CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Catherine Anne C. Delgado

Project Number

J0501

Project Title

Does the Presence of Food in the Stomach Affect Iron Absorption Rate?

Abstract

Objectives/Goals

The objective of this study is to determine whether or not the presence of food in the stomach affects iron absorption (and iron absorption rate).

Methods/Materials

Three solutions: Distilled water (control), vinegar-water dilution (model for full stomach), vinegar (model for empty stomach). pH was tested to accurately model stomach environments. 30 trials conducted. For each trial, add two iron reagents (from LaMotte Company)and then ½ teaspoon of broccoli into 10 mL of each solution. Record time it took to reach 0.5, 1, and 2 parts per million (ppm) of iron.

Results

The amount of iron absorbed and how fast it was absorbed was dependent on the presence of food in the stomach(in this case, stomach environment models). The empty stomach solution resulted in the fastest iron absorption rate with a mean of 5 minutes for 0.5 ppm, 19 minutes for 1 ppm, and 33 minutes for 2 ppm. The full stomach solution had a mean of 12 minutes for 0.5 ppm, 57 minutes for 1 ppm, and 90 minutes for 2 ppm. The control had a mean of 14 minutes for 0.5 ppm, 70 minutes to reach 1 ppm, and 2 ppm was never reached.

Conclusions/Discussion

30 trials modeling different stomach environments revealed that the presence of food does affect iron absorption, because of the acidity of the solutions. In the literature review, it was found that gastric acids were shown to enhance iron absorption. Iron absorption is dependent on the stomach environments created by food.This information can be used for regulating iron absorption through your diet.

Summary Statement

By measuring iron absorption and iron absorption rate in different stomach environments, I found that iron absorption is dependent on the presence of food.

Help Received

I was inspired by an experiment published by science buddies and tweaked it for myself. I performed the experiments by myself but materials were collected from my science teacher, Karen Madsen and my family. I purchased iron reagents (powder and liquid) from LaMotte Company.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Jessie L. Gan

Project Number

J0502

Project Title

Natural Antioxidant and Nano-Antioxidant Effects against Oxidative Stress

Abstract

Objectives/Goals

The objective is to determine which natural and nano-antioxidant are the most efficacious in Saccharomyces cerevisiae against oxidative stress. The natural antioxidants studied were Catechins in Green Tea, Allicin in Garlic, Glutathione, and Vitamin C, and the nano-antioxidants were MitoQ, Carbon-60 (C60), and Gold Nanoparticles. I hypothesized that Green Tea is the best natural antioxidant due to its large resonance, and MitoQ is the best nano-antioxidant since it targets ROS at the mitochondria.

Methods/Materials

The antioxidants were tested in 5 concentrations against hydrogen peroxide-induced oxidative stress in yeast, (ranging from 1.56 to 25 mg/ml for natural antioxidants, and 0.03125 to 0.5 mg/ml for nano-antioxidants) and were compared with 3 controls of yeast only, yeast and antioxidant, and yeast with hydrogen peroxide. The yeast optical density for each solution was measured using a handheld colorimeter from Hanna Instruments, before and after a 24 hour incubation period. A total of 3 trials were conducted for each antioxidant, where each trial consisted of these 8 solutions, and 5 samples of each.

Results

The results showed that Green Tea and C60 were the most effective natural and nano-antioxidants, which counter oxidative stress at 3.125 mg/ml and 0.25 mg/ml respectively. The results also displayed pro-oxidative effects in other antioxidants.

Conclusions/Discussion

Green Tea was highly efficacious because of its large polyphenol resonant structure and ability to carry out hydrogen atom transfer to free radicals. C60 fullerene was competent due to its extremely stable 60 interlinked carbon atoms molecular structure and targeted ability to mitochondria. Hence C60 nano-antioxidant, if combined with Green Tea Catechin into a super-antioxidant, could prove to be a promising therapy for oxidative stress diseases.

Summary Statement

My project investigates the effects and efficacies of natural antioxidants and nano-antioxidants against oxidative stress in the model organism Saccharomyces cerevisiae.

Help Received

Dr. Eisen helped me with graphs and gave me advice on poster display, and my mom assisted with purchasing of materials and gave encouragements.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Emma X. Hernandez

Project Number
J0503

Project Title
Sucrose vs. Glucose

Abstract

Objectives/Goals
The objective of my study was to observe how Invertase changes the glucose concentration in foods when sucrose is present.

Methods/Materials
Tested the glucose concentrations using urinalysis test strips that measure low concentrations. Affected how to perform the rest of the procedure by creating 10% food dilutions to be able to observe the glucose concentrations. Testing the Invertase activity with a known amount of sucrose to have a linear time point for the experiment because of product inhibition.

Results
Results of the experiment were affected by the limit of the invertase converted only 5% of the foods' original sucrose concentration. Foods with the highest glucose and sucrose concentration did not correlate when compared, however the glucose concentration increase when sucrose was present after adding invertase.

Conclusions/Discussion
The data collected will provide more insight of the importance of monitoring what you eat and how it affects your body because of the rise of obesity rates especially in the US. Also to know there are multiple sugars and process differently inside our bodies.

Summary Statement
I investigated how an enzyme converts sucrose into glucose and how this changes the amount of glucose we digest from different foods.

Help Received
No help with the experiment itself, but I do want to acknowledge my math and science teacher, Dr. Ullman, for the further understanding of chemical properties and structures.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Sophia P. Hussman

Project Number
J0504

Project Title
Testing the Effect of Marinade Acidity on Beef

Abstract

Objectives/Goals
The objective of this study is to determine whether varying the level of acidity in a steak marinade will affect the tenderness of a boneless beef top sirloin cap steak.

Methods/Materials
Two marinades (one with 1/2 the amount of acid to oil and one with the same amount of acid to oil), pH probe, beef samples, Warner-Bratzler Shear Force Machine, and a 1/2 inch corer. The meat was marinated and cooked, then cored and placed in the Warner-Bratzler Shear Force Machine for testing. This machine replicates the bite force needed to bite through a piece of steak.

Results
Two marinated steaks and one control steak were cooked and then measured in the Warner-Bratzler Shear Force Machine. The steak marinated in more acid proved to be more tender, but the control steak was more tender than both the treated steaks.

Conclusions/Discussion
The steak marinated in more acid proved to be more tender indicating the helpfulness of acid in the marination process, ultimately giving the consumer a more enjoyable experience. Although the untreated steak was more tender than the treated steaks, the speculation is that each steak was possibly altered due to feeding history, environmental history, and enzymatic tenderization. Each steak was the same cut but most likely from different cows. It is concluded that the marinade containing more acid was more successful but natural factors affected the outcome of the experiment.

Summary Statement
I tested the effect of two marinades with different levels of acidity on meat by measuring it's tenderness using the Warner-Bratzler Shear Force Machine.

Help Received
I created two marinades with different acidity levels. I also marinated, prepared, and cooked the beef. Dr. Phil Bass from Certified Angus Beef Inc. educated and lent me the Warner-Bratzler Machine. Gavin Hertz from Newport Meat advised me and oversaw my use of the Warner-Bratzler Machine.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Elisha D. Johnston

Project Number

J0505

Project Title

The Molecular Mechanisms of Regenerating Cartilage to Reduce Chronic Pain: Phenol-Glucose-Glycerin Upregulates FGF-2

Abstract

Objectives/Goals

To study the molecular mechanisms of cartilage regeneration. Specifically, I am interested to model a medical treatment called prolotherapy, in which a physician injects a phenol, glucose, and glycerin compound (P2G) inside a joint to regenerate cartilage. Newly published and compelling clinical evidence demonstrates prolotherapy regenerates cartilage, so the medical research community is now very interested in figuring out the mechanism of action. My hypothesis is that P2G upregulates Fibroblast Growth Factor 2 (FGF-2) expression, leading to cell proliferation.

Methods/Materials

I use a preosteoblastic murine in vitro model capable of assessing regeneration rates. To gather experimental data, I utilize quantitate Reverse Transcriptase Polymerase Chain Reaction (qRT-PCR). I use Microsoft Excel 2013 to compute t-tests and consider a p-value less than 0.05 as statistically significant.

Results

As hypothesized, qRT-PCR reveals that P2G upregulates FGF-2 expression after treatment (hours 24, 30, and 38 [$p<0.05$]). I also find that Cyclin D1 is upregulated at hour 30 ($p<0.05$). Upregulation of Cyclin D1 is consistent with my hypothesis because Cyclin D1 is a proliferation gene downstream of FGF-2.

Conclusions/Discussion

These novel findings illuminate the molecular mechanisms by which phenol-glucose-glycerin (prolotherapy) regenerates cartilage (P2G upregulates FGF-2 expression which triggers cell proliferation). My study points to the engineering of a new clinical tool that assesses FGF-2 and additional proteins to indicate if prolotherapy treatment is regenerating cartilage.

Summary Statement

I investigated a cartilage regenerating treatment that has an unknown mechanism of action (Phenol-Glucose-Glycerin) and showed that the treatment upregulates FGF-2 expression.

Help Received

Dr. Cory Tobin enabled me to conduct cell culture and qRT-PCR in TheLab. Mr. Nam Che provided on-site coaching. Dr. Rajendra Gangalum, Becky Maxen, and Mike Hagen consulted on research design and interpretation of results.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Malachi D. Maguregui

Project Number

J0506

Project Title

How Does pH Affect Glucose Production When Lactase Is Added to Lactose?

Abstract

Objectives/Goals

The purpose of this project is to see if there is a way for people who are lactose intolerant to better digest milk with the help of lactase.

Methods/Materials

Pre-test your experiment to make sure that regardless of the amount of lactase added it creates the same amount of glucose. Measure #÷ of a cup of additive into 5 different cups. Test the pH of the additive and make sure it matches the pH known for the substance. Add #ö cup of milk to each of the cups. Test the pH of the milk and additive mixture. Test the glucose level to make sure that no glucose had been created by the additive. If the glucose result is a zero and the pH is at an appropriate level, add one crushed lactase tablet into every cup at the same time. Stir each glass once a minute for eight minutes. At the end of eight minutes, use glucose test strips to find the amount of glucose present in each of your 5 glasses of milk. Record and analyze data. Repeat this procedure with every additive: lemon juice, soda (Coke), tomato juice, black coffee, water, egg, baking soda, Milk Of Magnesia.

Results

The results are given as the amount of glucose in milligrams to a deciliter. Liquids with a pH of 2 had an average of 2800 mg/dL. Liquids with a pH of 3 had an average of 2560 mg/dL. Liquids with a pH of 4 had an average of 2200 mg/dL. Liquids with a pH of 5 had an average of 1870 mg/dL. Liquids with a pH of 6 had an average of 1500 mg/dL. Liquids with a pH of 7 had an average of 1200 mg/dL. Liquids with a pH of 8 had an average of 970 mg/dL. Liquids with a pH of 9 had an average of 272 mg/dL. Liquids with a pH of 10 had an average of 15 mg/dL.

Conclusions/Discussion

In the stomach and small intestines are lots of acids such as hydrochloric acid. Lactase works in your stomach and small intestines, but is not affected by the acids created in the stomach. In this experiment, when the milk¡#s pH was lowered, it created slightly more glucose because the acids boosted glucose production. Since acids are more commonly found in the stomach, we rarely find bases in our digestive system which reduce the production of glucose. Bases are often identified with pH¡#s above a 7, and as the results show, those liquids with pH¡#s above 7 show a drastic reduction in glucose production. In some cases, with the baking soda and Milk of Magnesia, they completely counteract the breaking down of lactose because they damage the enzyme lactase.

Summary Statement

By changing pH of milk and adding lactase, I was able to increase glucose levels in milk.

Help Received

none

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Clara Mangali

Project Number
J0507

Project Title
Comparing the Ethanol Yields of Plant-Derived Sugars

Abstract

Objectives/Goals
The objective of this study was to compare the amount of ethyl alcohol (ethanol) distilled from fermented solutions of granulated sugars derived from plants.

Methods/Materials
Equal amounts of granulated plant-derived (sugarcane, sugar beet, sugar maples) sugars, dried Brewer's yeast (Saccharomyces cerevisiae) microbes, rubber latex balloons, distilled water, gram scale, and a traditional distillation apparatus with ring stand were used in this experiment. Solutions containing water and each granulated sugar were fermented in a glass bottle with balloon as an airlock. The solutions were distilled to separate out the pure ethyl alcohol.

Results
The amount of ethyl alcohol distilled from each solution was compared. Trials were repeated to discover which one produced the largest average volume. The fermented solution containing granulated cane sugar proved to contain the largest average amount of ethyl alcohol as reflected in its average yield of distilled liquid ethyl alcohol.

Conclusions/Discussion
The varying amounts of ethyl alcohol distilled from each solution and the cane sugar containing solution as the producer of the overall largest average volume of ethyl alcohol prove that the best source of sugar for ethanol production is unrefined and rich in glucose. These findings can be applied in the commercial production of ethyl alcohol as a natural fuel and energy source.

Summary Statement
I distilled ethyl alcohol from fermented solutions containing granulated sugars derived from various plant sources and found the most unrefined, glucose rich to yield the largest volume.

Help Received
With approval and consultation from my science teacher, I designed and performed the experiment myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Anson F. Noland

Project Number

J0508

Project Title

Computational Local Alignment Search of Neurodegenerative Disease-Related Proteins

Abstract

Objectives/Goals

The purpose of this study was to find non-human organisms that carry similar proteins to those associated with Parkinsons Disease, Alzheimers Disease, Marfan Syndrome, frontotemporal dementia, and Variant Creutzfeldt-Jakob Disease (vCJD).

Methods/Materials

Laptop computer with access to internet databases. The OMIM(Online Mendelian Inheritance in Man) database was used to find the human protein that was associated with each disease, and the online NCBI GenBank database was used to find the sequence for each protein. The sequence was then run in the online SmartBLAST program, and the five best matches were recorded with their local extreme metrics.

Results

The organisms that carried the closest proteins to the human query were recorded and compared from the software. Phylogenetic trees were generated from the results to compare the relationships between the organisms and proteins. These results showed that for each human protein, the organisms with the best matches were mostly primates and mice, with close phylogenetic relationships to humans.

Conclusions/Discussion

The human proteins all had similar proteins that could be found in primates and mice. Further study of the phylogenetic trees revealed that these organisms had close evolutionary relationships to humans. Similarities in proteins of humans and primates provide a different facet for tracing the history of the expression of certain neurodegenerative diseases across organisms, as well as examining and determining evolutionary relationships between these organisms.

Summary Statement

I used online bioinformatics databases to gather information about human proteins that are related to certain neurodegenerative diseases and aligned them with similar proteins found in other species, the majority of which were primates.

Help Received

None. I created the procedure, completed the experiments, and analyzed the data by myself.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
Anushka Sanyal

Project Number
J0509

Project Title
Developing a Tool for Studying Alzheimer's: A Bacterial Expression Vector for the M3-M4 Fragment of the nAChR alpha-7

Abstract

Objectives/Goals
The purpose of the Bacterial Expression Vector containing the M3-M4 fragment of the Nicotinic Acetylcholine Receptor (nAChR) Alpha-7 is to study Alzheimer's disease. I hypothesize that Gprin-1 (G-protein Regulator of Induced Neurite Outgrowth 1), as a key component of neural growth cones (developing neurons throughout the brain), combined with this expression vector, can potentially allow for the faster development and re-growth of neurons possessing the alpha-7 receptor.

Methods/Materials
PCR Template: Plasmid including Human nAChR (pcDNA3.1-CHRNA7 Addgene), Primers: Home designed, PCR Kit: Taq Kit (NEB), DNA electrophoresis: Agarose gel, Ligation: plasmid pGEX-KG, Ligation Kit, Competent Bacteria/Media, Selection Plates, Growth and Extraction: Miniprep Kit

Using miniprep, plasmids were extracted from 1.2mL bacterial culture. The M3-M4 part of the nAChR alpha-7 plasmid was replicated using PCR and primers F3-F4. Thereafter, the empty expression vector was cut at a specific part to allow for the insertion of a specific piece of the nAChR alpha-7, during digestion. In ligation, the nAChR alpha-7 PCR product was placed into the empty plasmid. The ligation product was used to enable the E.coli to absorb the expression vector. Bacteria were tested in selection plates to ensure these have plasmid inside of them. Working plasmid was taken out of bacteria through miniprep. The existence of the M3-M4 loop in the expression vector was verified using PCR and PCR products were visualized in gel.

Results
1. Verified size and confirmed that bacterial cells contained expression vectors
2. Verified correct ligated fragment in the bacterial expression vector
3. Final Plasmids: Average purity for HB-101 = 1.65; Average purity for BL-21 = 1.62; Average ng/ul of HB-101 = 12.33, BL-21 = 21.26 (HB-101 and BL-21 are E. Coli strains)

Conclusions/Discussion
The nAChR alpha-7 M3-M4 Loop Bacterial Expression Vectors (pASNGST and pASCGST) met production goals of quantity and quality. The plasmids were visualized in agarose gel and the nanodrop machine provided quantity in ng/ul. The nanodrop machine also provided the A260/A280 ratio that confirmed high purity of the vectors with values close to 1.8. These Expression Vectors are available to produce and purify the protein segment and to test intracellular interactions of the receptor nAChR alpha-7, including the potential interaction between nAChR alpha-7 and Gprin-1.

Summary Statement
I developed a bacterial expression vector for the M3-M4 fragment of the nAChR alpha-7, to study Alzheimer's disease.

Help Received
I designed and built the expression vector by myself. I got help in understanding specifically why I was performing the protocol (why it would work) and how the expression vector would function from Dr. Sonia Cuellar, my mentor. I used Schmahl Science Workshop's labs to conduct my experiment.

CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

Charlotte L. Zhang

Project Number

J0510

Project Title

A Novel Gene Therapy Using CRIPR/Cas9 Mediated Cellular Reprogramming

Abstract

Objectives/Goals

Gene therapy shows great promise in treating many human diseases. However, one major drawback of the current technology is that it can only be directed to a particular mutation or a single gene at best. Retinitis pigmentosa (RP) is a major cause of blindness characterized by retinal rod photoreceptors degeneration. It can be caused by numerous mutations in many genes. My goal is to restore tissue architecture and visual function by switching a mutation-venerable/sensitive rod cell type to a mutation-insensitive/resistant cone cell type. This is accomplished by inactivating Nrl, a key gene controlling binary switch between rods and cones.

Methods/Materials

I designed AAV constructs to introduce CRISPR/Cas9 system into rod photoreceptor cells in the eye. I used PCR and immunohistochemistry to assess efficiency of gene editing.

Results

We show an increase in cone like cells with concomitant preservation of both cone and rod photoreceptors and visual function in a RP models by inactivation of NRL gene.

Conclusions/Discussion

Our approach shows promise of cellular reprogramming in preventing retinal degeneration and preserving vision, and points to a novel approach in treating human diseases in a gene and mutation independent manner.

Summary Statement

I used CRISPR/Cas9 mediated gene therapy to inactivate NRL gene in rod photoreceptors in the eye and achieved prevention of retinal degeneration and restoration of visual function.

Help Received

I designed and performed the in vitro gene editing assay, and helped with immunohistochemistry and with animal experiment design. I received guidance in project design from Dr. Xin Fu at UC San Diego.