My A-maiz-ing and S-wheat Adventures at CIMMYT

Maize and Wheat Science for Improved Livelihoods

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CIMMYT
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THE WORLD FOOD PRIZE

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About Me

I am a student at the Chicago High School for Agricultural Sciences in Chicago, Illinois. Before I attended this school, I didn't realize the importance of agriculture and the many opportunities it contains. However, my high school is not like any other. I knew that this may be the high school for me. I enrolled at CHSAS and was introduced to agriculture and the many areas of study it contains. I have taken agricultural courses including Agricultural Careers & Leadership, Agricultural Communications and Sales, a rotation course of my school's pathways, and Food Science & Technology which I am currently enrolled in. CHSAS introduced me to the National FFA Organization where I served the last four years as various officer positions, participated in many Career Development Events, volunteered for service projects, and went on many field trips. Over my past few summers, I have participated in fascinating agricultural programs and internships such as the Research Apprenticeship Program at the University of Illinois Urbana-Champaign and the USDA Ag Discovery Program at the University of the Virgin Islands.

Sophomore year, I was assigned to write a research paper for the World Food Prize. I researched and wrote my paper on climate volatility in Bangladesh, India. I identified the problems that relate to this issue and how it affects their food insecurity. My proposed solution was to implement storm water green infrastructures in their country to control the flooding and runoff waters brought on by the seasonal monsoons. I first presented my research at the Regional Youth Institute at the University of Wisconsin-Madison and then advanced to the Global Youth Institute at the World Food Prize in Des Moines, Iowa in October of 2016. While I was there, I met with many individuals who were passionate about fighting hunger. I was able to absorb information about food insecurity across the globe and how people are showing innovative leadership to combat it. In my junior year, I was chosen along with two other students from my high school to attend the annual Global Youth Institute Conference. While attending this conference, I learned about the Borlaug Ruan Internship program and made a decision to apply. I was fortunate enough to be selected and I was placed at the International Maize and Wheat Improvement Center in El Batan, Mexico. Because of my interest in food science, this was an amazing opportunity to work and study at the same place where Norman Borlaug has saved millions of lives at his center with his research to increase wheat yields therefore feeding more people. I was excited and grateful for this opportunity. I will always treasure the memories and remember my friends and colleagues who mentored me tremendously throughout this internship. Who honestly knew that a farm school in the South Side of Chicago will take me to Mexico and study maize and wheat quality at one of the top research centers in the world? Agriculture opened up a door of opportunities for a city person like me. Even though I may live a whole country apart from CIMMYT, I am grateful for what I learned and how I have grown as an agriculturalist. I sincerely appreciate the opportunity to serve as a World Food Prize Borlaug-Ruan International Intern so at the International Maize and Wheat Improvement Center.

Expectations

My school year was coming to an end and I knew I was getting closer to depart for my internship. I remember passing the Chicago O'Hare International Airport a few times too saying to myself: "Get ready! You'll be there soon!" Obviously, I had mixed emotions. I was excited because I knew I would be working in Mexico at one of the top research centers and was ready to explore a new field of agriculture. I was curious about learning about food insecurity in my world. I was nervous because I was going to a place I had never been to before, work with people I never met, and be involved in research at a level out of my comfort zone. However, there was no turning back. When I thought about it, there are people nervous as to whether or not they will have food to eat or if they will have the proper nutrition to survive. This meant I had no excuse not to face this challenge before me.

It was June 24th and it was time to go. I said my goodbyes and farewells to my friends and family. I arrived at Chicago O'Hare Airport and said my last good-byes to my parents then passed through security and walked to my gate. Anxiously, I waited to board the plane. The plane took off and I knew one thing: there's no turning back! I sat back and relaxed on the plane wondering what to expect. I landed in Mexico City, gathered my luggage, went through customs, and found my driver outside the gate. While sitting in the passenger seat of the car, I observed poverty right outside my window. I saw some wrecked buildings and homes, trash on the streets, people selling what they can to get money, and lots of stray dogs. This really opened my eyes to what I would experience the next two months.

I was excited when I finally arrived at CIMMYT. As we approached, endless green fields of wheat and maize welcomed us. Beyond the campus, beautiful mountains with forests and homes could be seen. I had seen pictures of CIMMYT in videos and on the website, but it was more beautiful than I imagined. I couldn't wait to explore the rest of the campus. This was quite a change of scenery for me compared to the city of Chicago where I come from. In Chicago, the land is flat and I am surrounded by buildings and concrete. The CIMMYT facility had several buildings spread out over its campus. There was a massive administration building that had a great, big letters "CIMMYT" on it, a Bioscience Laboratories building, greenhouses, and the residential dormitories. The driver dropped me off at apartment and I unpacked and set up my apartment. Later that evening, there was a pizza party where I was able to meet some CIMMYT staff, fellow research students, and mentors who I would be working with over the summer. Everybody was very friendly and I couldn't wait to start my work.

My First Day on the Job

On that Monday of June 21st, I had my very first day of work. I did not know exactly what to expect but I was anxious to get to work. I toured the bioscience laboratories for the very first time, met some more of the people there including my coworkers and mentors. First, I was given a tour of the laboratories and learned about the purpose of each one. We walked through the laboratories that I would be working in over the summer which included the maize chromatography lab, molecular biology labs, and the wheat quality laboratories. I was also excited to find out that I was given my own office area with a computer! It was almost overwhelming being introduced to so many people around CIMMYT. Lastly, I was given my research project and curriculum for the summer. My research project involved comparing the degradation of maize provitamin A carotenoids in two different types of maize with different particle sizes and whole grain versus degermed grains. My research goal was to determine which sample maintained the highest quantity of provitamin A over a period of time. In addition to my research project, I found out that I would be spending some time in the molecular biology department doing research with DNA in maize and I was going to spend a week in the Wheat Quality Department. We didn't waste any time and that day I began my research project by placing even amounts of seeds into small envelopes. At the end of the day, I felt more comfortable in my new work environment. I couldn't wait to see what was in store for the rest of my summer.

About CIMMYT

CIMMYT first started out as a pilot program in 1940, and was then sponsored by the Mexican Government in partnership with the Rockefeller Foundation. Its purpose was to raise farm productivity in Mexico. Norman Borlaug who was a wheat specialist at the time, worked with Mexican researchers and farmers to develop hardier, short-stemmed wheat varieties that resisted devastating rust diseases and yielded much more grain than traditional varieties. The new wheat lines were then bred and selected at various Mexican locations in a range of climate conditions meaning they were adaptable to a range of farm settings. The higher yielding varieties of wheat had helped Mexico attain self-sufficiency in wheat production in the 1950's. These varieties were then imported by countries such as India and Pakistan when they suffered from famine, bringing those countries record harvests. Due to the widespread adoption of improved varieties and farming practices developed, the "Green Revolution" had started. In 1966, CIMMYT was launched as an international organization. Norman Borlaug had then received the Nobel Peace Prize in 1970 due to his wheat research and leadership providing bread for the hungry world.

Maize Research

CIMMYT develops and deploys maize germplasm with high yield, stress resilience and nutritional quality for over 600 million maize-dependent people, including about 120 million malnourished children in Africa, Latin America and Asia.

The product development team focuses on developing germplasm with tolerance to drought, heat, poor soil fertility, waterlogging, acidity, diseases, insect-pests and parasitic weeds, in partnership with an array of public and private institutions. Trait pipeline work includes identification, validation and deployment of molecular markers for key traits, and implementation of marker-assisted recurrent selection and genomic selection for increasing genetic gains in tropical maize germplasm. The program also undertakes strategic research on doubled haploid technology for the tropics, for accelerated development of homozygous parental lines, and offers related development service to national agricultural research systems and small- and medium-enterprise seed companies.

This work plays a key role in facilitating the deployment of improved maize seed in the tropics, especially targeting women farmers and disadvantaged groups to maximize impact. Work includes identification of easy-to-produce, best-bet hybrids and improved open-pollinated varieties, seed production research and recommendations, promoting scale-up and delivery of new and promising products through seed company partners. (CIMMYT Global Maize Program. "Maize Research.")

CGIAR Research Program on Maize

"MAIZE" is a CGIAR Research Program (CRP) launched in 2012 by the CGIAR, a global partnership for a food secure future. CGIAR research is dedicated to reducing rural poverty, increasing food security, improving human health, nutrition, and ensuring more sustainable management of natural resources. It is carried out by 15 research centers, which are members of the CGIAR Consortium, in close collaboration with hundreds of partner organizations including national and regional research institutes, civil society organizations, academia and the private sector.

Led by CIMMYT, with the International Institute of Tropical Agriculture as its main CGIAR Consortium partner, MAIZE focuses on increasing maize production for the 900 million poor consumers in Africa, South Asia and Latin America for whom maize is a staple food.

MAIZE is an international collaboration involving more than 300 partners from the public and private sectors, national institutions, international research organizations and seed companies. This unique partnership seeks to mobilize global resources in maize research and development to achieve a greater strategic impact on maize-based farming systems in Africa, South Asia and Latin America. The overarching goal of the program is to double maize productivity, increase incomes and improve livelihood opportunities resulting from sustainable maize-based farming systems. (CIMMYT Global Maize Program. "CGIAR Research Program on Maize.")

My Role

Over the summer I had many roles during my stay at CIMMYT. I was a Scientist, a student, an ambassador and hunger fighter. I worked as a Maize Nutritional Quality Scientist. I was responsible for working on a research project related to the importance of high quality maize consumption. This will involve extracting carotenoids from maize, investigating the quantity and quality of DNA in maize, and expanding my knowledge on maize nutrition. As a student, I acquired knowledge of the importance of maize including how staple it is to the world. I learned about how to tackle food insecurity, especially malnutrition in our global society through STEM preparing as a young scientist. Furthermore, I was a CIMMYT ambassador who is responsible for spreading awareness of malnutrition and the importance of high-quality maize. Lastly, my most important role is to be a hunger-fighter knowing that many in our world today are hungry and malnourished. When I left CIMMYT, I felt more empowerment, strength, and pride in becoming a hunger fighter.

Introduction/Background

There are many issues when it comes to the food security in Mexico. One main concern of Mexican food security is nutrition. Much of the Mexican population is known to not have a healthy diet. Similar to areas in the United States, this is due to factors such as access to organic food, poverty, and taste influences. The challenge that we are faced with is how to make sure the food that is consumed contains the highest nutritional value. Unfortunately, many foods may lose its nutritional value due to its preparation processes and during the time it takes to get from the field to the consumer's table. Frequently fruits, vegetables, and grains may take several weeks to actually be consumed after harvest and often are subject to processes that accelerate this degradation process.

Maize is a cereal of ears that consist of either white, yellow or rust colored grains and is rich in starch which are attached to a cob protected by layers of fibrous leaves. Maize can be processed and consumed in different ways depending on the country. Two very popular maize products include maize flour and maize meal. Maize meal is made by granulating whole grains with a range of particle sizes from coarse to fine. Maize flour is obtained from milling the endosperm of the maize grain after the germ and outer layers are removed. These products substituted whole maize as important components in the diet in several parts of the world. As with all cereals, most micronutrients are concentrated in the outer layers of the grain; therefore removing these layers in the milling process results in the loss of most vitamins and minerals. Losses of these vitamins and minerals can be replaced through enrichment or fortification without affecting the quality or acceptability of foods made from maize flour or maize meal. Maize flour and maize meal are staple foods in many parts of the world, they can be considered for fortification programs. For example, in Zambia, over two-thirds of the daily energy intake comes from maize. In Central America, almost one-half of the daily energy intake comes from maize flour. In a number of other countries, maize flour or maize meal is between 10 and 30 percent of the daily intake.

Whole maize is a great source of thiamin, pyridoxine and phosphorus along with a fair source of riboflavin, niacin, folate, biotin, iron and zinc. However, many of these nutrients can be lost during grinding and milling processes. One micronutrient not present in significant amounts is Vitamin A. Deficiency of this vitamin is a leading cause of blindness and contributes to high rates of childhood mortality from infectious diseases as well. When a deficiency of Vitamin A is present during pregnancy, the outcome can be serious birth defects. β-Carotene is a plant compound that the body can convert to Vitamin A and is a common source of vitamin in the diet.

Vitamin A deficiency is a leading cause of blindness and contributes to high rates of childhood mortality from infectious diseases. Deficiency during pregnancy can cause serious birth defects. β-Carotene is a plant compound that the body can convert to vitamin A, and is a common source of this vitamin in the diet.

Fortification refers to the process of adding micronutrients to a certain food products after it lost micronutrients. The process of adding micronutrients to maize flour or maize meal and the selection of the dosifiers or feeders must be carefully considered. Losses during processing, storage and cooking should be calculated and taken into account when determining the level of micronutrients to be added.

There are many factors influence the stability of added vitamins and minerals during storage and preparation of maize flour or maize meal. Factors that relate to storage are: temperature, moisture content, the presence/absence of light, pH of the system, presence of oxygen, length of storage, and packaging. Vitamin A are unstable when exposed to air, light, and heat. One study showed that yellow maize flour retained all its vitamin B6, over 95% of vitamin A after six months at room temperature. Warm and humid storage conditions adversely affect the stability of micronutrients like Vitamin A. This factor must be considered, especially in warehouses and storage units are not climatically controlled. Despite the gradual loss of vitamin A during storage, its bioavailability from maize flour stored for three months at room temperature 40 C and 45 C, is above 95 percent, which is excellent. (Fortification Basis Maize Flour/Meal, USAID)

This research project will focus on the degredation of provitamin A carotenoids when exposed to different grinding and milling processes, presence of a seed germ, and periods of time between two different varieties of maize.

Abstract

Comparing the Stability of Maize Provitamin A Carotenoids in Whole vs. Degermed Grains with Different Milled Particle Sizes

What: Maize contains many essential nutrients including provitamin A carotenoids. These are the precursors of vitamin A, which are essential in the different systems of the human body and the prevention of diet-related chronic diseases. As time passes and as maize is physically damaged, vitamin A carotenoids are lost. Carotenoids are typically lost during grain or flour storage, food preparation, and industrial processing. It is important to preserve them for maize during maize processes in order to have a consumable and nutritious product. It is hypothesized that the smaller and finer the particle, and when there is absence of the germ, there will be a greater degradation of provitamin A carotenoids.

Why: This research solely focuses on the preservation of carotenoids which is essential for high-quality maize. However, these carotenoids are lost during post-harvest. Maize is a staple crop in the Latin American region and is used to make a variety of different food products. Vitamin A deficiency is common amongst preschool children and pregnant women too in third-world countries such as Zambia too. Physical influences is done to the food before consumption, so the degradation of provitamin A carotenoids occurs, preventing a nutritious diet for consumers. This research is important because it will help us understand the reasons for the loss of these essential vitamins and hopefully they help us prevent these losses. Ultimately the goal is to try to produce more nutritious and healthier foods.

How: In order to prove the given hypothesis, this experiment will involve two genotyped varieties of maize: one high in β-cryptoxanthin and the other one high in β-carotene. Specifically, there will be two genotypes, 4 particle sizes, and different storage times. For the genotypes, there will be two reps per genotype and 30 maize seeds per envelope. For the different particle sizes, there will be 2 blue mill and 2 clonic mill. The two storage times used are 4 weeks and 12 weeks. The data produced will be the degradation of carotenoids over a period of time. There will be a total of 44 samples that will be measured using a qPCR machine. The

copy number of CCD1 which is involved in carotenoid degradation will be determined as well. The experimental design and data will prove the hypothesis if more provitamin A carotenoids degrade over the given time periods when the maize samples are at the finest particle and degermed. The hypothesis will be disapproved if more carotenoids are degraded with larger particles and whole grains.

Results: In order to investigate the degradation and concentrations of β-cryptoxanthin β-carotene in the maize samples, an Ultra Performance Liquid Chromatography Machine will be used to measure vitamin content. For visualizing the data, graphs will be drawn including the degradation of the carotenoids. It will consist of the y-value of AU (Area under the curve) and the x-value will be time. The higher the area of curve, the the higher the concentration of carotenoids. Based on the graph, the degradation of the two carotenoids can be investigated with the different particle sizes of the maize.

Conclusion: It is very important to preserve the provitamin A carotenoids in maize to maintain its healthy quality. Even though maize is rich in these nutrients, impactful influences such as storage and food preservation, food preparation, and industrial processes can cause the carotenoids to degrade. It can be reasoned that the smaller the flour particle of the maize and when there is absence of a germ, the more carotenoids will degrade. Maize is a very staple crop and is used to make a variety of food products and many consumers depend on its nutritional value. This research can be repeated in order to obtain accurate, reliable, and more thorough data. For further understanding, more maize varieties, post-harvest preparation methods, and time periods can be implemented for more ideas.

Carotenoid Degradation Experiment

Objectives:

1. Compare the stability of provitamin A carotenoids in flour with different particle size
2. Compare the stability of provitamin A carotenoids in flour from whole grain and degermed grains

Materials:

- Two genotyped maize in provitamin A carotenoids: one is high in β-cryptoxanthin and the other one is high in β-carotene
- UPLC Machine
- Centrifuge
- Maize Grinder and Miller
- Test Tubes
- Knife (for degerming)
- Evaporator
- Hexane
- Scale
- Spreadsheets for Data

Methodology:

Carotenoids Analysis By Ultra Performance Liquid Chromatography (UPLC)

1. Sampling and Grinding Seeds (30 seeds)
2. Determination of Moisture (0.5g)
3. Weighing of Samples (0.6g)
4. Incubation (85 C/5, 10 min)
5. Centrifugation (3000 rpm/3 min)
6. Extraction (Hexane)
7. Evaporation (Nitrogen, 2 h)
8. Resuspension (1,2-Dichloroethane)
9. Injection (Run time 10 min)
10. Integration
11. Calculations and Report

Two Genotypes (2 reps per genotype, 30 seed per envelope)

Whole grain	De-germed

4 particle sizes (In addition, samples of whole grain and de-germed will be also stored)

2 blue mill	2 cyclonic mill

Storage

4 weeks	12 weeks*

Measure:

1. In whole kernel: Oil, structures.
2. In flour: particle size and microscopy
3. In flour: Carotenoids by UPLC, tocopherols, ORAC

Data: Whole Grain - Trial Averages

TIME 0, WHOLE GRAIN (8227)							
	LUT	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
G6	4.2485	10.3348	4.77118	1.38837	5.33878	1.68932	10.8021
G1	4.72864	11.4286	4.66163	1.56285	5.99114	1.92576	11.8106
CYC 1.0	5.22081	11.7348	4.61539	1.66929	5.89073	2.03904	11.9068
CYC 0.5	4.79294	10.6547	4.97756	1.6853	5.80178	2.04678	12.0226
TIME 1 (Week 4), WHOLE GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
G6	3.23435	7.52172	3.6462	1.0593	3.97381	1.5165	8.37271
G1	3.83356	9.27656	3.87513	1.2182	4.03046	1.62473	8.81096
CYC 1.0	4.26798	10.0383	4.32529	1.31258	4.31109	1.67997	9.46628
CYC 0.5	4.02232	8.93219	3.86224	1.29778	4.02619	1.74654	9.00163
TIME 1 (Week 4) % LOSS, WHOLE GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
G6	-23.87%	-27.22%	-23.58%	-23.70%	-25.57%	-10.23%	-22.49%
G1	-18.93%	-18.83%	-16.87%	-22.05%	-32.73%	-15.63%	-25.40%
CYC 1.0	-18.25%	-14.46%	-6.29%	-21.37%	-26.82%	-17.61%	-20.50%
CYC 0.5	-16.08%	-16.17%	-22.41%	-22.99%	-30.60%	-14.67%	-25.13%
TIME 2 (Week 12), WHOLE GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
G6	3.9665	8.9224	3.4646	0.9049	3.0132	1.6020	7.2524
G1	4.5977	10.3065	4.1473	1.0412	3.5262	1.7976	8.4387
CYC 1.0	4.6318	9.8325	3.9263	0.9983	3.3669	1.7720	8.1003
CYC 0.5	5.0182	10.5547	3.7175	0.9974	3.2797	1.7459	7.8818
TIME 2 (Week 12), % LOSS, WHOLE GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
G6	-6.64%	-13.67%	-27.38%	-34.82%	-43.56%	-5.17%	-32.86%
G1	-2.77%	-9.82%	-11.03%	-33.38%	-41.14%	-6.65%	-28.55%
CYC 1.0	-11.28%	-16.21%	-14.93%	-40.20%	-42.84%	-13.10%	-31.97%
CYC 0.5	4.70%	-0.94%	-25.32%	-40.81%	-43.47%	-14.70%	-34.44%

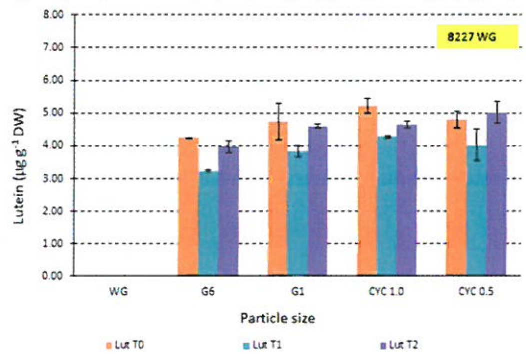
TIME 0, WHOLE GRAIN (8228)							
	LUT	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
G6	3.42526	9.89774	9.64984	0.78598	2.3321	0.97333	8.91633
G1	4.23629	11.7975	10.3051	0.90045	3.00115	1.04784	10.102
CYC 1.0	3.77865	10.4277	10.5966	0.89765	2.83498	1.04339	10.0743
CYC 0.5	4.49185	11.0426	10.8109	0.89492	2.70832	1.05187	10.0606
TIME 1 (Week 4), WHOLE GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
G6	2.61656	7.615	7.25251	0.61797	1.6923	0.75138	6.68791
G1	2.8512	8.38365	9.16558	0.7632	2.2747	0.92046	8.54115
CYC 1.0	3.61287	9.14392	9.04911	0.81722	2.42131	1.02638	8.78947
CYC 0.5	3.82317	9.16566	8.45775	0.84981	2.43793	1.05129	8.5679
TIME 1 (Week 4) % LOSS, WHOLE GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
G6	-23.61%	-23.06%	-24.84%	-21.37%	-27.43%	-22.80%	-24.99%
G1	-32.70%	-28.94%	-11.06%	-15.24%	-24.21%	-12.16%	-15.45%
CYC 1.0	-4.39%	-12.31%	-14.60%	-8.96%	-14.59%	-1.63%	-12.75%
CYC 0.5	-14.89%	-17.00%	-21.77%	-5.04%	-9.98%	-0.06%	-14.84%
TIME 2 (Week 12), WHOLE GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
G6	3.3613	8.5240	6.4901	0.6219	1.8789	0.9335	6.6794
G1	3.3409	8.4796	6.1434	0.6372	2.0038	0.9058	6.6185
CYC 1.0	3.7779	8.8844	7.3431	0.6793	2.0867	1.0355	7.4731
CYC 0.5	4.1532	9.9760	6.9406	0.6852	2.0571	1.0640	7.2766
TIME 2 (Week 12), % LOSS, WHOLE GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
G6	-1.87%	-13.88%	-32.74%	-20.88%	-19.43%	-4.10%	-25.09%
G1	-21.14%	-28.12%	-40.39%	-29.23%	-33.23%	-13.56%	-34.48%
CYC 1.0	-0.02%	-14.80%	-30.70%	-24.32%	-26.39%	-0.75%	-25.82%
CYC 0.5	-7.54%	-9.66%	-35.80%	-23.43%	-24.04%	1.15%	-27.67%

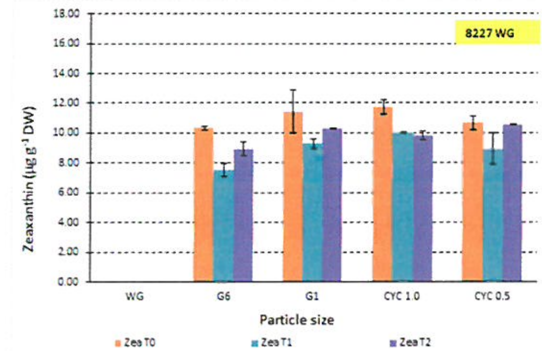
Data: De-Germed Grain

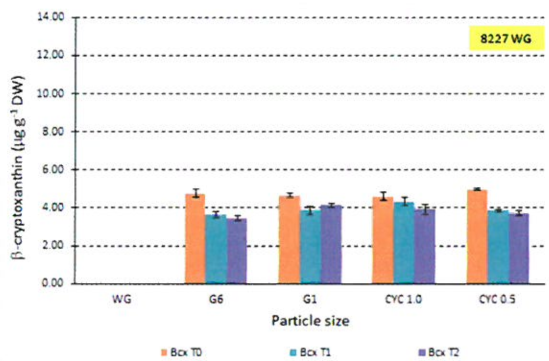
TIME 0, DE-GERMED GRAIN (8227)							
	LUT	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.39235	0.92803	0.4059	0.30672	0.46983	0.34278	1.32229
G6	4.98481	11.8824	4.61035	1.5103	5.61602	1.8415	11.273
G1	5.25774	12.692	4.79819	1.67713	6.67015	2.06911	12.8155
CYC 1.0	5.26997	12.3616	4.72376	1.59806	5.68731	1.94094	11.5882
CYC 0.5	5.0762	10.9213	3.97172	1.40391	4.69198	1.7415	9.82325
TIME 1 (Week 4), DE-GERMED GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.33292	0.73894	0.36007	0.24724	0.36041	0.2749	1.06259
G6	3.93955	9.78361	3.92411	1.0852	3.86186	1.47223	8.38135
G1	4.68977	10.8694	4.3199	1.25206	4.29582	1.70087	9.40869
CYC 1.0	5.94039	14.326	4.59507	1.36007	4.70707	1.8614	10.2261
CYC 0.5	6.1873	14.8882	4.7576	1.48046	4.83175	1.88161	10.5726
TIME 1 (Week 4), % LOSS,DE-GERMED GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	-15.15%	-20.37%	-11.29%	-19.39%	-23.29%	-19.80%	-19.64%
G6	-20.97%	-17.66%	-14.88%	-28.15%	-31.23%	-20.05%	-25.65%
G1	-10.80%	-14.36%	-9.97%	-25.35%	-35.60%	-17.80%	-26.58%
CYC 1.0	12.72%	15.89%	-2.72%	-14.89%	-17.24%	-4.10%	-11.75%
CYC 0.5	21.89%	36.32%	19.79%	5.45%	2.98%	8.05%	7.63%
TIME 2 (Week 12), DE-GERMED GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.15551	0.46854	0.24847	0.2345	0.29284	0.25448	0.9061
G6	4.64939	9.62413	3.58146	0.9275	3.10637	1.66466	7.4893
G1	5.01572	10.2905	4.02165	0.9451	3.34606	1.73629	8.03823
CYC 1.0	5.20278	10.7217	3.68866	0.9832	3.18908	1.76697	7.78361
CYC 0.5	4.73169	9.68596	3.62824	0.9457	3.19959	1.7506	7.71002
TIME 2 (Week 12), % LOSS,DE-GERMED GRAIN (8227)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	-60.36%	-49.51%	-38.79%	-23.53%	-37.67%	-25.76%	-31.47%
G6	-6.73%	-19.01%	-22.32%	-38.59%	-44.69%	-9.60%	-33.56%
G1	-4.60%	-18.92%	-16.18%	-43.65%	-49.84%	-16.08%	-37.28%
CYC 1.0	-1.27%	-13.27%	-21.91%	-38.47%	-43.93%	-8.96%	-32.83%
CYC 0.5	-6.79%	-11.31%	-8.65%	-32.64%	-31.81%	0.52%	-21.51%

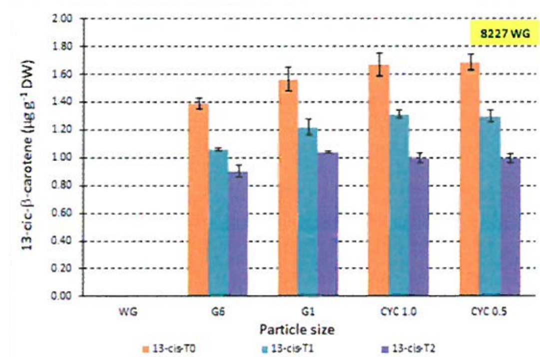
TIME 0, DE-GERMED GRAIN (8228)							
	LUT	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.44875	1.09933	0.62614	0.24473	0.40066	0.25307	1.21153
G6	4.16587	11.6123	10.1858	0.73265	2.41002	0.99042	9.22597
G1	4.84991	13.567	11.7515	1.03543	3.38424	1.1649	11.4603
CYC 1.0	4.3054	11.9074	11.0036	0.94996	3.17345	1.06775	10.693
CYC 0.5	4.56836	12.0262	10.4922	0.88684	2.48622	1.00466	9.62383
TIME 1 (Week 4), DE-GERMED GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.12675	0.37888	0.26017	0.20422	0.22596	0.20572	0.76598
G6	3.55759	9.25904	9.03913	0.72844	2.09232	0.86669	8.20701
G1	3.9849	10.4659	9.89334	0.7584	2.27663	0.98463	8.96633
CYC 1.0	5.4206	15.0847	10.4802	0.9244	2.77423	1.11337	10.0521
CYC 0.5	4.41105	11.6364	10.0312	0.81461	2.31622	0.98759	9.13403
TIME 1 (Week 4), % LOSS, DE-GERMED GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	-71.76%	-65.54%	-58.45%	-16.56%	-43.60%	-18.71%	-36.78%
G6	-14.60%	-20.27%	-11.26%	-0.57%	-13.18%	-12.49%	-11.04%
G1	-17.84%	-22.86%	-15.81%	-26.76%	-32.73%	-15.48%	-21.76%
CYC 1.0	25.90%	26.68%	-4.76%	-2.69%	-12.58%	4.27%	-5.99%
CYC 0.5	-3.44%	-3.24%	-4.39%	-8.14%	-6.84%	-1.70%	-5.09%
TIME 2 (Week 12), DE-GERMED GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	0.17259	0.4734	0.27551	0.23044	0.26149	0.23576	0.86546
G6	3.64856	9.0370	5.47802	0.57089	1.71491	0.86639	5.8912
G1	4.18776	10.5210	6.72125	0.68521	2.11129	1.06813	7.22526
CYC 1.0	4.3994	9.4903	8.62052	0.70199	2.22779	1.1014	8.34144
CYC 0.5	4.27024	9.1869	7.3444	0.6473	1.95624	1.04749	7.32322
TIME 2 (Week 12), % LOSS, DE-GERMED GRAIN (8228)							
	LUT1	ZEA	BCX	13-CIS-BC	BC	9-CIS-BC	PVA
WG	-61.54%	-56.94%	-56.00%	-5.84%	-34.73%	-6.84%	-28.56%
G6	-12.42%	-22.18%	-46.22%	-22.08%	-28.84%	-12.52%	-36.15%
G1	-13.65%	-22.45%	-42.81%	-33.82%	-37.61%	-8.31%	-36.95%
CYC 1.0	2.18%	-20.30%	-21.66%	-26.10%	-29.80%	3.15%	-21.99%
CYC 0.5	-6.53%	-23.61%	-30.00%	-27.01%	-21.32%	4.26%	-23.91%

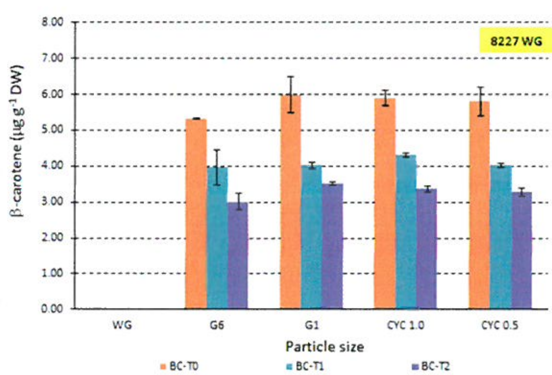
WHOLE GRAIN Sample 8227 (comparative of carotenoids at different particle sizes)

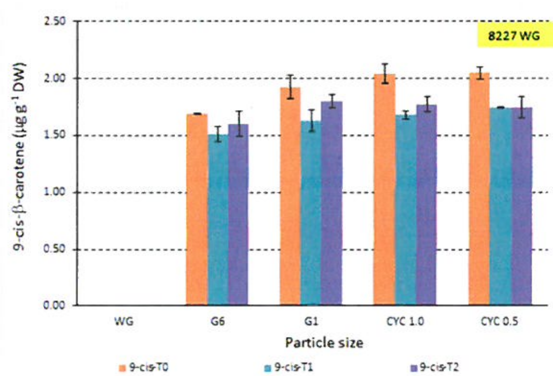




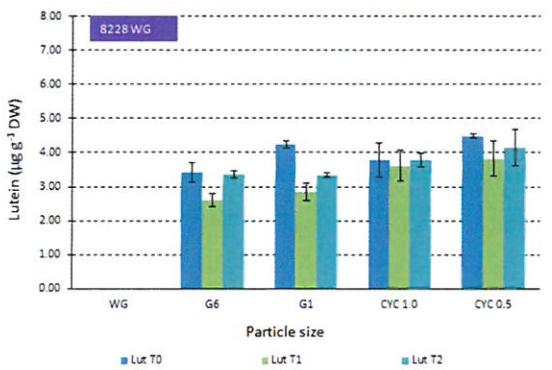


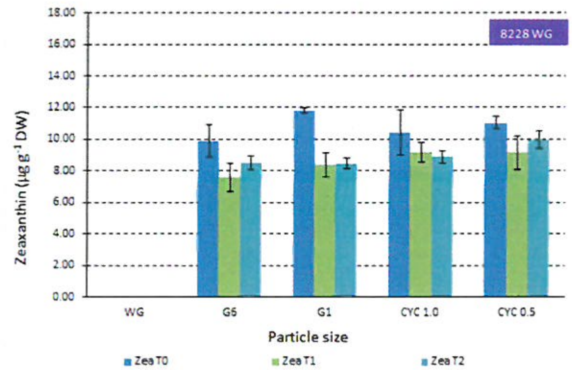


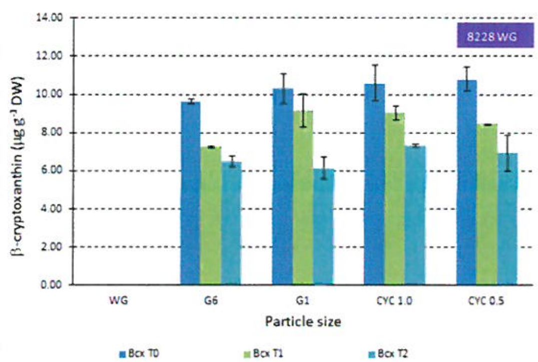


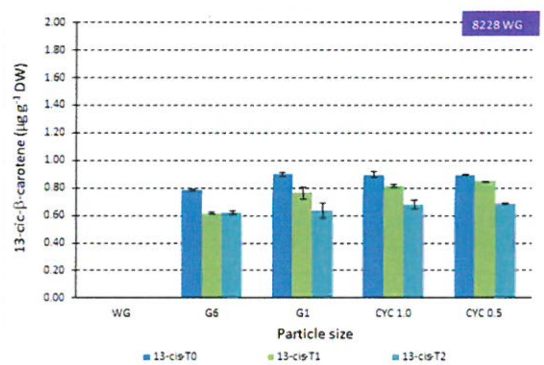


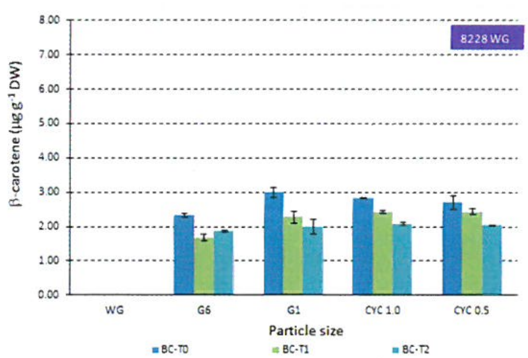
WHOLE GRAIN Sample 8228 (comparative of carotenoids at different particle sizes)

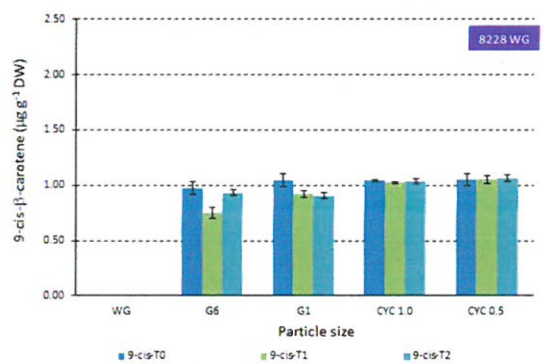




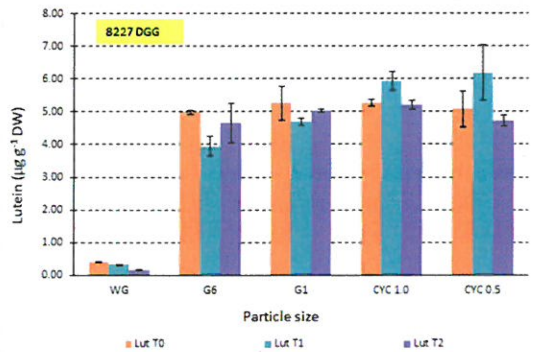


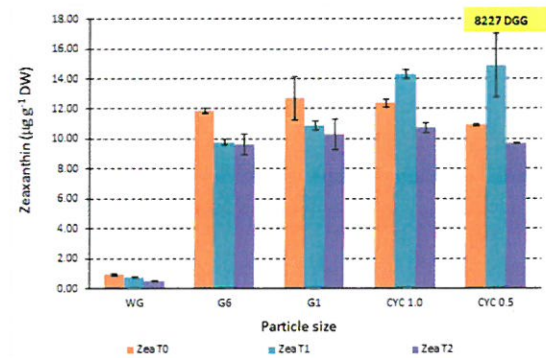


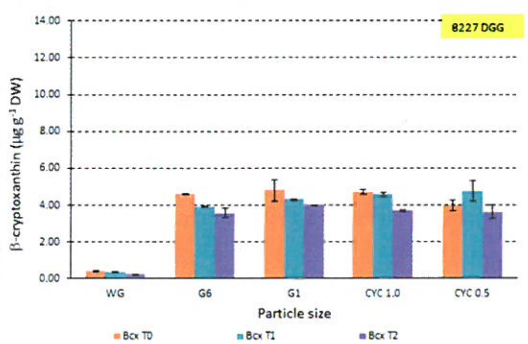


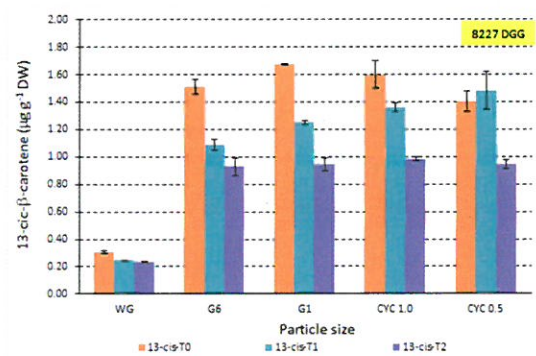


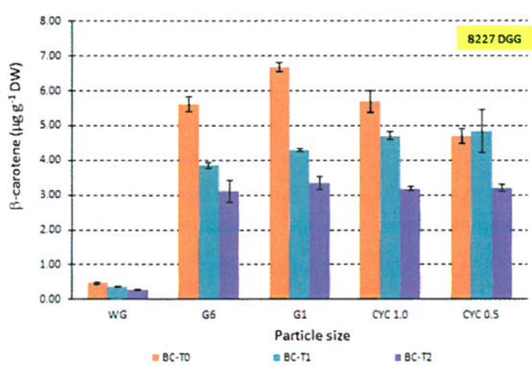
DE-GERMED GRAIN Sample 8227 (comparative of carotenoids at different particle sizes)

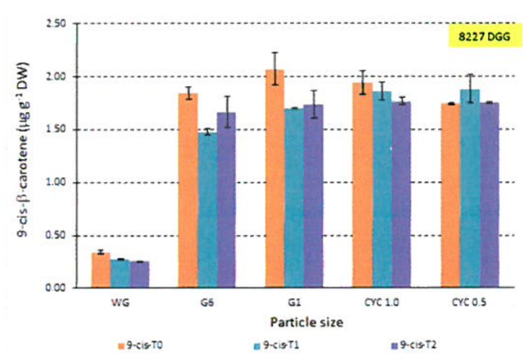




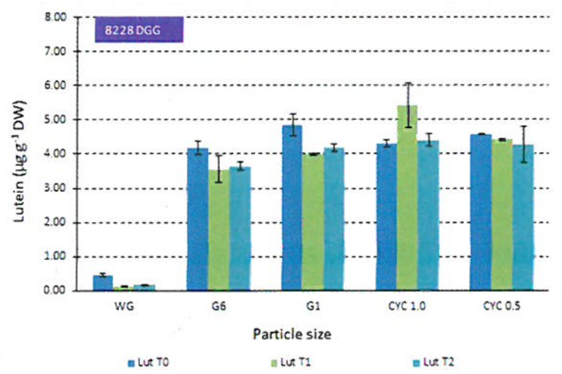


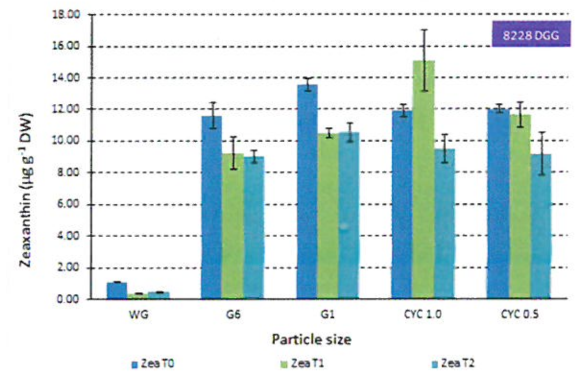


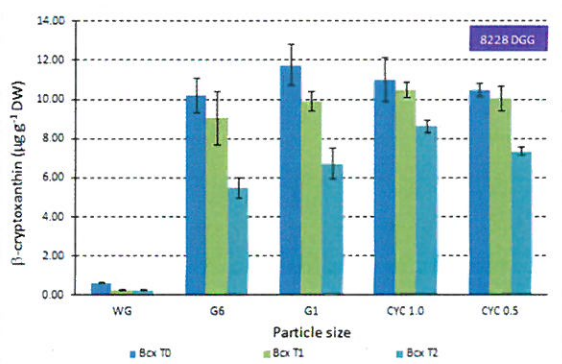


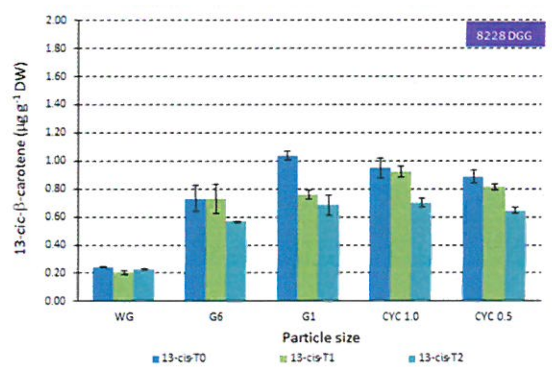


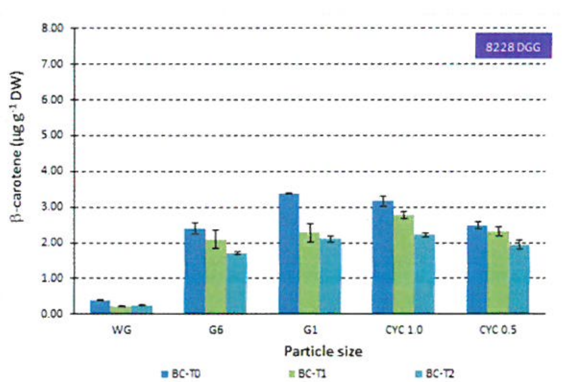
DE-GERMED GRAIN Sample 8228 (comparative of carotenoids at different particle sizes)

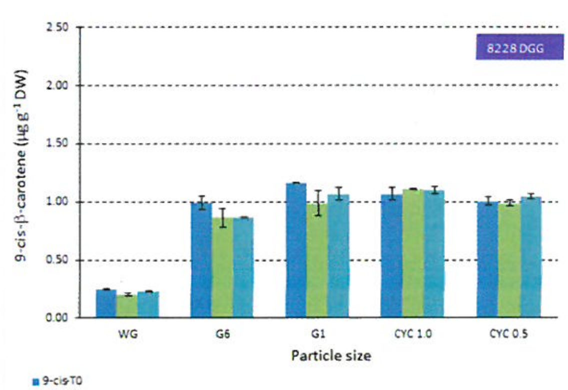












Discussion/Conclusion

This experiment examined the potential loss of provitamin A carotenoids in harvested, processed maize over a period of time. Two genotypes: one high in β-cryptoxanthin and the other one high in β-carotene, were chosen for testing. The methodology included a whole grain and a degermed sample of each genotype. Each sample was then divided and ground into four different particle sizes as well as original grain size. Provitamin A carotenoid measurements were recorded initially and after a 4-week time period. It was hypothesized that the smaller the particles and the absence of seed germ would mean a greater degradation of provitamin A carotenoids. According to our results, our hypothesis was proved to be incorrect. Compared to the whole grain, the degermed samples with the smallest particle size showed the lowest loss of provitamin A carotenoids of all tested samples. In fact, genotype degermed genotype (8227), particle size CYC 0.5 showed a gain of provitamin A carotenoids.

This research examined the provitamin A carotenoid loss in a variety of post-harvest processed maize over a period of time. This research is important because it will help us determine which maize genotype and processing methods will yield the highest nutritional product for consumption. This will help us reach our goal to produce healthier foods that contain the essential vitamins for the human diet. To expand on this research, it would be recommended to investigate a greater diversity of maize genotypes, a larger variety of particle sizes, and increased trials for each sample. In this experiment, only two different genotypes of corn were used. It is possible that using a greater assortment of genotypes, more favorable results may be achieved. Another variable that affected this experiment was particle size. Our results showed that the smaller the particle size, the less provitamin A carotenoid loss occurred. Future research should include even smaller particle sizes, for example, a particle size of cyclonic mill, mesh .25 mm. Furthermore, different methods of storage should be experimented with such as different temperatures, moisture levels, and packaging to evaluate the effect of vitamin loss.

After performing all of this research, I became even more open-minded to global food insecurity, especially malnutrition. I knew that maize is a staple crop that is packed with vitamins and minerals, but I was not as familiar with the loss of them when it comes to industrial processing. This project is one of the many factors that is sparking my fire of pursuing a career related to Food Science & Human Nutrition. During my internship, I listened to a symposium presentation from my mentor Dr. Natalia Palacios Rojas, and I absorbed in a lot more information about malnutrition. She mentioned about how people choose to purchase processed foods over whole foods due to many factors including price, convenience, and preference. I have made it a career goal to develop food products that have a high nutritional value, easily affordable, and convenient. (Palacios Rojas, N., Resource Poor Farmers and Households Value Chains August 2017)

Molecular Biology

During my internship, I was able to spend some time in the Molecular Biology Laboratories with Dr. Martha Hernandez of the Global Maize Program. Dr. Hernandez explained to me the importance of DNA research and how it affects maize quality and characteristics. She taught me laboratory skills such as pipetting with different pipettes, preparing agarose gels, preparing mixes for the DNA, and how to use a PCR (polymerase chain reaction machine). Together, we took DNA samples from various varieties of maize and investigated the quantity and the quality of the DNA. After I learned about how to do these various activities, I was able to work efficiently and do many things on my own. After all of the practice, I was able to perform many laboratory activities that relate to molecular biology. For instance, I was able to prepare an agarose gel with all the ingredients and prepare the dye which will be used for electrophoresis within the gel These are valuable skills which I can use in my future career path in the STEM sciences.

My Week in Wheat Quality

Even though I was an intern under Maize Quality, I had the opportunity to discover Wheat Quality Department of CIMMYT as well. This department deals with the quality of wheat grains to wheat flour to the main product of wheat: bread. I started out my week in the measuring and observing grain wheat quality. There I used many devices and machines that calculated the quality aspects of the wheat grains. I completed several activities including testing the moisture, hardness, protein content, and diameter of seeds. I also had the opportunity to produce actual flour from the grains, grinding and milling the seeds in order to prepare flour samples. Later on in the week, I worked with the dough of the bread and measured the toughness and other physical properties of it. In addition, we applied molecular biology to wheat as well by preparing gels for electrophoresis and testing the quality of DNA. At the end of the week, I had the opportunity to make bread using the flour samples from the wheat grains. This was my favorite part of the week because it dealt with Food Science, which is an area of which I want to study. First, we made the dough of the bread, proofed it for it to rise, baked it, and tested the bread for different aspects of quality. Some aspects tested were the mass of the bread, the volume, the appearance, color, and texture. I learned a lot about wheat quality and I was able to discover the other aspect of CIMMYT.




Growing as a Person

When I was about to go on this internship, I was nervous and didn't know what to expect. I was uneasy about the length of time I would be gone and feared that I would have a hard time measuring up to this challenge. I reassured myself by learning more about CIMMYT and the World Food Prize and the wonderful things that this organization achieves. It is a goal of mine that I too can be part of the solution to the challenge of providing food security to the global society. All over the world, there are people who struggle to feed themselves and their families on a daily basis. My internship at CIMMYT has helped me begin to realize my goal by allowing me to explore the relationship of the importance of food nutrition value and its preservation from field to table.

During my stay in Mexico, I was able to observe both the extreme wealth and the extreme poverty that existed side by side. I visited malls with high end stores and restaurants but also saw the poverty of the slums and backstreets. The poor class lived in homemade shacks and begged for money or food on the streets. Clearly, these people were hungry and lived in uncertainty where their next meal would come from. It was heart-breaking to see people live like this.

It is estimated that in the year 2050 that the population will rise to 9 billion people. As population rises, so will the need for more food to feed the masses. It's concerning that today we already have people that wake up each day and are uncertain as to whether they will have enough to eat. We need to increase our efforts to resolve the problem of world hunger today and prepare to conquer food insecurity in the future. The solution will include scientific research in food production, food processing, and food storage. Leadership will also be an important key to organize and lead these efforts. My World Food Prize Internship has further inspired me to be part of this solution.

I feel I have grown because of my experiences here at CIMMYT. My internship has opened my eyes to the hard work that goes into solving the food insecurity crisis. Many dedicated people are working to improve food security and raise awareness. I believe that if we work together, we can tackle food insecurity and feed the world. I know that I can make a difference and contribute. The World Food Prize has just paved the road to another future global hunger fighter!

Highlights of the Journey

I have made so many treasured memories on this journey and there are so many things I will miss. The Mexican culture was so neat to experience along with the beautiful landscape and the wonderful friends I have made.

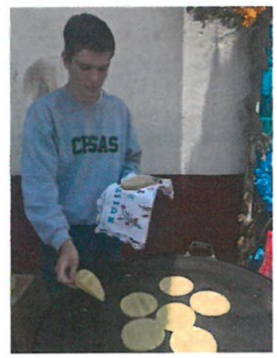
My one favorite part of Mexico was the food. Mexican food is honestly one of my favorite foods and I was grateful that I had the opportunity to try Mexican food at its authentic finest. One of the foods I will miss is street tacos. They were so good because the meat was so tasty and taken right off the grill onto a tortilla. There was even delicious salsas available to put on them. In addition, I will miss the chile, lime, and the variety of salsas that were available to put on Mexican food. Whenever it came to eating the food at the cafeteria or eating at a restaurant, I always put some sort of condiment on the food. Also to mention, I am a fan of spicy food so I enjoyed the food. Even though my mouth may have been on fire from the spice, I was living the life. The cheap packaged snacks available in Mexico are something I will always miss as well including the different cookies, chips, and candy that was available.

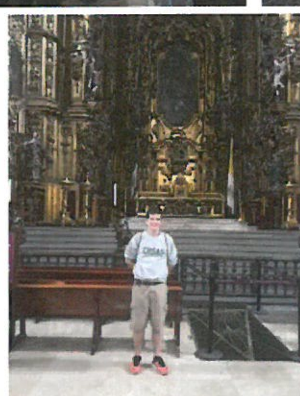
I will miss the green landscape and wonderful climate of Mexico. I could look out my bedroom window and gaze out at a background of mountains, unlike my bedroom at home. They were so beautiful and looked so breath-taking when seeing them in the sunlight and seeing them layered beyond each other in the morning fog. I will miss the beautiful trees and lush plants that grew there. The tall palm trees and conifer trees that had pinecones the size of a football was so neat to see. I will miss the vast fields of wheat and corn that surrounded CIMMYT and reminded me why I was here. I will remember the beautiful sunrise and orange sky as sunset came each day. El Batan, Mexico is a wonderful place and I hope to return there someday soon.

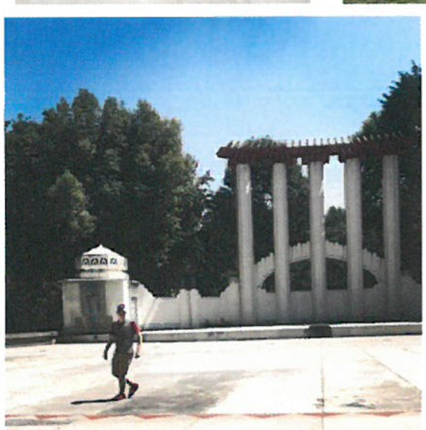
The best memories of my internship include all the wonderful people that I met. I have made so many friends at CIMMYT and it felt like it was my second home there. Whenever I walked down the halls of my laboratory building everyone would give me an "Hola" and a smile or even a peace sign even if I didn't know the person. I was also referred to as "amigo" sometimes. I made so many friends in the laboratories and grew close with many and I felt like part of a community. Every morning, my coworkers and I would have breakfast together and have a cup of coffee. In addition, we would eat lunch together at the comidor. Even though I may be a country apart, I am truly grateful for the many special and treasured connections.

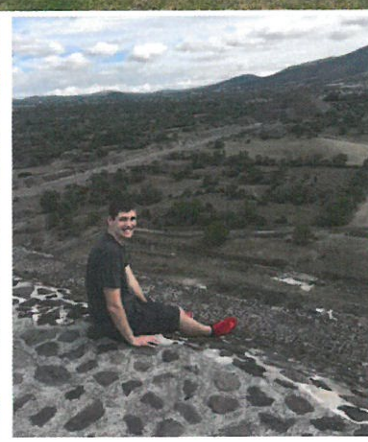
Another benefit of my internship was I was able to practice my Spanish. True story: I have been studying French for a very long time, grades 1-8 specifically. At my high school, I knew I would have to make the choice between taking French or Spanish for my junior and senior year. Obviously, my heart was set on French. However, at an all sophomore meeting, it was announced that the French program was cut. This meant that I was guaranteed to take Spanish. In Spanish class, I was taught many useful concepts. This included Spanish greetings, verbs, adjectives, objects, and many other things. Everything I was taught in this class had greatly helped me here in Mexico. For instance, when I go shopping, talking to my coworkers, or eating at a restaurant. Being immersed in the Spanish language, I expanded my vocabulary quickly. Like my mom says: "Everything happens for a reason, just trust!"

Pictures from my Journey









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