment of neurological diseases, at the desired dose and duration. In accordance with this purpose,

✓ Synthesis of p(HEMA) nanopolymers and modification with Arginine by graft procedure,

✓ Characterization of the developed Arginine-g-p(HEMA) nanopolymer by Dry Mass Analysis, FTIR, SEM Measurements, Elemental Analysis Measurements, Surface area calculation,

✓ Optimization of pregabalin adsorption conditions of arginine-g-p(HEMA) nanopolymers,

✓ Loading pregabalin into Arginine-g-p(HEMA) nanopolymer under determined optimum conditions and performing controlled release studies,

✓ Determination of the biocompatibility of the developed nanopolymeric controlled release system by cytotoxicity analysis were performed.

3. METHODS AND MATERIALS

Within the scope of the project, Arginine-g-p(HEMA) nanopolymers for the controlled release of pregabalin, which is used in the treatment of neurological diseases selected as a model drug, were synthesized, characterized with advanced characterization methods, adsorption conditions were optimized and controlled release studies were carried out.

4. RESULTS

Considering the results, it was concluded that nanopolymers could reach 18383.4 mg/g adsorption capacity in just 30 minutes due to their high specific surface areas. It was determined that the developed Arginine-g-p(HEMA) nanopolymers released approximately 87% of the loaded pregabalin in a controlled and efficient manner within 60 minutes at physiological pH = 7.4.

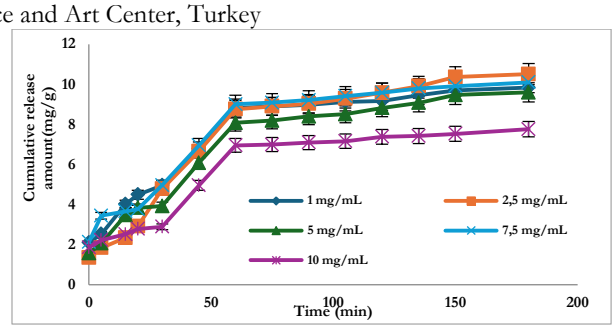

Figure 1. Controlled release of pregabalin with arginine-g-p(HEMA) nanopolymers (0.1 M pH 7.4 buffer solution, 37℃)

With cytotoxicity analysis, it was concluded that the cells to which different concentrations of Arginine-g-p(HEMA) nanopolymers were applied showed 97.02% viability compared to the control group, the nanopolymer did not have a toxic effect and supported cell growth.

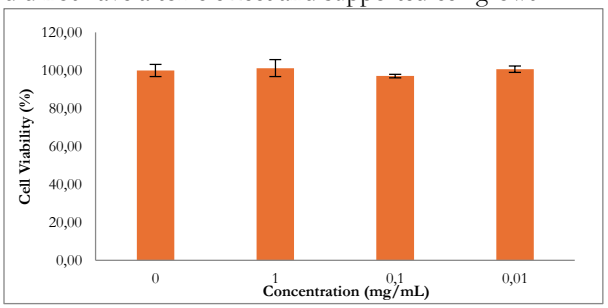

Figure 2. Cytotoxicity analysis of arginine-g-p(HEMA)

5. DISCUSSION

The nanobiotechnology-based controlled drug release system we have developed will lead to promising developments in terms of low cost, biocompatibility, easy preparation, being suitable for both oral and intravenous drug administration for drug release in effective dose and duration, supporting the therapeutic effect, and improving the quality of life of patients.

6. CONCLUSIONS

We believe that it will contribute to the scientific literature of nanobiotechnology and pharmacology.

7. ACKNOWLEDGEMENT

We would like to thank Buca Municipality Buca Science and Art Center and Ege University for enabling us to realize this project.

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Effect of Moisturizing Agents in Cosmetic Emulsions on their Physical Stability and Skin Parameters After Application

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1. Introduction

The project Effect of moisturizing agents in cosmetic emulsions on their physical stability and skin parameters after application deals with the influence of different moisturizing agents in cosmetic emulsions on their physical stability and on skin parameters after application of manufactured emulsions.

2. Aims

The aim of the work was to prepare individual emulsions with different hydrating agents in the same molar and mass concentration, to determine their physical stability and to determine the hydration effects of the produced emulsions.

3. Methods and materials

In the preparation of emulsions, the machines used were the RZR 2021 mixer and the ULTRATURRAX homogenizer for dispersion of the aqueous and oil phases. The physical stability of the emulsions was tested using a LUMiSizer to measure the sedimentation of dispersed particles and light transmission [1]. The method of corneometry was used to evaluate the hydration effect of the emulsions after their application. Samples of all six emulsions were applied to the forearms of 10 volunteers, and the hydration of the corner cells of the upper skin layer was analyzed at intervals of 1 h, 2 h, 3 h, 4 h, and 5 h after application.

Figure 1. Corneometer

4. Results

The measurement results showed that emulsion sample o/v 1, which did not contain any hydrating agent, was the most stable. On the other hand, the sample of emulsion o/v 5 containing hyaluronic acid was the least stable.

The highest moisturizing effect was achieved by the o/v 5 emulsion with HyActive moisturizing agent, namely 2.5%. The lowest moisturizing effect was measured for emulsion o/v 1, which was free of any moisturizing agent.

5. Discussion

The results of the physical stability measurements showed that the most stable emulsion was the emulsion without any hydrating agent, while the emulsion containing hyaluronic acid was the least stable of all tested samples. The average instability index was 0.0096. Thus, the chosen composition of the aqueous and oil phases of the emulsions contributed to the formation of stable cosmetic emulsions.

6. Conclusions

The work as a whole pointed out that the choice of a given hydrating agent and its concentration can significantly affect the physical stability of the emulsion. Consequently, it also influences the intensity of the moisturising effect on the skin. The formulation containing hyaluronic acid proved to be the most effective in terms of moisturising effects.

7. Acknowledgement

My deepest thanks to doc. Ing. Iveta Hrádková, Ph.D. for providing me with valuable information, for enabling me to carry out all the necessary laboratory work and for her great support. I would also like to thank Mrs. Hana Bendova, Ph.D., Head of the Centre of Toxicology and Health Safety, for her help in measuring skin parameters.

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Can Venous Thrombosis be Diagnosed by Anyone?

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1. INTRODUCTION

Compression ultrasonography (CUS) has recently gained prominence as a diagnostic method for the detection of venous thrombosis because it is easily accessible, affordable and rapid [1]. Nowadays, the technology is so advanced that an ultrasound probe can be connected to smartphones or tablets. This prompts contemplation on the possibility of ultrasound devices for self-examination or for use in emergency departments and developing countries. In addition, the CUS procedure relies on the subjective assessment of the pressure applied to the veins. Venous thrombosis is not diagnosed if the examiner can completely occlude the vein during the examination **[Figure 1a]**. Conversely, incomplete flattening of the vein, even if no clot is present, can lead to **a false-positive diagnosis [Figure 1b]** [2].

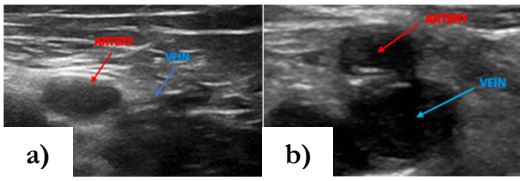

Figure 1. Compression Ultrasonograpy, a) No venous thrombosis, b) Venous thrombosis is present.

2. AIMS

The aim of this research is to improve the proper force application in the CUS procedure. The idea was to enhance the probe with a dynamometer and an integrated speaker. This modification would trigger an audible beep when the applied force reaches an optimal level at which the vein is fully closed. The beep provides feedback to the CUS examiner that he or she has closed the vein. Research shows that this upgrade improves the precision of the force application and therefore the accuracy of the diagnosis.

3. METHODS AND MATERIALS

We designed an experiment in which we compared the correctness of the procedure execution of two groups of non-professional examiners. The first group used a conventional ultrasound probe, while the second group used an upgraded probe with a dynamometer. It was previously calibrated to the force required to completely occlude the vein. Before the experiment, the examiners were familiarized with the correct use of the probe through a phantom model. Later, they performed a CUS procedure on the common femoral vein and artery in the groin area. The examiner with the conventional ultrasound probe was instructed to press hard enough to occlude the vessel, while the examiner with the dynamometer probe was instructed to press hard enough to hear a beep. Each examiner completed a questionnaire in which they rated the degree of opening of each vessel based on the maximum pressure applied or the beep.

4. RESULTS

The results show that 20% of examiners without a dynamometer stated that they had fully compressed the vein, while this percentage increased to 53% among examiners with a dynamometer. In addition, the chi-square test was conducted to determine whether the group with the dynamometer differed significantly from the group without the dynamometer in terms of correct answers. The chi-square test allowed us to state with 95% confidence that there was a significant difference between the results of the two groups.

5. DISCUSSION

Overall, the experiment proved that the dynamometer improves proper force application and increases the number of correct answers and not just by chance.

6. CONCLUSIONS

In our research, we focused on the problem of insufficient pressure applied on the veins during the CUS procedure, which can lead to a false positive diagnosis of venous thrombosis. Through our experiment, we demonstrated the effectiveness of an improved probe with a dynamometer that helps the examiner to apply enough pressure on the vein to ensure that no clot is present.

7. ACKNOWLEDGEMENT

The author acknowledges to mentors Polona Gros Remec (Bežigrad High School), Janez Urevc and Andrej Bergauer (University of Ljubljana, Faculty of Mechanical Engeneering).

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Regioselectivity by Cyclopalladation of m-substituted Acetanilids

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1. INTRODUCTION

The cycloaddition reaction of 3-substituted derivatives containing a directing group (DG) proceeds to two positions. The preferred position is most often the one that is less sterically shielded. It is reported in the literature that in the case of small substituents, such as fluorine, and derivatives containing a dimethyl directing group, it is observed that with some palladium compounds, palladation occurs to the position that is less sterically hindered. I wanted to verify this fact in the case of compounds with an acetamide directing group using 5-meta-substituted acetanilids.

2. AIMS

The aim of this work was to determine whether compounds with an acetamide directing group also palladate to a sterically less shielded position in the presence of palladium acetate. This was measured by spectroscopy using a nuclear magnetic resonance instrument.

3. METHODS AND MATERIALS

The method of chemical research in the laboratory was used. All substrates were prepared using acetic anhydride and aniline, except for 3-fluoroacetanilide, which was commercially produced, hence nuclear magnetic resonance spectroscopy was not measured. Because of the already established information that these substrates form dimers in cyclopalladation reactions, which could complicate the analysis of the results, pyridine was added to the substrates to cause their decomposition into mononuclear complexes that are easily measurable.

4. RESULTS

The shielded isomer could only be detected by NMR measurement of 3-cyanoacetanilide. For the other substances, the isomer could not be detected and the spectrum that should be seen was not visible. Both N-H hydrogen and 4 aromatic C-H hydrogen signals could be observed, the splitting of which follows a pattern typical of meta substitution. In the aliphatic signal region, there is a signal of the acetamide CH3 group and possibly other substituents. The yields of all reactions were measured to be around 50 percent.

	bs	s	d, J=8,0 Hz	m	s
H NMR	8,26	7,99	7,74	7,44-7,37	2,22

Table 1. Resulting values after nuclear magnetic resonance spectroscopy of 3-cyanoacetanilide

5. DISCUSSION

However, the analysis of NMR spectra has not yet yielded clear conclusions. It seems that the formation of the shielded isomer occurs only in the case of 3-cyanoacetanilide. For a more precise determination of the results, it would be necessary to perform the reactions on a larger scale and isolate the products. The potential possibility of the formation of a shielded isomer could be done for a larger number of small substituents. With nuclear resonance magnetic spectroscopy, more measured results could be analysed. Isolation of all the products to be measured would be helpful for more qualitative and clearer results.

6. CONCLUSIONS

According to NMR analysis, the formation of the shielded isomer appears to occur only in the case of 3-cyanoacetanilide, but due to the formation of many interfering dimers, it was not possible to have clear and accurate results from the other derivatives. Despite the negative and unclear result for all other derivatives, the work provides very important information, as cyclo-palladation reactions or substances are widely used in the production of countless pharmaceuticals including quite common drugs such as headache medications.

7. ACKNOWLEDGEMENT

Doc. Ing. Jiří Váňa Ph. D., University of Pardubice Ing. Klára Vydrová, First Private Language Grammar School, Hradec Králové

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Distribution and Relatedness of Czech Hydnoid Fungi

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1. INTRODUCTION

Hydnoid fungi, are a group of fungi with very characteristic teeth resembling fingers. They grow in mycorrhizal relationships with conifers, and are important ecological indicators.

Figure 1. *Sarcodon squamosus,* an example of hydnoid fungi.

Sanger sequencing is a modern scientific method, which is used to read DNA and RNA. This DNA sequencing technology digitalizes the DNA code, and is then read and further worked with.

2. AIMS

This project had three main goals. Firstly, to create quality sequences, and upload them to NCBI. Secondly, to study the relatedness of these fungi, and thirdly to find out and visualise the distribution of studied species.

3. METHODS AND MATERIALS

The process of obtaining the results of this project was divided into three main parts.

Firstly, samples were collected from various places in the Czech Republic.

Secondly, samples were cultivated, sequenced, checked, and made into consensus sequences by combining data from forward primers, and reverse primers.

Lastly, the refined data was uploaded to NCBI. Our sequences were made into a dataset from which a phylogenetic tree was made using PhyML. The sequences were used to obtain geographical data from Globalfungi, which was visualised in maps.

Figure 2. Sequenced data shown in a chromatogram.

Figure 3.

4. RESULTS

The results of this study are the sequences available on NCBI, the phylogenetic tree showcasing the relatedness of studied species, and the Maps, which visualise obtained geographical data.

Figure 4. World distribution of studied species.

5. DISCUSSION

All questions posed in the aims chater were answered, and thus the goals were fulfilled. When comparing this study to other works, the following was found. No previous mapping of the spread of hydnoid fungi had previously been done. The sequences created in this project are new, accessible, and ideal for future use, because their reference material is stored. The phylogenetic tree showcases the relatedness of studied fungi, an confirms the findings of Nitare et. al..

6. CONCLUSIONS

In conclusion, this project focused on the relatedness and spread of hydnoid fungi. It studied this with genome sequencing. The sequenced data were then visualised in maps and trees. The consensus sequences were then uploaded to NCBI for future use.

7. ACKNOWLEDGEMENTS

I thank my project leader RNDr. Michal Hruška for his advice, my consultant Doc. Mgr. Miroslav Kolařík Ph.D. and his colleagues for all their help. And finally, I want to express my gratitude to Mgr. Jan Holec Dr., and the other authors, for acknowledging my work and including me in their article as a co-author.

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Student's Microbial Load on the Way to School and at School

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1. INTRODUCTION

On a daily basis, we are faced with many surfaces of which many we touch without the knowledge of what microorganisms we are letting on our body. Understanding the importance of maintaining clean surfaces is crucial as these microbes can easily transfer from surfaces to hands and subsequently to the mouth, nose, or eyes, possibly leading to infections. Moreover, the prevalence of antimicrobial resistance adds another layer of concern, as it diminishes the effectiveness of conventional cleaning methods.

2. AIMS

The subject of this study was to measure the extent of microbial load on everyday surfaces with which a student comes into contact with and to analyse its composition.

3. METHODS AND MATERIALS

Swabs were conducted on the surfaces with a FLOQ® swab and then transported to the lab of Institute of Clinical Microbiology, Hradec Králové University Hospital. There the samples were inoculated on Blood agar (Oxoid®) for growth of all microorganisms, McConkey agar (Oxoid ®) which supports growth of gram-negative rods and Saboraud agar (Oxoid ®) supporting growth of moulds and yest. The inoculation was done by dropping several drops on said agars. Cultivation was conducted in a thermal box for 24 hours at 37°C. After cultivation a sample of each differently looking bacterial colony was removed and fed into MALDI-TOF mass spectrometer (Bruker ®). This machine identified the microbe. From some colonies were additionally conducted light microscopy and gram staining.

4. RESULTS

In total, I processed 74 samples in which I found 45 distinct species of bacteria, surprisingly no species of yeast or mould were found. Samples were carried out from the residence of two students, a wheeled mass transit vehicle, the premises of the First Private Language School and the men's toilets at the main train station. Bacteria were quantified (cfu/plate) after 24 hours culture. The resulting bacteria were then divided into non-pathogenic and potentially pathogenic. Ranging from harmless *Staphylococcus epidermidis* to a potentially pathogenic *Staphylococcus aureus*. Some surfaces were found to be contaminated with faecal bacteria and taps at sinks, for example, were identified as being at risk. Other surfaces were also contaminated with potentially pathogenic bacteria. The most contaminated areas were identified as jet hand dryers, where enterobacteria were present at a quantity of more than 50 cfu/plate.

Table 1. Most frequently found bacteria with a percentage representation out of 74 samples

Genus	Times identified	Percentage representation
Staphylococcus epidermidis	51	77,3%
Staphylococcus hominis	21	31,8%
Staphylococcus warneri	18	27,3%
Enterobacter hormaechei	10	15,2%
Bacillus cereus	8	12,1%
renamed *Bacilli*	8	12,1%
Micrococcus luteus	7	10,6%
Citrobacter freundii	6	9,1%

5. DISCUSSION

The results of this study yet new in their nature identified, similarly to the foreign literature, hand dryers as risky, which, especially with jet hand dryers, allow the spraying of these bacteria over a long distance. It was also interesting to find that significantly higher contamination was found in the hand dryers at the main station compared to compared to the dryers at the school [E. L. Best].

6. CONCLUSIONS

No bacteria found were identified as strictly pathogenic, only some were potentially pathogenic. Apart from the jet dryers in the toilets at the main train station, no surfaces were at risk as the quantity of potentially pathogenic bacteria found was relatively low. The results can be used to identify at-risk contamination and to improve the disinfection of these areas and possibly modify the hygiene standards in these areas.

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AN ANALYSIS OF SAGE INFUSED POLYMER NANOFIBERS AS A STERILE COATING

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1. Introduction

In recent years, the scientific community has increasingly focused on the environmental impact of packaging materials, particularly the pervasive use of non-biodegradable plastics, resulting into a concerted effort to identify sustainable, effective alternatives that mitigate spoilage and reduce waste. The antibiotic and antimicrobial properties of Sage, *Salvia officinalis*, a Mediterranean herb of the mint family *Lamiaceae*, long time recognized for its culinary and medicinal value, are garnering attention, making it a potential interesting solution.

2. Aims

The aim of this project was integrate sage's antibacterial capabilities into a decomposable polymer nanofiber and test its potential use and efficiency of as alimentary or healthcare coating, with the goal of finding a novel alternative for plastic packaging that is that is both environmentally friendly and effective against rot and mold.

3. Methods and Materials

To develop the coating I created a polymer based nanofiber from 2 non-toxic, water soluble and bio degradable polymers (Chitosan and Polyvinyl alcohol – PVA) and infused it with volatile oil, extracted from sage using a Clevenger Apparatus.

Figure 1 – Electro-spinning nanofabrication and result

As a main experiment, I wrapped samples of test fruits in the sage infused nanofiber and monitored them, together with a control group set, at room temperature and exposed to light testing preservation properties against rot and mold.

In parallel I went through several in-depth sets of tests and analysis to develop a more complete view of the material's characteristics and potential: thermo-gravimetric analysis, to evaluate the material's stability, and gas chromatography and antioxidant activity, to determine the active ingredients and their protection capabilities.

4. Results and Discussion

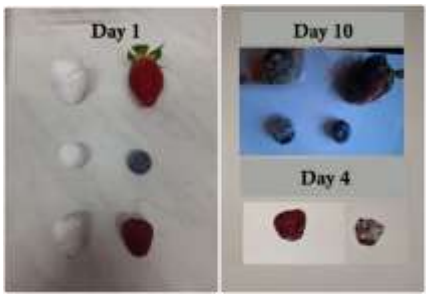

Figure 2 – Test and control fruits in Days 1, 4 and 10

Over a 10 days observation period the sage infused nanofibers have demonstrated a clear efficiency in protection against mold. The raspberry control sample was completely molded by Day 4, when the test one was un-coated for examination and proven free of mold; the test strawberry, although being also moldy in Day 10, lasted longer and was affected way less than the control strawberry, which started showing signs of black mold by Day 6 and was fully rotted by Day 10; Neither of the blueberries grew moldy, but the control blueberry wilted and lost 20% of the mass while the test blueberry remained very close to its original form.

The other tests also generated promising results, confirming sage's potential as protective coating active ingredient. The thermo-gravimetric analysis showed that nanofiber with sage oil is more durable and remains active for longer periods of time than both the oil and the nanofiber by themselves. Similarly, both sage oil and sage infused nanofiber have very high antioxidant activity, with the nanofiber performing slightly better. Chromatography identified sage oil's main components, cineole, camphor and beta pinene, all with recognized antioxidant and antimicrobial properties.

Table 1 – Antioxidant activity of sage oil and nanofiber

	1h	2h	20h	24h	48h
Sage oil	67.96%	72.26%	88.28%	90.62%	90.62%
Nanofiber	32.03%	47.65%	73.43%	78.51%	91.79%

5. Conclusions

Sage nanofiber acted as an efficient coating, protecting against mold and rot, proving applicability in the food industry. The coating's antibacterial and antimicrobial properties indicates also potential applications in healthcare, as a fast acting sterile bandage.

6. Acknowledgement

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Effects of Caffeine Consumption on Iron Absorption: Investigating Inhibitory Mechanisms and Implications for Nutrition

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1. INTRODUCTION

Plant-based diets including tea and coffee commonly consumed in India contain an abundance of phytates and polyphenols that limit the absorption of dietary nonheme iron by forming insoluble complexes (1). In India, 74% of children <5 years old and 52% of young women have anemia. Lower iron absorption could be a significant mechanism by which nutritional iron deficiency affects populations.

2. AIMS

The research aims to examine the iron content in supplements and the inhibitory effects of caffeinated drinks on iron absorption and assesses potential implications for nutritional health.

3. METHODS AND MATERIALS

a. Iron content in a supplement: Cofol-Z capsule by Cipla was dissolved in dilute sulfuric acid and titrated with $KMnO_4$.

b. Qualitative analysis:
   i. The study investigated the inhibitory effects of various beverages, including Nescafe classic coffee, lemon ginger tea powder, green tea, and Tata tea premium, on iron concentration. Beverage samples were mixed with iron and centrifuged to observe precipitates. Water samples were also tested for precipitates similarly.
   ii. Excess solid NH_4Cl and excess NH_4OH were added to dilute $FeCl_3$ solution to form precipitates, which were dissolved in dilute HCl. Potassium ferrocyanide was added to one part and potassium thiocyanate to the other. Both parts were mixed with separate tea samples.

c. Quantitative analysis:
   i. Tea samples were treated with Mohr's salt solution, and the leftover liquid after removing precipitates was titrated with $KMnO_4$.
   ii. Tea and coffee samples were each mixed with a standardized iron solution and the bioavailable iron was measured using a spectrophotometer.

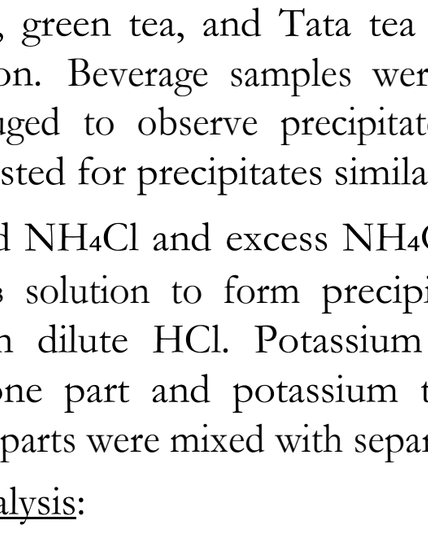

Figure 1. Titration setup

4. RESULTS

S. No.	Initial Reading ($\mathbf{10^{-6}}$ m^3)	Final Reading ($\mathbf{10^{-6}}$ m^3)	Amount used ($\mathbf{10^{-6}}$ m^3)
1.	35.9	36.3	0.4
2.	14.2	14.7	0.5
3.	14.9	15.5	0.6

Table 1. Titration readings of the iron sample with $KMnO_4$

$$\frac{No.\ of\ moles\ of\ KMnO_4}{No.\ of\ moles\ of\ Fe\ sample} = \frac{1}{5} \quad (1)$$

The analysis revealed discrepancies between the stated and observed iron content in an iron capsule, indicating a lower concentration of iron per capsule than claimed.

Different beverage samples exhibited varying levels of precipitates post-centrifugation, with coffee showing the highest and lemon ginger tea the least. Only tap water displayed minimal precipitates from the water samples, suggesting that the precipitation observed in tea/coffee solutions results in reduced iron concentration.

Tea samples exhibited fading colors upon the addition of Fe^{3+} solutions, indicating absorption of Fe^{3+} ions.

Further, the concentration of Mohr's salt solution was altered from 0.1 M to 0.04 M after precipitates from the tea samples were removed.

Initial Reading (10^{-6} m^3)	Final Reading (10^{-6} m^3)	Amount used (10^{-6} m^3)
15.6	17.2	1.6

Table 2. Titration readings of the tea samples with $KMnO_4$ after treatment with Mohr's salt solution

5. CONCLUSIONS

Tea and coffee both limit iron absorption. Prolonged consumption of caffeinated beverages with iron-rich meals leads to decreased iron intake. By spacing out your tea or coffee indulgence from iron intake, you can mitigate the inhibitory effects and ensure your body reaps the full nutritional benefits.

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