

Peru: A Synopsis of my Internship at the International Potato Center in Lima, Peru

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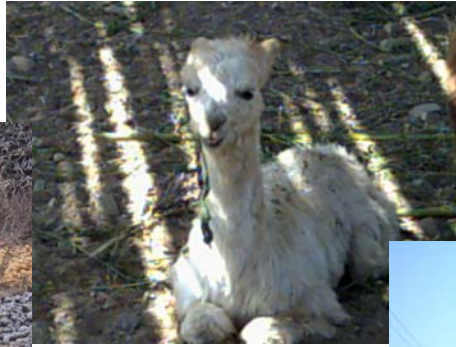


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Looking back on my summer internship is a feat in itself. I know that this opportunity would never have been possible if it hadn't been for the hard work and spirit of so many great people I know.

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I sit in the quality lab, peeling potatoes; Dave Matthew's Band plays on the computer for the lab workers and me. As I work, I listen to snatches of conversation in Spanish and the occasional bursts of laughter. Every once in awhile I chime in with a bit of my own humor or answer a question. I look out the window and see the visiting staff from China eating lunch in the courtyard. As I turn back to my work I smile to myself; I am a Pakistani-American in a Peruvian quality lab that devotes its research to potatoes and sweet potatoes. "That's ridiculous!" people say when I tell them what I did over the summer of 2005. However, interning at the International Potato Center in La Molina and living in Lima, Peru were some of the most practical, interesting, and enlightening days I have ever experienced

Introduction

History of the World Food Prize and the Internship

As a teenager quickly approaching adulthood, I found myself being underestimated by my peers and family. Often most people think of youth as a lack of responsibility, and it is viewed as a precursor to some inevitable disasters that young people find themselves in sometimes. With these feelings in mind, I finally received the confirmation that I had been selected as a Borlaug~Ruan (BR) intern. I was ecstatic at the thought of traveling abroad and devoting my summer to research. This type of altruism, something new to me, was a pivotal event that broadened my sense of the international community and increased my awareness of various scientific projects in progress around the globe. In addition, it was a major stepping-stone for my transition into adulthood and to it, I credit the development of a sense of direction in my future aspirations.

I owe my opportunity to intern partly to my older sister, Aysha Chowdhry. Aysha is a previous BR intern who worked at the M.S. Swaminathan Research Institute in Madras, India in 1999. Her interest in the World Food Prize (WFP) sparked an interest of my own, one that lingered for years, until high school when I was old enough to attend the youth symposium and learn more about the WFP.

Every year, during the month of October, the WFP gives Iowa high school students the chance to talk and interact with Nobel and World Food Prize Laureates and gain valuable knowledge from experts in facilities and organizations relating to food security. Through this three-day all expenses-paid opportunity Iowa youth are exposed to the different careers in the food, agriculture, and natural resource fields. Through the

Youth Institute, participating students learn about the importance of food production and security and all the nuances concerning cooperation among nations that are necessary in attempting to adequately feed the world.

During the three-day excursion, attending students are required to prepare discussion papers pertaining to a certain topic, which is designated by the WFP each year. These papers are then presented to a panel of World Food Prize Council of Advisors and Laureates - individuals who are educated in many food and agricultural disciplines.

As a prospective attendee of the 2003 World Food Prize Symposium and Youth Institute, I had a vague understanding of the far-reaching efforts of the WFP thanks to my sister's interactions with the foundation. As I started to prepare my paper for the institute and through my research of the WFP, I finally began to see the magnitude of the work being conducted. "The World Food Prize focuses attention on providing the world with a sustainable, secure food supply" (The World Food Prize). This statement is monumental, and for me a life-changing notion that is only the surface of an issue that has existed since the beginning of civilization.

When symposium week arrived, I traveled to Des Moines and spent three enlightening days learning and listening. To see that such enormous achievements could be based in Iowa gave me new assurance that anything was possible, even in the Midwest. When I gave my own presentation to a formidable panel that included Dr. Norman Borlaug, I was slightly nervous but proud that I was able to develop solutions, though probably naïve at the time, to problems plaguing food security. I discussed the paper that I had written with Dr. Borlaug, keeping in mind that he had been awarded the Nobel Peace Prize in 1970 for his isolation of genetic material that developed a strain of

wheat, which produced so abundantly that it became the foundation of the “green revolution.” Dr. Borlaug discussed the structure of my paper and my solutions and gave me critical but positive advice to enhance my research. I will never forget that discussion. I listened in awe to the tales of summer interns and their completed works in their host countries. The WFP foundation’s internship gives students the opportunity to become involved in research projects with world-renowned researchers while getting a first-hand view of food security issues and nutritional problems in poverty-stricken areas. I knew that I wanted to participate in this internship and, after applying for the position and sitting through an interview, in the spring of 2005 I was notified of my internship at the International Potato Center (CIP) in Lima, Peru.

History of Peru

After I had learned of my placement at CIP, much time during my last year of high school was devoted to research of Peru and its history. Through my informational searches on Peru, I came to learn the basics of the country. The most apparent facts about Peru are its basis as the setting of early civilization. With a vast area stretching



1,285,215 sq km all kinds of life flourished. Most notably, the Incan Empire, made up of a warlike tribe, lived in the southern mountains of Peru. From 1100 to 1300, they moved into the Cuzco Valley and managed to overrun the neighboring lands. By 1500, the empire stretched from the Pacific Ocean to the sources of the Paraguay and Amazon rivers and from the region of modern Quito in Ecuador south to the Maule River in Chile. This empire was a theocracy, organized along socialistic lines and ruled by emperor who

was seen as a religious authority. Because the geographical Incan scope contained extensive deposits of gold and silver, it became the attraction of Spanish imperial ambitions in the Americas in the early 16th century.

The Incan Empire thrived; however, it was not resistant to dissent within the ranks of authority. When, in 1532, Francisco Pizarro landed in Peru with 180 men it would be an understatement to say he arrived at a good time. The conquest was met with favorable conditions as the empire had just concluded a civil war between the heirs to the Incan throne. This internal struggle, in addition to the fear inspired by the unfamiliar Spanish guns and horses, made it easy for so few Spaniards to conquer the vast empire.

Although the Spanish conquered the Incas, they did little to maintain the flourishing society. Many of the irrigation projects and the north-south roads that had connected the empire were destroyed which added to the empire's disintegration; by 1533, Cuzco had fallen to the Spanish. In addition to the warfare and strife, new diseases introduced by the Spaniards bombarded the indigenous people. The lack of immunity to these diseases and the continuous fighting forced part of the Incan population into the mountains where they were able to stave off the Spaniards for four decades. Though valiant, these attempts were futile and in 1572, the Spaniards executed the last Inca ruler. Pizarro founded the "City of Kings," now known as present-day Lima, in 1533. This was the last of his actions because in 1541 one of his opposing factions assassinated him.

Freedom from Spanish rule for indigenous Peruvians came later on through the outside efforts of Argentines including José de San Martín, who was able to defeat Spanish troops in Chile. Because of him, Peruvian independence was proclaimed formally on July 28, 1821. Over the next century, Peru would continue to struggle with

Spanish rule and influence but would eventually be able to institute a somewhat democratic presidency. During my stay in Peru, it was common to hear politically charged arguments over the latest presidencies in Peru, proving to me that the infrastructure of the country was one of many nuances needing strengthening.

History of the International Potato Center (CIP)

Once I had become familiar with the history of Peru, I began research on the International Potato Center (CIP) and its extensive work. CIP is located in the district of La Molina, an irrigated coastal valley twenty minutes outside of Lima. “CIP seeks to reduce poverty and achieve food security on a sustained basis in developing countries through scientific research and related activities on potato, sweetpotato, other root and tuber crops, and on the improved management of natural resources in the Andes and other mountain areas” (Mission Statement). In addition to the center in La Molina, there are experimental stations in Huancayo, which is part of the high Andes, San Ramón, a city located in the rainforest-covered slopes of the Andes, and Quito, Ecuador.

CIP employs an international team of scientists from 25 countries, supported by nationally recruited staff and has a budget underwritten by more than 40 donors. As a Future Harvest Center, CIP receives its principal funding from 58 governments, private foundations and international and regional organizations known as the Consultative Group on International Agricultural Research (CGIAR). The main goal of Future Harvest is to build awareness and support for food and environmental research for a world with less poverty, a healthier human family, well-nourished children and a better environment. Future Harvest supports research, promotes partnerships and sponsors projects that bring the results of research to rural communities, farmers and families in

Africa, Latin America and Asia. Learning about CIP and the history of Peru provided me with some insight but did little to quell my growing anxiety in the face of my impending adventure. I was informed of my living arrangements- a room in the household of the Bartolini family in San Isidro, Lima, Peru. No further details about the family were provided so I was left to wonder in the weeks up until my departure.

Chapter 1

Journey to Peru

On June 6th, I left the green and gold fields surrounding my home in Independence, Iowa and headed off to Lima. I was hoping for a smooth trip but two hours into my flight from Atlanta to Lima the plane was turned around due to mechanical troubles. In addition to my own worries, I felt even worse about calling my mother and telling her about my difficulties. Fortunately, my second flight to Lima was successful and I arrived safe though slightly disgrunteled at 3:30 a.m. I corralled my luggage, navigated through customs and immigrations without a hitch, and set out in search of a driver that I was told would be waiting for me. I found this task daunting once I faced the large crowd of expectant people waiting for people to disembark from the doors of the airport, but luckily, amidst a few waving signs I saw my own name written on one and immediately made a beeline for the short and friendly-looking man holding up the sign. In my short time at the airport, I made one discovery very quickly: I could easily pass for a Peruvian woman.

The drive from the airport to the Bartolini home took about half an hour. Downtown Lima was beautiful and early colonial influence was evident in the architecture of the buildings. Once we had driven through downtown, even in the early morning dark, I could see the state of disrepair in which the outskirts languished. The buildings, all differently colored, seemed to look like their construction had been stopped



A cathedral in downtown Lima

halfway into the job and now stood precariously balanced with the help of structural supports. Fluorescently lit shops beckoned invitingly to late-night eaters and every once in awhile a street cleaner with a mouth mask securely in place could be seen sweeping the streets. As I neared my home for the next two months, I noticed a distinct change in the scenery. The buildings were more modern and business-like. Manicured lawns that divided the roads were graced with beautiful landscaping and large signs proclaiming the district. All the residences were hidden behind tall walls as a form of security I learned later, not aestheticism. As my driver escorted me to the door in the wall, I waited nervously to be received by strangers. After a few minutes I began to think that, despite repeated ringing of the bell, no one was coming. Finally, when it seemed that my driver had reached the end of his patience and I began to make plans to stay at a hotel, the door finally swung open to reveal a sleepy-eyed woman with curly black hair. Charro, a woman of the family with whom I would become familiar over the weeks, quickly embraced me and ushered me into the sleeping house. She showed me my room and the bathroom across the hall and bid me goodnight. I quickly unpacked a few things and promptly fell into bed, only to be awakened a few minutes later by a knock on my door. I got up, opened the door, and met Ida Bartolini, my designated host mother for the next eight weeks. Her embrace and salutation were equally as warm as that of Charro, who I later learned was her sister. Ida told me to get to bed and that I could rest the whole day and not worry about going to work. To be honest, I had not given a second thought to work. I was silently congratulating myself on making it to Lima without losing my luggage.

Family life with the Bartolinis

My days in the Bartolini household became routine after a few days. Initially my Spanish provoked friendly grins and often time, gales of laughter but I managed to communicate efficiently with my surrogate



My host family: Edwin, Milena and Ida

family members. It took me weeks to become accustomed to the layout of the Bartolini household and to this day, I can only estimate the number of family members I met and actually lived in the house. I quickly became familiar with Ida Bartolini, her husband Edwin, and their ten-year-old daughter Milena. These people welcomed me into their household with such warmth that I could not help but feel at home. Ida's mother, Mama



Mama Ida and me

Ida, ate dinner with me every night and Ida's nieces accompanied me once in awhile. On nights when all of Ida's sisters and their families would join me, chairs would be brought to the table and dinner would last for hours.

I became a part of family celebrations, birthdays, holidays, and vacations. It would have been easy for the Bartolinis to ignore me and let me do what I wanted, but instead, they drew me out with their curiosity and genuine compassion for me. When I first arrived in Peru, the Bartolinis questioned my heritage, thinking me a fellow South American. When I revealed to them that my parents were from Pakistan they were so enthused by this information. Many of our discussions became informational exchanges

bouncing between Peruvian, Pakistani, and American cultures. A unique personal aspect was that I came to Peru as a Muslim Pakistani-American. My multitude of identity had caused me some initial apprehension but that faded when I was embraced completely.

While I was in Peru, I had the opportunity to travel within the city. I became familiar with many of the surrounding districts. I lived in San Isidro, which is one of the



Paintings on display in Barranco

more affluent suburbs of Lima. San Isidro, while locally famous for its financial and banking businesses, also hosts great hotels, restaurants, and well-kept residences. A ten-minute drive in the direction of the Pacific Ocean leads to Barranco, another upscale district of Lima known for its arts, music scene, and various clubs. Miraflores is close to Barranco which is one of Lima's shopping

districts and always has various markets, vendors, and artists displaying their works.

During the months of June, July, and August Lima is an overcast, cold, dusty city. The temperature hovered around 55-65 F throughout most of my stay, forcing me to pack away t-shirts and don my sweaters. The air in urban Lima is thick with pollution and diesel fumes. I was able to note many

disparities between Lima and the surrounding areas. For example, CIP is in La Molina which is about 20 minutes from San Isidro, where I lived. In La Molina, almost every day at 11:00 am, the sun came out. It warmed the entire day and



A sunny day in La Molina

made the CIP grounds beautiful. However, when I got home at the end of the day, San Isidro revealed in only a slight hint of sun which usually faded into overcast skies.

Despite the sometimes temperamental weather, I made it a point to enjoy my stay in Peru.

Chapter 2

My Travels Within Peru

While Lima and its surrounding district's weather often varied from very cold to moderately warm I did have the pleasure of going to San Andrés with Ida and her family. San Andrés is a gated community in the south of Lima, very close to the coast. A private hacienda, the



A home in San Andrés

grounds consisted of apple orchards, avocado and banana trees, and eucalyptus bushes.

The contrast between the rolling, brown hills, green orchards, and red and yellow flowers was incredible. The area was beautiful and the air, fresh and clean, a major difference in comparison to Lima's air. In addition to the new sights and smells I encountered in San Andrés, I also had the pleasure of meeting Edwin's mother, his sister and her family. Despite my eagerness to see all of Peru and buy souvenirs to take home to family and friends, I realized that family is the basic root of Peruvian life, a rich part of Peruvian culture, and the defining factor in what made my stay so memorable. The difference that I made in my trip, what separated me from every other tourist, was not just the fact that I worked, but that I threw myself wholeheartedly into experiencing genuine Peruvian life. Eating, talking, laughing, and most of all, listening to everything- anecdotes and folktales and childhood stories- made me appreciate the depth of culture I had been given the opportunity to experience.

Towards the end of my internship I was invited to San Ramón by Elisa Salas, a vivacious



On the way to San Ramón

woman who, despite being 3-months pregnant, managed to participate in a few lively soccer tournaments at CIP. On July 17th, I left CIP with Elisa and three other employees of CIP. San Ramón is about a six hour drive from Lima and the road runs through

the mountains. The entire journey is accompanied by amazing view of majestic mountains, blue skies and the occasional llama herd. San Ramón, which is located in the Chanchamayo Valley, is one city that marks the beginning of the jungla east of Lima.

It's generally hot and muggy with rain every once in awhile.

CIP has potato fields in San Ramón that are grown in order to be tested for virus resistances. The day after we arrived there I spent 6 hours picking potato leaves from plants that would be analyzed back in Lima. Although the work was difficult I felt good to be toiling alongside other workers, all of us hoping to



Natives of Oxapampa

gain some knowledge from our work. In our free time, we were able to explore the city and even visit the village of Oxapampa. The sheer beauty of San Ramón was enough to make the trip memorable.

Two days after I returned to Lima I was off again, this time to Andahuaylas. I accompanied Dr. Bonierbale and Walter Amaros, an agronomist and Research Assistant in the Improvement and Genetic Resources Department of CIP. They had been invited to witness a harvest in the highlands and I knew this would be the perfect opportunity to see where potatoes are actually grown. In San Ramon the heat was almost unbearable but in

Andahuaylas I was forced to wear several layers and a winter jacket. In addition to the frigid cold the few thousand meter increase in altitude also made it difficult to breathe at times. When we arrived at the harvest in the mountains I was introduced to the



A farmer digs for potatoes

farmers who would be picking their harvest. They were delighted to meet a new American though slightly perplexed that I was not white. Dr. Bonierbale explained my situation as a visiting intern and the harvest began. The farmers walked through the rows of potatoes, and with pickaxes, dug the potatoes out of the dirt. As I watched I noticed that most of the farmers wore thin jackets and sandals. I attempted to pick and bag potatoes to be taken back to CIP but the altitude and cold proved to be too much; making



A poncho helped me brave the elements

me feel rather weak. The farmers, who fretted over my condition, made me sit and one even gave me a heavy poncho to wear. The simple gestures of warmth made me appreciate their genuine concern for me.

A week after my return to Lima from Andahuaylas I traveled to Chiclayo for vacation with Ida and her family. Chiclayo is in the north of Peru and considerably warmer and sunnier than Lima during the winter. The 8 hour drive along the coast was picturesque,



Part of the Bartolini clan and me

filled with rolling brown hills and many seaside roads. In Chiclayo we stayed with Ida's brother, Oscar, and his family. I was not surprised to find that Ida's family was just as hospitable, curious, and warm as her own. In Chiclayo I had the chance to explore the city, shop, and try new Peruvian foods. Since my first week in Peru I had been warned that it would not be right if I did not try something called "ceviche," Peru's national dish. Ceviche is a popular appetizer in all of South America that consists of raw fish and lemon. During my last dinner in Chiclayo I was served ceviche. As the expectant faces of Ida and her family anxiously watched me raise the fork to my mouth I felt an overwhelming sense of pressure to love ceviche. Much to my relief, I did.

Chapter 3

My Introduction to CIP

Not all of my days in Peru were so relaxing. I kept most of my sightseeing limited to the weekends and holidays and spent most days working at CIP. When Ida first brought me to CIP she explained

some of her work. As a research assistant in the Crop Improvement and Genetic Resources Department, much of her work was concerned with improvements in tubers and virus resistances. While I was



The International Potato Center

very much interested in that aspect of work, Ida introduced me to Dr. Meredith Bonierbale, the Senior Potato Breeder at CIP, one of my advisers. Dr. Bonierbale, a petite blond woman with intelligent blue eyes, explained to me the basics of CIP and its structure. She gave me a small tour of the grounds and then left me in the hands of Mercedes Suito, a bilingual secretary in the training department at CIP. Mercedes gave



My main adviser Gabriela, and me

me another small tour of CIP and explained the situation with meals and computer use on the grounds. I was then introduced to Gabriela Burgos, a bright and energetic woman who immediately made me feel welcome. Gabriela, a research assistant in the Social Sciences Department of CIP, showed me to the Quality Laboratory, the place where I would spend most of my internship working.

While being introduced to the workers of the Quality Lab I felt apprehensive and nervous. Because I had arrived in the middle of a large shipment of potatoes I was immediately put to work milling dried potato samples. To ensure that I completed this task correctly I was put under the watchful eye of Lupita Muñoa. Lupita was a tiny woman who just barely came up to my shoulders. Being very shy and speaking little English, I often had to ask her to repeat what she had just said. Once she had shown me how to mill and package potato samples correctly I spent the rest of the morning doing so. At noon I was ushered to the cafeteria for lunch. My first lunch at CIP was a mild interrogation administered by the Quality Lab workers. I didn't mind answering questions and despite my broken Spanish was able to relay much of my background to the group and in turn, learn much about my coworkers and their lives.

In my workdays at CIP, I noticed a common characteristic among the Peruvians with whom I worked. Despite the workload and massive amounts of research and analysis that needed to be conducted, everyone had a smile and cheerful hello for me. The daunting task of processing hundreds of potatoes in one day was no match for the attitudes of my ever-optimistic coworkers. I came to believe that this innate trait was one of the most refreshing things I have ever experienced. When I found myself frustrated in the lab, unable to understand procedures or succumbing to the difficulties of overcoming the language barrier, or just tired at the idea of such tedious work, everyone would smile and say, “Se positiva, Zenab”, “be positive.”

I didn't know it right away but these people would soon become my very good



My second family in Peru



Cutting and quartering potatoes

friends. I owe much of my love of Peru to Mariella, Lupita, Guido, Diego, Evelyn, Rossemary, Gabriela and Carolina. During my first few weeks in the Quality Lab at CIP I spent most of my time trying to be as helpful as possible. I milled and packaged potato samples that were to be sent to research centers in Brazil and Australia to be tested for mineral content. I sliced many, many potatoes and also washed petri dishes for a week. This was a

humbling task but I was more than happy to contribute to the group effort. It wasn't until my trip to Huachipa that I began to formulate a project idea.

Huachipa: The Defining Experience in my Project Focus

I received an invitation from researchers at the Instituto de Investigación Nutricional (Institute of Nutritional Investigation) in La Molina to attend a research excursion. I consented to this trip and on June 23rd headed to Huachipa with researchers from the Institute. Huachipa is about 30 minutes from CIP and one of the poorest parts of Lima. This area is complete slum and shanty towns with trash and dogs everywhere. The living quarters are made of any type of scrap material; wood, metal, fabric. It seemed like a truly difficult place to live.



The homes of Huachipa

The purpose of the Institute's trip to Huachipa was to gather mothers who had children under the age of two into the community kitchen. Community kitchens are often constructed in developing countries to encourage women to pay attention to the



Balancing Act: This mother cooks while keeping her baby precariously perched on her back.

quality, rather than the quantity, of food they prepare for their children. One woman from the institute, Minuska, told me that they wanted to see if the mothers knew what kind of food they should prepare for their babies and if they knew the proper type of preparation with certain foods to obtain maximum health benefits for their children. Minuska went around and asked all the mothers for recipes or dishes they thought they could prepare to feed their children with certain types of food. After they had brainstormed the mothers were then asked to prepare the food and feed the meals to their children. While all of this was occurring, workers from the institute recorded technicalities like ingredients used, weight of each quantity, and whether or not the children liked the food. Afterwards, the mothers were asked if their meal was easy to prepare or what difficulties they encountered. The Huachipan cuisine preparation I saw consisted of several meats and vegetables. There was fish, beef, chicken, turkey, carrots, broccoli, squash, onions, and of course, potatoes.

For the infants able to eat, the mothers prepared a thick, yellow gruel of mashed fish and squash. For the toddlers (approx. age 1-2 years), rice with beef and potatoes was prepared. The meals were simple but the focus was on keeping the food appropriate for the age of the child while still maximizing nutrient potential. Minuska informed me that,

unfortunately, while the mothers expressed genuine interest in nutritional quality of the food they prepare for their young children, the odds of them upholding this ideal were not likely. In addition to the dire economic status of Huachipa, the lack of education in terms of food fuels the malnutrition and rampant illness amongst the young.

Throughout discussion and meal preparation I made myself useful by holding an infant and kicking a soccer ball around with waiting children. In a place where I could see no possible source of happiness, these children were content in talking to me and playing in the



Children wait for a meal

dirt. What moved me so much in the living conditions of Huachipa were simply the ways of life of the mothers and children with whom I spoke; my bias and indignance as an outsider, when I reflect on my feeling at the times, were probably not reciprocated by the actual inhabitants. While the children I encountered were able to look past the grime and grit of their homes I knew that eventually they would learn what it meant to live a hard life, to live from hand to mouth. It was difficult to look at this experience as just an observer, a guest on a tour of Peru. During my discussions with Minuska, I began to think about an easier way in which Peruvians, despite socioeconomic status, could obtain the proper and maximum amount of nutrients from available foods. The most obvious answer was to focus on potatoes; the most consumed and accesible food in Peru and also the heart of its agricultural world.

Chapter 4

The Potato

For the past 8000 years, in much of the Andean region of South America, specifically Peru, farmers have grown varieties of potatoes exclusive to the region. The diversity of taste and texture is emphasized by the amazing shapes and colors into which these potatoes develop. However, despite their nutritional and economic worth, these native potatoes were ignored by science and the potato and health food industries. Perhaps it was



because they differed so greatly in comparison to their white-fleshed and smooth-skinned counterparts but only recently have native Andean potatoes been noticed. With research institutes like CIP, that focus on promoting and emphasizing the major potential of crops like tubers, native farmers are working on bringing not only economic benefit back to their families, but nutritional value as well.



In Peru, potatoes are grown at altitudes around 4200 m. The potato plant needs roughly 13 hours to produce tubers, the edible portion of the plant, and do not grow at higher altitudes. For the majority of time, Peruvian farmers do not grow crops commercially and therefore their products are grown with little to no agrochemicals which makes organic certification easier. Andean potatoes come in flavors and textures that can be appreciated in the kitchen, and additionally there is generally low fat absorption during frying. In addition, pigments like yellow carotenoids and red and purple anthocyanins produce amazing colors and are antioxidants vital to proper nutrition. CIP has been working with poor farmers in Peru to preserve potato diversity in

the field and in genebanks. Currently, there are over 4000 native potato varieties stored at CIP. While CIP works with organizations and entrepreneurs to identify and implement markets for them, there is a major emphasis on alleviating rural-poverty through value-added potato production. While the aspect of potato commercialization interested me, I wanted to focus more on health related research. Four weeks into my internship I decided to focus my project on concentrations of Vitamin C in native potatoes of Peru.

My Project Focus, Purpose, and Objectives

While discussing my project idea with Gabriela, she gave me a plethora of information on my intended topic. In 2004, CIP had characterized Vitamin C concentration in 39 Peruvian potato varieties.

Cooking studies were conducted for 12 of those varieties and major differences in content were found between cooked and raw potatoes. Because it was necessary to conduct cooking experiments for all the samples, my project was a continuation of this plan. I decided to focus my project on one aspect of the potato while keeping an objective and a significant variable in mind.

My purpose:

To research and quantitatively conclude the amount of Vitamin C concentration in samples of raw and cooked potatoes grown in two different environments in Peru.



In the lab: Mariella Auqui and I pause for a picture. Mariella was my project supervisor and also a great friend.

My objective:

To better understand and conclude the greatest health benefits each variety of potato offers and what effect the different environments have on the Vitamin C concentration of the potato.

Significance of project:

The significant part about this project is that the analysis is conducted on raw and cooked potatoes in order to note the drops in Vitamin C content of the potatoes based on preparation. This may seem insignificant but it is better to characterize Vitamin C in cooked potatoes to keep in mind that there is a target population's health at stake in this research. Also, people eat cooked, not raw, potatoes.

Among the various projects available to me, I chose this work with my trip to Huachipa in mind. The meal preparation I saw emphasized economic status as a main factor in nutrition for Peruvians. The women of Huachipa are forced to create a meal of sustenance, taste, and nutrition for their families with what they can buy. Potatoes are to Peru what corn is to Iowa: abundant. The difference is that not all Iowans are forced to eat corn with every meal. In Peru, it is very likely that families of lower economic standing will eat potatoes at almost every meal. It only made sense to me to research the agricultural resources available to Peruvians in order to help them. If Peruvians can find potatoes that yield high concentrations of Vitamin C even after being cooked, efforts can be devoted to growing and harvesting these specific potatoes. In places like Peru where getting the maximum amount of nutrients from a potentially small amount of food is key, knowing what types of potatoes yield maximum amounts of Vitamin C is a major advantage.

Vitamin C

My decision to focus on Vitamin C was related to my interest in continuing CIP's own research, which at that point was not extensive. In addition, Vitamin C is one of the more basic nutrients that all people need to maintain a healthy lifestyle.



A Visible Spectrophotometer (machine pictured) is used to read Vitamin C concentration from liquefied potato

Vitamin C, which is referred to as Ascorbic Acid (AA) at CIP, is a water-soluble vitamin. It is comprised of two major forms that are present in both biological tissues and food. Citrus and soft fruits provide the highest concentrations of Vitamin C; however, mealy vegetables like potatoes also offer high concentrations of Vitamin C. An acidic molecule, Vitamin C provides protection against disease like Scurvy. Scurvy, an illness once feared by seamen, is characterized by failure of wound healing, bleeding gums, and bone and joint lesions, which can eventually lead to death. It is also an important scavenger for free radicals, which may cause tissue damage.

It is important to recognize the populations at risk for Vitamin C deficiency. In many developing countries, like Peru, limitations are placed on the amount of available Vitamin C sources due to seasonal factors. Potatoes are readily available year around, which is another reason to focus on Peru's natural resources.

Vitamin C intake varies depending on age and gender (see Appendix 1). However, in order to alleviate at least Vitamin C deficiency in all potato-dependent people of developing countries the best potato breed, in terms of Vitamin C concentration, must be found to ensure good health for generations to come.

Chapter 5

Results of Research

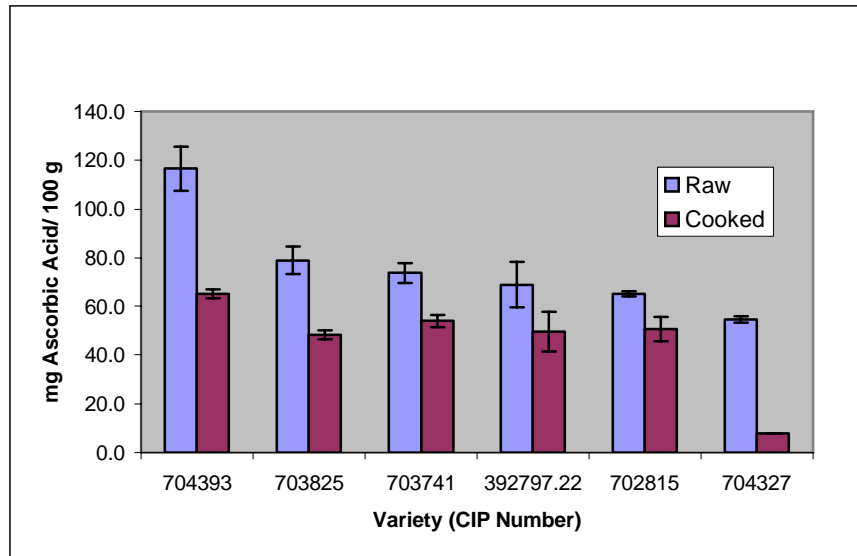
Below are the results of my analysis of Vitamin C concentration in 6 native varieties of Peru. The Lab Procedure I used can be found in Appendix I.

Comparison of Ascorbic Acid Values (Raw vs. Cooked)

Table 1

La Victoria (Dry basic)			Raw Values		Cooked Values	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	116.62	9.04	65.26	1.90
NP-01.05	703825	China Runtush	79.01	5.54	48.26	1.85
NP-02.03	703741	Ambar	73.85	4.07	53.92	2.48
C92.140	392797.2	UNICA	68.92	9.39	49.50	8.12
NP-09.02	702815	Morar Nayra Mari	65.31	0.97	50.52	4.99
NP-02.05	704327	Color Unckuna	54.54	1.40	7.89	0.09

Graph 1



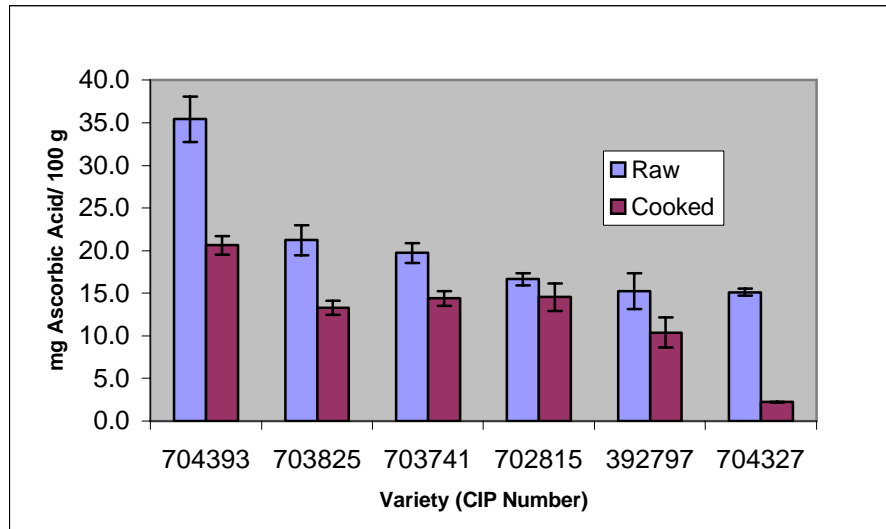
The raw potatoes retain large concentrations of AA. For the majority, cooked samples maintain 50-80% of AA, except in the case of 704327, which has a major decrease in AA levels after being cooked. Only fresh basic can be noted because this state is edible.

Comparison of Ascorbic Acid Values (Raw vs. Cooked)

Table 2

La Victoria (Fresh basic)			Raw Values		Cooked Values	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	35.40	2.67	20.64	1.10
NP-01.05	703825	China Runtush	21.25	1.78	13.26	0.85
NP-02.03	703741	Ambar	19.76	1.16	14.35	0.84
NP-09.02	702815	Morar Nayra Mari	16.68	0.73	14.50	1.65
C92.140	392797.2	UNICA	15.22	2.15	10.35	1.77
NP-02.05	704327	Color Unckuna	15.08	0.42	2.24	0.04

Graph 2



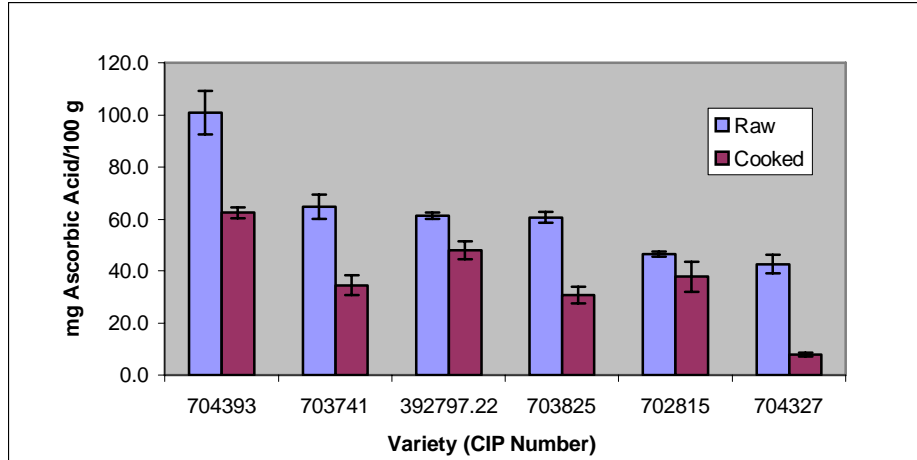
The variety 704393 (Maria Cruz), when cooked, retains about 20 mg of AA per 100 grams of potato. This means that, for example, an 18-year old female, would need to consume 200 g of this type of potato a day to get my daily recommended amount of Vitamin C (see Appendix III). Now, in the U.S. there are other alternatives to getting Vitamin C. But in Peru, where potatoes are the most commonly grown and eaten crop, knowing what variety of potato produces the highest concentration of AA. and retains the highest percentage of AA. after being cooked is a vital piece of information to potato farmers and consumers.

Comparison of Ascorbic Acid Values (Raw vs. Cooked)

Table 3

Aymara (Dry Basic)			Raw		Cooked	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	100.85	8.43	62.47	2.15
NP-02.03	703741	Ambar	64.86	4.71	34.38	3.78
C92.140	392797.22	UNICA	61.26	1.21	47.97	3.54
NP-01.05	703825	China Runtush	60.73	1.99	30.69	3.28
NP-09.02	702815	Morar Nayra Mari	46.39	0.98	37.71	5.78
NP-02.05	704327	Color Unckuna	42.56	3.66	7.89	0.75

Graph 3



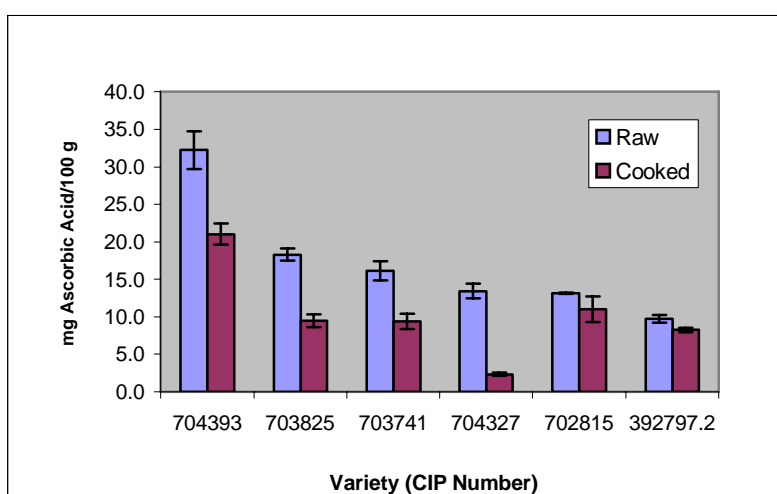
In this trial Maria Cruz retains more than 50% of its Vitamin C concentration even after being cooked. Variety 704327 experienced a severe drop in AA concentration after being cooked. With this kind of research, farmers will be able to tell what they should and should not plant in order to maximize nutritional benefits.

Comparison of Ascorbic Acid Values (Raw vs. Cooked)

Table 4

Aymara(Fresh Basic)			Raw		Cooked	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	32.22	2.51	21.06	1.39
NP-01.05	703825	China Runtush	18.34	0.78	9.45	0.87
NP-02.03	703741	Ambar	16.14	1.30	9.35	1.03
NP-02.05	704327	Color Unckuna	13.40	1.00	2.33	0.21
NP-09.02	702815	Morar Nayra Mari	13.08	0.10	10.96	1.73
C92.140	392797.22	UNICA	9.69	0.51	8.22	0.27

Graph 4



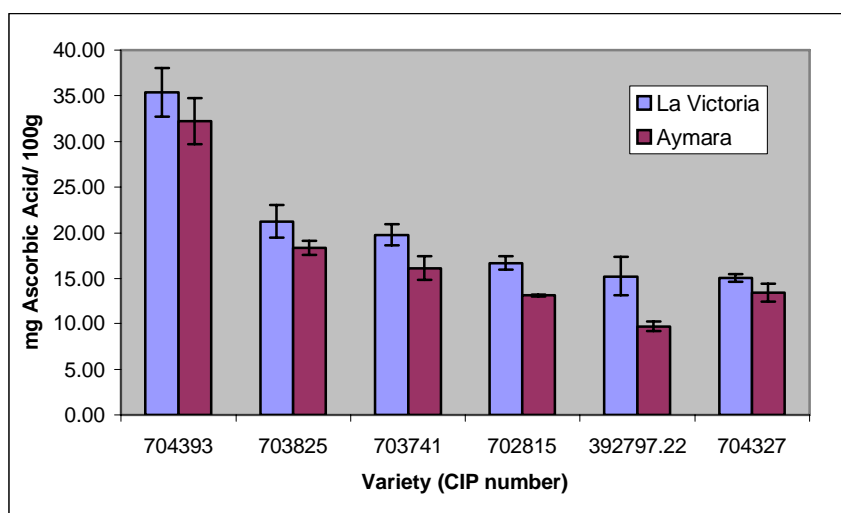
Again, in this trial Maria Cruz retains more than 50% of its Vitamin C concentration even after being cooked. However, this trial shows that variety 704327 experienced the greatest decrease in AA concentration.

Comparison of Location (La Victoria vs. Aymara)

Table 5

Raw Samples (Fresh basic)			La Victoria		Aymara	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	35.40	2.67	32.22	2.51
NP-01.05	703825	China Runtush	21.25	1.78	18.34	0.78
NP-02.03	703741	Ambar	19.76	1.16	16.14	1.30
NP-09.02	702815	Morar Nayra Mari	16.68	0.73	13.08	0.10
C92.140	392797.22	UNICA	15.22	2.15	9.69	0.51
NP-02.05	704327	Color Unckuna	15.08	0.42	13.40	1.00

Graph 5



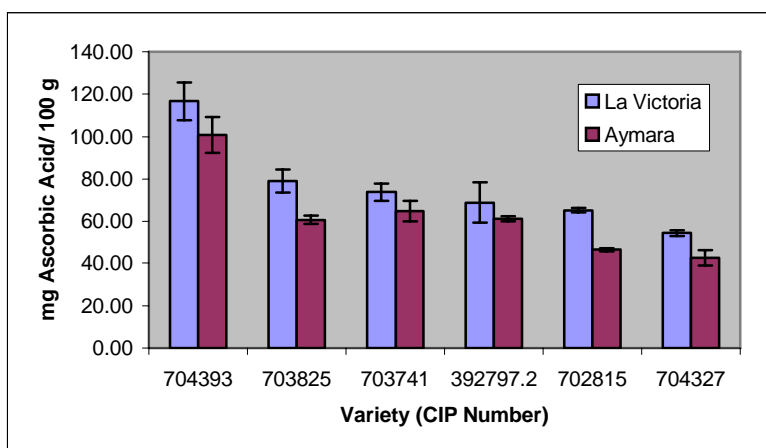
CIP grows potatoes in various environments to gauge how they grow in conjunction to their surroundings. La Victoria and Aymara are two different environments (see Appendix II) that allow CIP researchers utilize to understand the effects of environmental differences have on mineral content in potatoes. Here, it is clear that La Victoria is an environment that yields high AA concentrations, but there is no significant difference in the amount of AA that Aymara can produce. (Note: Maria Cruz still has highest AA concentration)

Comparison of Location (La Victoria vs. Aymara)

Table 6

Raw Samples(Dry basic)			La Victoria		Aymara	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	116.62	9.04	100.85	8.43
NP-01.05	703825	China Runtush	79.01	5.54	60.73	1.99
NP-02.03	703741	Ambar	73.85	4.07	64.86	4.71
C92.140	392797.22	UNICA	68.92	9.39	61.26	1.21
NP-09.02	702815	Morar Nayra Mari	65.31	0.97	46.39	0.98
NP-02.05	704327	Color Unckuna	54.54	1.40	42.56	3.66

Graph 6



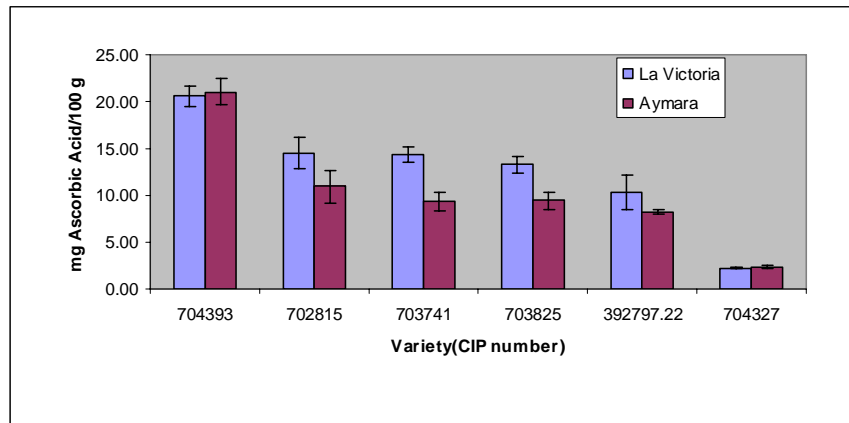
La Victoria still maintains the highest concentrations of AA but in this trial it is evident that Aymara induces decreases in AA concentration.

Comparison of Location (La Victoria vs. Aymara)

Table 7

Cooked Samples (Fresh basic)			La Victoria		Aymara	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	20.64	1.10	21.06	1.39
NP-09.02	702815	Morar Nayra Mari	14.50	1.65	10.96	1.73
NP-02.03	703741	Ambar	14.35	0.84	9.35	1.03
NP-01.05	703825	China Runtush	13.26	0.85	9.45	0.87
C92.140	392797.22	UNICA	10.35	1.77	8.22	0.27
NP-02.05	704327	Color Unckuna	2.24	0.04	2.33	0.21

Graph 7



In one trial Aymara, in the case of Maria Cruz, yields the highest concentration of AA.

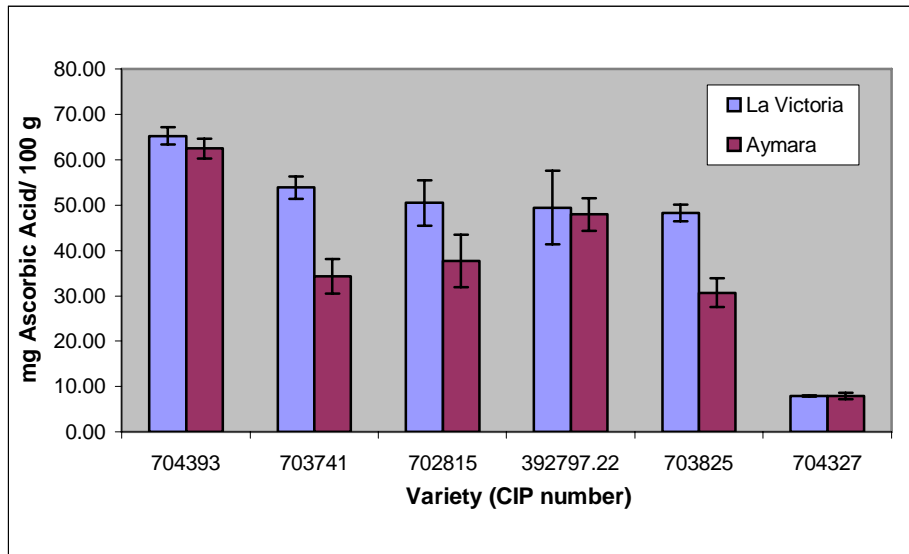
In the case of variety 704327, the concentration is decreased greatly.

Comparison of Location (La Victoria vs. Aymara)

Table 8

Cooked Samples (Dry basic)			La Victoria		Aymara	
Local code	CIP Number	Common name	Average	St. Deviation	Average	St. Deviation
NP-01.09	704393	Maria Cruz	65.26	1.90	62.47	2.15
NP-02.03	703741	Ambar	53.92	2.48	34.38	3.78
NP-09.02	702815	Morar Nayra Mari	50.52	4.99	37.71	5.78
C92.140	392797.2	UNICA	49.50	8.12	47.97	3.54
NP-01.05	703825	China Runtush	48.26	1.85	30.69	3.28
NP-02.05	704327	Color Unckuna	7.89	0.09	7.89	0.75

Graph 8



La Victoria still maintains the highest concentrations of AA.

Conclusions

The information gathered from the graphs and tables can provide various conclusions concerning Vitamin C concentrations in the six native potatoes I analyzed.

Comparison of Ascorbic Acid Values (Raw vs. Cooked)

- 1.) The variety Maria Cruz (704393) proves to be the breed of potato that contains the largest amount of concentrate AA.
- 2.) The variety Maria Cruz (704393) retains more than 50% of its initial AA after being cooked.
- 3.) The variety Color Unckuna (704327) shows a significant decrease in AA concentration after being cooked.

Comparison of Location (La Victoria vs. Aymara)

- 1.) La Victoria is the ideal environment for potato growth because concentrations of AA were highest in this region.

Ideas for the Future

My research was conducted in the hopes of adding to CIP's monumental start towards creating new ways to effectively feed Peruvians and other potato-dependent people around the world. After studying the results of my work, I have come up with a few broad ideas that can be considered in the future.

- 1.) While focusing on the isolation of a single mineral in a food like the potato may provide interesting research, it would be more practical to find a breed of potato that contains high concentrations of many minerals in order to provide an all-encompassing and easier means of maintaining a healthy diet. If no such potato

exists, it might be beneficial to crossbreed varieties high in mineral content to see if such a potato can be created.

- 2.) It would be advantageous to farmers if they were aware of what potatoes yield the highest amounts of Vitamin C. With this knowledge, they could plant and harvest these varieties, which would be beneficial to them and their families. New farm technique implementation programs could be created to foster agricultural knowledge for native farmers of Peru.
- 3.) In repeated trials, the variety Maria Cruz (704393) maintains the highest concentrations of AA. This positive indication should encourage farmers to plant this variety to ensure health benefits. In addition, perhaps Maria Cruz seeds, and other potato breeds that prove to be high in mineral content, can be grown in federally funded fields and distributed to farmers.
- 4.) In all of the trials I conducted, one result remained the same. Cooked potatoes have a decrease in Vitamin C concentration. While this result is somewhat obvious, it is still possible to harness the maximum amount of Vitamin C in potatoes through various cooking techniques. In the future, it would be interesting to note what types of cooking methods preserve the mineral content in potatoes.

Chapter 6

Things to Keep in Mind

It should be noted that my research and conclusions only apply to 6 varieties of native Peruvian potatoes. My work was a very small part of a huge, ongoing effort to identify the highest mineral-yielding potatoes in Peru. In addition, Vitamin C is only one nutrient that is vital to human health. At CIP, equal amounts of research are directed towards other nutritional factors found in potatoes.

A New Perspective

When I think of poverty and malnutrition, images of distended bellies and Africa often come to mind. However, South America is also a continent that suffers from poverty and poor health. My time in Peru has proved to me that issues of food security stretch to all corners of the earth. During the first few weeks of my internship, many people would ask me about my career plans and I would reply, “medicine”. At this, most people would laugh and say, “What do potatoes have to do with medicine?” I had gone into this internship with premed as my projected career path. At the end of my 8 weeks, I found myself very interested in the health aspects of research at CIP, but I had also become interested in the research focus of crop growth. I am considering careers outside the realm of medicine because I learned over the summer that it is not just a doctor that can keep people healthy; the agronomists, farmers, food engineers, potato breeders, and CIP researchers I met and interacted with me showed me how their work is helping to feed people all over the world.

8 weeks seemed like an eternity when I faced the prospect of unfamiliar places and strange faces. In my last few days abroad, I spent my time visiting with friends,

eating as much Peruvian food as possible and buying chocolates for my family. These mundane activities left a lump in my throat. The end had come and I did not want to leave. A group of friends accompanied me to the airport on the day of my departure. While we waited, we reminisced about the past few weeks and how fast time had gone. One of my friends told me, “Tell everyone how much you loved Peru and how much you learned. Don’t forget the things you saw and the places you visited. And don’t forget us, the people you met. We are what made Peru what it is and what it will be. When you tell people about us, they will see how amazing Peru is.” These were our parting words, and as I boarded my plane, I found myself smiling. I know I will go back to Peru someday. In the meantime, I will revel in my memories and share my stories so everyone can see that Peru is an amazing country.

Appendix I

Lab Procedure

Vitamin C Content Analysis in 6 Varieties of Potatoes Grown in Two Different Environments

Purpose: To research and quantitatively conclude the amount of Vitamin C concentration in samples of raw and cooked potatoes grown in two different environments in order to better understand and conclude the greatest health benefits each variety of potato offers and what effect the environments have on the Vitamin C value of the potato.

Method: 2 different growing environments in the highlands

- 1.) La Victoria
- 2.) Aymara

6 varieties of potato

- 1.) China Runtush
- 2.) Maria Cruz
- 3.) Ambar
- 4.) Color Unckuna
- 5.) Morar Nayra Mari
- 6.) Unica

Equipment:

Reagents: Acetone, Oxalic Acid, Concentrated Sulfuric Acid, 2, 6 Dichloroindophenol, Ascorbic Acid, Sodium Bicarbonate

Major Equipments: Visible Spectrophotometer, pH-meter, Homogenizator-Omni Mixer, Vacuum pump

Minor Equipment: Analytic balance, Pipette 1000 ul, Dispenser, Shaker, Magnetic Shaker

Laboratory Material: volumetric flasks (1 liter, 500 ml, 100 ml), filtering glass (500 ml), cylinder flask (50 and 100 ml), Buchner funnel (aprox. 9cm), glass beakers (100 ml, 250 ml, 500 ml, 1 L), test tubes, wash bottles, tips (1000 ul), filter paper (Whatman No. 2- 90 mm), tissue paper, amber bottles, magnetic bars, knives, peelers, slicers, trays, cutting board

Reagents Preparation:

Extracting Solution: Oxalic Acid 0.4% (dry), Acetone 20%

Dissolve 4 g of Oxalic Acid in 100 ml of distilled water and agitate with the help of a magnetic bar until acid has dissolved completely. Add distilled water until 500 ml and then add 200 ml of Acetone. Agitate this mixture slowly and carry to pH 1.1 with concentrated Sulfuric Acid (about 30-40 drops). *To avoid Acetone evaporation cover the beaker with aluminum foil.* Finally transfer the extracting solution to a volumetric flask and carry to 1 liter with distilled water.

Stock Solution of 2, 6 Dichloroindophenol (DCIP):

Dissolve 100 mg of 2, 6 DCIP in 100 ml of warm water (40-50⁰C). Add 84 mg of NAHCO₃, shake with magnet bar, transfer the solution to a volumetric flask, and carry to 500 ml with distilled water. Filter with suction and store the solution in an amber flask. *Avoid light during this process.*

For its use, the stock solution should be diluted with distilled water such that when 1 ml of the extracting solution and 9 ml of DCIP solution are reacted, an absorbance value (at 520 nm) of 0.300 to 0.350 is obtained. This range of absorbance is usually obtained by diluting 1 ml of the stock solution of 2, 6 DCIP in 12.5 ml of diluted solution. Since a larger amount of colorant is needed

Stock Solution of Ascorbic Acid:

Dissolve 100 mg of Ascorbic Acid in 50 ml of extracting solution. Shake with magnet bar. Carry to 100 ml using an amber volumetric flask.

Preparation of the Ascorbic Acid standard curve:

Prepare standard solutions of Ascorbic Acid with concentrations of 5, 10, 20, 30, 40 and 50 ug/ml. Take aliquots of 1, 2, 3, 4, 5 ml of the stock solution and carry to 100 ml with the extracting solution. Analyze 1 ml of each one of the prepared standards as follow:

- (BR) Mix 1 ml of the extracting solution with 9 ml of the diluted dye (2, 6 DCIP) and read the absorbance (Reagent blank) at 520 nm (read 3 times).
- (Ab. Sample) Mix 1 ml of the standard solution with 9 ml of the diluted dye (2, 6 DCIP) and after 1 minute read the absorbance (standard absorbance) at 520 nm (read 3 times).
- (B. Sample) Mix 1 ml of the standard solution with 9 ml of distilled water and read the absorbance at 520 nm (Standard blank).
- Subtract the sample blank from the sample absorbance and then subtract this value from the reagent blank. This final value (Real Absorbance) is used to build the standard curve (Real Absorbance vs. concentration).

$$\text{Correct Absorbance} = \text{BR} - (\text{Ab. Sample} - \text{B. Sample})$$

Sampling: For each variety, collect 18-24 tubers (60-70 g weighed non-damaged tubers) from the field at random.

Sample Preparation:

Cooked Sample Preparation: The potatoes selected for cooking will be boiled in distilled water for, depending on their weight in grams, 10-20 minutes. Once they have finished cooking, they will be peeled and then quartered longitudinally into 4 sections. Two opposite sections of each tuber will be taken and with the help of a slicer obtain 3 or 5 slices of each section. Mix the slices and take 10 g for determining the matter content and 15 g to analyze the Vitamin C immediately.

Aymara

- 1.) China Runtush
- 2.) Maria Cruz
- 3.) Ambar
- 4.) Color Unckuna
- 5.) Morar Nayra Mari
- 6.) Unica

La Victoria

- 1.) China Runtush
- 2.) Maria Cruz
- 3.) Ambar
- 4.) Color Unckuna
- 5.) Morar Nayra Mari
- 6.) Unica

Raw Sample Preparation: Potatoes selected for raw analysis will be peeled and rinsed. They will then follow the same procedure for analysis as cooked sample preparation.

Aymara

- 1.) China Runtush
- 2.) Maria Cruz
- 3.) Ambar
- 4.) Color Unckuna
- 5.) Morar Nayra Mari
- 6.) Unica

La Victoria

- 1.) China Runtush
- 2.) Maria Cruz
- 3.) Ambar
- 4.) Color Unckuna
- 5.) Morar Nayra Mari
- 6.) Unica

Analysis:

- Weigh 15 g of the homogenized sample in the extracting glass, add 75 ml of the extracting solution, and mix in the Omni-Mixer for 5 minutes.
- Rinse the mixer with the extracting solution (aprox. 3 pipettes) and filter the extract through filter paper using the vacuum pump.
- Transfer the filtered extract into an amber volumetric flask; carry to 100 ml and mix.
- Mix 1 ml of the extracting solution with 9 ml of the diluted dye (2,6 DCIP) and read the absorbance (Reagent blank) at 520 nm (read 3 times).
- Mix 1 ml of the extract with 9 ml of the diluted dye (2, 6 DCIP) and after 1 minute read the absorbance (Sample Absorbance) at 520 nm (read 3 times).
- Mix 1 ml of the extract with 9 ml of distilled water and read the absorbance at 520 nm (Sample blank).
- Subtract the sample blank from the sample absorbance and then subtract this value from the reagent blank. This final value (Real absorbance) is used to estimate the concentration of Vitamin C using, as a reference, the Ascorbic Acid standard curve.

Appendix II

Conditions of Environment

Location	District	Province	Region	Altitude(m)	Average T°C	Minimum T°C	Maximum T°C	Texture	PH	Rain (mm/year)
La Victoria	El Tambo	Huancayo	Junin	3800	12.0	4	22	Clay	7.2	700 aprox
Aymara	Pazos	Tayacaja	Huancavelia	3300	5.0 - 8.0	0	20	Dark	3.8-4.2	700 aprox

Appendix III

Daily Recommended Intake of Vitamin C

Age	Vit C mg/day
Infants	
0-6 months	25
7-11 months	30
Children	
1-3 years	30
4-6 years	30
7-9 years	35
Adolescents	
10-18 years	
Males	40
Females	40
Adults	
Males	45
19-65 years	
Females	45
19-65 years (pre-menopausal)	45
50-65 years (menopausal)	45
Older Adults,	45
65+ years	45
Males	
Females	
Pregnancy	55
Lactation	70(e)

Human Vitamin and Mineral Requirements, Report of a Joint FAO/WHO Expert
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