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Understanding Perceptions of Genetically Modified Food Among Natural Food Shoppers in Southern Nevada

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UNDERSTANDING PERCEPTIONS OF GENETICALLY MODIFIED FOOD AMONG NATURAL FOOD SHOPPERS IN SOUTHERN NEVADA

By

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ABSTRACT

Understanding Perceptions of Genetically Modified Food Among Natural Food Shoppers in Southern Nevada

by

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Today, 85% of corn, 93% of soybeans, and 88% of cotton in the U.S. are genetically modified (GM). Using laboratory methods, genes from one species, such as a plant, can be transferred to an unrelated species, such as an animal. Genetically modified crops may lead to higher yields, have improved food quality, texture, and nutritional value, and have an increased shelf life.

Despite these promising benefits, the potential health risks relating to the consumption of GM food remain inadequately assessed. Genetically modified food is not subjected to rigorous safety testing, such as epidemiologic studies, to identify potential health risks. Two principal public health concerns include the development of novel allergens in GM food and increased pesticide exposure from consuming such food. Other concerns relate to environmental and social impacts of GM food. Nine participants were recruited for this study. Three main themes emerged, which emphasized vegetarian and vegan diets, increasing consumption of whole foods and reducing processed foods, and having the right to know whether food contains GM ingredients. The results of this study have revealed that natural food shoppers' perceptions of GM food play an important role in food purchasing behaviors.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

2,4-D – 2,4-Dichlorophenoxyacetic Acid

AAS – AquAdvantage® Salmon

BT – *Bacillus thuringiensis*

DNA – Deoxyribonucleic Acid

EPA – Environmental Protection Agency

FAO – Food and Agriculture Organization

FDA – Food and Drug Administration

GM – Genetically Modified

GMO – Genetically Modified Organism

HBM – Health Belief Model

IRB – Institutional Review Board

OECD – Organization for Economic Cooperation and Development

RCT – Randomized Controlled Trial

UCSC – University of California, Santa Cruz

UNL – University of Nebraska-Lincoln, Plant and Soil Sciences

UNLV – University of Nevada, Las Vegas

USDA – United States Department of Agriculture

WHO – World Health Organization

CHAPTER I:

INTRODUCTION TO THE STUDY

Introduction

Today, 85% of corn (Center for Food Safety, 2014a), 93% of soybeans (United States Department of Agriculture [USDA] Economic Research Service, 2013), and 88% of cotton in the U.S. (Center for Food Safety, 2014a) are genetically modified (GM). The World Health Organization (WHO) defines GM food as foods whose genetic material has been altered in a manner that does not occur in nature (WHO, 2014). Using laboratory methods, genes from one species, such as a plant, can be transferred to an unrelated species, such as an animal (Lewin, 1999; Klug & Cummings, 2002). These methods are different compared to traditional cross-breeding, which allows the transfer of genes only across related species (University of Nebraska-Lincoln, Plant and Soil Sciences [UNL], 2014).

The first genetically modified product, insulin, was developed by scientists and approved by the Food and Drug Administration (FDA) in 1982 (Junod, 2007). The availability of the first genetically modified food began in 1994 with the now defunct FLAVR SAVR® tomato (Life Sciences Foundation, 2014). It was not until 1996 when widespread planting of GM crops began, covering about 4.1 million acres worldwide (Brookes & Barfoot, 2013). The percentage of GM soybeans in the U.S. increased from 17% in 1996 to 68% in 2001 to 93% in 2013. Likewise, the percentage of GM corn increased from 8% in 1997 to 26% in 1999 to 29% in 2003 (USDA Economic Research Service, 2013). By 2011, global planting of GM crops reached over 365 million acres (Brookes et al., 2013). In addition to corn, soybeans, and cotton, other crops that have genetically modified varieties include canola, papaya, alfalfa, sugar beets, and squash (Center for Agriculture, Food and the Environment, 2014).

The development of GM food was initiated to improve several aspects of conventional (non-GM) food. Genetically modified crops may lead to higher yields, have improved food quality, texture, and nutritional value (University of California, Santa Cruz [UCSC], 2005), and/or have increased shelf life (UCSC, 2005 & Food and Agriculture Organization [FAO], 2003). *Bt* corn, developed to resist pests and diseases to increase corn yields, is a genetically modified corn variety that contains a gene from the bacterium *Bacillus thuringiensis*. This gene enables the corn to produce a protein that is toxic to many pests (Colorado State University, 2013). Golden Rice, a rice variety that is genetically modified to be high in beta-carotene, has been developed to address vitamin A deficiency in developing countries (FAO, 2003 & Potrykus, 2001). Arctic Apples®, a genetically modified apple variety, has been developed to prevent browning of sliced or bruised apples (Okanagan Specialty Fruits, 2014).

Problem Statement and Significance to Public Health

Despite the global planting of GM crops and their promising benefits, the long-term health risks, environmental impact, and social and economic consequences relating to the cultivation and consumption of these foods remain inadequately assessed and unforeseen and thus, questioned by food safety organizations, environmental groups, and researchers (Miller, Brunner, & Mayer, 1999; Pusztai, Bardocz, & Ewen, 2003; Conner & Jacobs, 1999; Domingo, 2007; O'Neil, Reese, & Lehrer, 1998; Dona & Arvanitoyannis, 2009; Center for Food Safety, 2014b; Food Democracy Now!, 2012). Genetically modified products are found in almost all establishments in the U.S. that sell food, including supermarkets, grocery stores, convenience stores, and restaurants, although adequate testing has not been conducted to establish the safe consumption of

these foods by the FDA. Other than meat, poultry and eggs, the FDA is the government agency responsible for assessing the safety of the U.S. food supply (FDA, 2013). Unlike pharmaceuticals, GM food is not subjected to epidemiologic studies, such as randomized controlled trials (RCTs) or prospective studies, to identify potential health risks, and food manufacturers are not required to consult with the FDA when manufacturing GM products (FDA, 1992). Moreover, products with GM ingredients are not required to be labeled as having such ingredients because the FDA identifies GM food equivalent to conventional food, an indication by the agency that the consumption of GM food pose no additional health risks (FDA, 1992).

From the environmental and ecological perspective, the growth of superweeds, unwanted hybrid plants in croplands and farms, have emerged in great numbers as a result of overspraying GM crops with Monsanto's Roundup® herbicide; these GM crops successfully withstand such high herbicide applications, unlike conventionally grown crops. However, over time, superweeds develop resistance to Roundup, which makes them difficult for farmers to eliminate and control (Benbrook, 2012). In addition, spraying high amounts of herbicides, such as Roundup, may impact public health as a result of bioaccumulation (Environmental Protection Agency [EPA], 2012; Ribas-Fitó et al., 2007; Eskenazi et al., 2007; Handal, Lozoff, Breilh, & Harlow, 2007; Ribas-Fitó et al., 2003; Torres-Sánchez et al., 2007; Guillette, Meza, Aguilar, Soto, & Garcia, 1998). Another emerging public health concern is the FDA's pending approval of AquaBounty's AquAdvantage® salmon (AAS) which contains genes from two other fish; these genes allow AAS to grow at a much faster rate than unmodified salmon, which may prove favorable for rising consumer demand for fish and farmers' profits (FDA, 2012).

However, rigorous testing of GM products is not currently being conducted to assess possible long-term population health impact (FDA, 1992) and AAS may disrupt ecosystems and native fish populations should such fish be released into the wild (FDA, 2012).

Food safety and environmental groups and organizations have also long expressed concern regarding unanticipated and unpredictable social and economic consequences of GM food (Center for Food Safety, 2013a; Food Democracy Now!, 2013; Organic Consumers Association, 2013; Greenpeace, 2013). Numerous incidents involving GM seeds and plants being found in farms that grow conventional crops, an issue known as cross-contamination, have occurred, which question the co-existence of GM and conventional crops. In three separate instances, the FDA discovered that unapproved versions of Bayer CropScience's GM rice was sold in packaging marketed as conventional to local and international markets (GM-Free Cymru, 2007a), which negatively impacted U.S. farmers, the economy, and the reputation of the U.S (Greenpeace, 2007). More recently, an unapproved version of Monsanto's GM wheat was found in an Oregon farm (USDA Animal and Plant Health Inspection Service, 2013), resulting in a class-action lawsuit against the company and prompting countries around the world to require testing of imported U.S. wheat or to completely stop its importation (Center for Food Safety, 2013b).

In light of potential health risks and past environmental, social and economic consequences, consumer feedback has indicated a strong disapproval of GM food in several states, leading to initiatives to label GM food in these states.

Purpose and Need Statement

Although the public has voiced their disapproval of GM food in several states, prompting legislative action in many cases, the perceptions of Southern Nevada residents regarding GM food was unknown, and literature searches on the subject did not return results. As such, the purpose of this ethnographic study is to understand the views, opinions, attitudes and behaviors of GM food among natural food shoppers in Southern Nevada. In this study, natural food shoppers refers to individuals that purchase food with the Non-GMO Project seal and/or the USDA's organic seal for the intention of avoiding GM food.

The results of this study can be used to inform stakeholders, such as food manufacturers, grocery stores, farmers, health-based organizations, and local lawmakers for the eventual implementation or modification of local food policy.

Summary

Genetically modified food are foods whose genetic material has been altered in a manner that does not occur in nature (WHO, 2014), which is different than traditional cross-breeding methods. Genetic engineering, which allows the transfer of genes across unrelated species, was designed to improve a number of aspects of conventional food.

A primary concern with GM food is that the FDA considers these foods equivalent to conventional foods, although GM food has not been adequately tested for safety. Some GM foods are designed to withstand repeated applications of pesticides, which is not only a public health concern, but also an environmental concern. In addition, farms that do not grow GM crops have been contaminated with GM material and traces of GM food have been found in overseas shipments designated as conventional.

Because of these and other concerns, the public has voiced their disapproval of GM food. This qualitative study is designed to understand the perceptions of GM food among natural food shoppers in Southern Nevada.

CHAPTER II:

THEORETICAL FRAMEWORK AND LITERATURE REVIEW

Theoretical Framework

This study was designed to follow certain principles of the Health Belief Model (HBM). HBM aims to understand individual perceptions of benefits when performing a health behavior, barriers to performing a health behavior, disease susceptibility and severity if the behavior is not performed, and self-efficacy related to engaging in a health behavior (Glanz, Rimer, & Viswanath, 2008). In this particular study, the perceptions of GM food among natural food shoppers in Southern Nevada have been investigated.

Certain individuals may fail to engage in the intentional avoidance of GM food due to various reasons, such as lack of general knowledge of GM food or the difficulty in identifying food as conventional. Collectively, these are known as "perceived barriers" in the model. Perceived susceptibility measures how susceptible an individual feels about contracting an illness or disease if GM food rather than conventional food is consumed. Individuals that seek and purchase conventional food due to health reasons may have the notion that an illness or disease may develop due to the consumption of GM food. Likewise, perceived severity measures how an individual feels regarding the seriousness of the conditions. The belief that an individual has the means to overcome barriers is termed "self-efficacy". Those with a high level of confidence in engaging in healthy behaviors often demonstrate a high level of self-efficacy. Lastly, although not part of individual perceptions, "cues to action" plays an important role in the model because they are strategies that serve as reminders for individuals to participate in the intended behavior (Glanz et al., 2008). "Self-efficacy" and "cues to action" did not apply in this study.

The cornerstone concept of HBM as it relates to this study is the participants' perceived benefits of consuming conventional food rather than GM food. Since the

participants in this study have willingly decided to purchase and consume conventional food and avoid GM food at least to a certain degree, it can be anticipated that they perceive that food that has not been GM is beneficial to health, the environment, and/or society.

Rationale for Using Qualitative Methods

Qualitative research designs encompass a distinct approach compared to quantitative designs. Qualitative methods take advantage of natural settings to study the phenomenon in question by using various data collection tools that enable interaction with study participants (Marshall & Rossman, 1999). This interaction typically takes place at the site where participants experience the issue or problem that is being studied (Creswell, 2013). Qualitative researchers use observations, interviews, focus groups, and other methods as data collection tools. Data analysis consists of identification of common themes, or topics, that emerge from the data. Qualitative research often focuses on *what* and *how* questions to explore the topic of interest. Participants are encouraged to freely discuss their individual meaning about the topic (Creswell, 2013) to paint a rich and vivid picture of their views and experiences (Grbich, 2013).

The inquiry to this qualitative research study focuses on the perceptions of GM food. Specifically, the aim of this study was to explore the ideas, views, opinions, attitudes, and lived experiences regarding GM food among natural food shoppers in Southern Nevada. Various types of study designs exist within qualitative research (Creswell, 2013; Marshall et al., 1999) and an ethnographic approach has been used in this study.

Ethnographic Studies

The identification and examination of a culture-sharing group is a landmark approach to ethnographic studies (Creswell, 2013). A culture-sharing group is defined as a group of people, regardless of size, that share patterns of behavior, beliefs, values, ideas, language, and/or other characteristics. Ethnographic research aims to understand a culture-sharing group's social behavior by looking for patterns in their mental processes (Creswell, 2013) while the researcher remains in a neutral position as an observer (Grbich, 2013). In addition, ethnographic studies begin with a theory about the phenomenon in question, constructing an explanation that the researchers hope to find (Creswell, 2013). In this particular study, the culture-sharing group is natural food shoppers within the Southern Nevada population. The individuals under study share certain beliefs, values, ideas, and behaviors regarding GM food that translate into group-sharing behaviors that this study sought to understand.

Literature Review

In the next three sections, the following topics in genetic engineering will be discussed in detail: substantial equivalence, the difference between cross-breeding and genetic engineering, and pleiotropic effects. Substantial equivalence describes how the FDA views similarities and differences between GM and conventional food, which in turn influence and govern food regulation and policy. Methods to obtain desired traits from different species of plants or animals differ between cross-breeding and genetic engineering, which also marks a crucial topic of discussion. According to the literature, using genetic engineering methods to choose desired traits in the offspring of plants and animals can have detrimental human health consequences due the possibility of

pleiotropic effects, which marks the cornerstone concern among researchers (UCSC, 2005; Pusztai et al., 2003; Prescott et al., 2005).

Substantial Equivalence

The concept of "substantial equivalence", as created by the Group of National Experts on Safety in Biotechnology of the Organization for Economic Cooperation and Development (OECD) (2000) in 1993 (OECD, 1993), provides a basis for comparing GM food to their conventional counterparts in terms of nutritional characteristics (FDA, 1992). Due to extensive inquiries by the public, academic institutions, and the media regarding the FDA's stance on GM food, the agency has adopted this measure to assure the safety of consuming such food. By the agency's definition, GM food is deemed as safe as their antecedent to consume due to the long history of cross-breeding various plant varieties, the proven safety record of using such methods, and the experience and knowledge gained over the years by professionals in the appropriate fields. Based on this conclusion, the FDA has determined that it is not necessary for the agency to label or conduct rigorous safety testing, such as RCTs or prospective studies, on GM food. In addition to the absence of a pre-market approval process of GM food by the FDA, consultations between GM seed producers and the FDA are not required for GM food to be approved for sale. As such, GM seed producers are ultimately held accountable for any health risks posed by their products. The primary methods employed by the FDA to assess the safety of such novel foods include the observation of quality, agronomic, and nutritional properties (FDA, 1992).

Widespread concern over the meaning of substantial equivalence has surfaced ever since the term was adopted by the FDA. In particular, some have expressed concern that the concept has been crudely defined at best with no set standard defining the

allowed deviation between GM and conventional food before foodstuffs no longer qualify as being substantially equivalent. Moreover, no precise definition has been established by legislators (Miller et al., 1999). Because GM seeds are patented, some have questioned the rationale for recognizing GM food as no different than conventional food, yet different enough to be patented. Some argue that comparing nutritional characteristics, such as protein, carbohydrate, and fat content between GM and conventional lines is unacceptable to determine potential risks to human health; instead, toxicological, allergenic, and other biologic tests would be more appropriate (OECD, 1993). Critics signify that substantial equivalence creates a loophole that excuses GM seed producers from conducting proper toxicological and allergenic testing to determine if consuming GM food indeed carries no increased health risks (Pusztai et al., 2003).

Cross-Breeding and Genetic Engineering

It is widely recognized that traditional cross-breeding methods, also known as Vertical Gene Transfer, have inherent limits on what species can be cross-bred (UNL, 2014). For example, two different types of plants can be cross-bred if at least one of them possesses desired traits. If Plant A possesses desired traits that Plant B does not have, and if Plant B has desired traits that Plant A does not have, it may be possible to cross-breed these plants to yield a novel plant, a hybrid, that may produce the desired traits from both parent plants (UNL, 2014). Likewise, two different but similar types of animals can be cross-bred to produce a novel one, as is the case of a mule produced when cross-breeding a male donkey and a female horse (U.S. Library of Congress, n.d.). When cross-breeding occurs, many other traits in addition to the desired ones are inherited by the resulting offspring (UNL, 2014). In contrast, genetic engineering allows for direct DNA manipulation across species and "…involve the capacity to isolate, cut and transfer

specific DNA pieces, corresponding to specific genes" (Lewin, 1999; Klug et al., 2002). In other words, due to the monumental achievement of genetic engineering, only the favorable genes from living organisms including plants, bacteria, humans, insects, and other animals can now be extracted and inserted across each other (UNL, 2014), a process known as Horizontal Gene Transfer, which may lead to unintended and unforeseen health and environmental consequences (UCSC, 2005).

Pleiotropic Effects

The expression of genes of a plant after genetic engineering is often cited as unpredictable and unstable with different results produced at each insertion attempt. This may produce unintended plant characteristic known as pleiotropic effects (Pusztai et al., 2003; Dona et al., 2009). These effects usually result when multiple copies of the desired gene are inserted into the plant genome unintentionally and/or when these copies are inserted into random locations. These scenarios usually occur because current genetic engineering technology does not allow scientists to perform gene insertion with great accuracy and precision. As a result, scientists have limited control in regards to the number of copies of genes inserted and the insertion location in the chromosomes. It is this lack of control that may dictate plants' allergenicity, toxicity, and nutrient levels in addition to their resistance to pesticides and other characteristics (Pusztai et al., 2003).

Potential Benefits of Genetically Modified Food

Genetically modified crops may have numerous benefits in terms of improved quality and nutrition compared to their conventional counterparts (UCSC, 2005). Two crops with potential benefits include Arctic Apples, which have been approved for growing in the U.S., and Golden Rice, which is still in the testing phases.

Improved Food Quality

Arctic Apples, a genetically modified apple variety, has been developed to prevent the oxidation process, which cause browning of sliced or bruised apples (Okanagan Specialty Fruits, 2014). The non-browning feature of these apples results in higher apple quality along with better texture and taste after slicing or bruising. As such, benefits are gained throughout the supply chain. Growers may lose fewer apples due to browning as a result of slight bruising as apples are handled. Producers of pre-sliced apples may rely on fewer chemicals to preserve apples' appearance. From the consumer standpoint, fewer apples may be thrown away due to browning, and apple consumption among children may increase due to their appealing appearance after slicing.

Improved Nutrition

Golden Rice, a rice variety that is genetically modified to be high in beta-carotene, has been developed to address vitamin A deficiency in developing countries (FAO, 2003 & Potrykus, 2001). These countries, which highly depend on rice as a source of nourishment, may benefit from Golden Rice to decrease the incidence and prevalence of disease associated with low vitamin A intake (FAO, 2003 & Potrykus, 2001). According to the United Nations Children's Fund (UNICEF) (2015), "vitamin A deficiency is the leading cause of preventable childhood blindness and increases the risk of death from common childhood illnesses such as diarrhea." Vitamin A deficiency affects about 250 million children worldwide, which 250,000 to 500,000 of them become blind every year (WHO, 2015a). In addition, the condition also affects pregnant women in developing countries. Because vitamin A deficiency affects children in more than half of all countries, Golden Rice has the potential to improve public health throughout the world.

Potential Health Hazards of Consuming Genetically Modified Food

Although some GM crops, such as Arctic Apples and Golden Rice, may provide numerous benefits to growers, manufacturers, and consumers, various concerns, such as allergenicity (Pusztai et al., 2003; Prescott et al., 2005; Nordlee, Taylor, Townsend, Thomas, & Bush, 1996) and increased pesticide exposure (Benbrook, 2012) have been raised about other GM crops in previously published papers and literature reviews focusing on the health risks of consuming GM food (Miller et al., 1999; Pusztai et al., 2003; Conner et al., 1999; Domingo, 2007; O'Neil et al., 1998; Dona et al., 2009). The World Health Organization, environmental organizations, and studies relating to GM food list increased toxicity levels and changes in nutritional composition as additional potential concerns, which have been described elsewhere (UCSC, 2005; Miller et al., 1999; Pusztai et al., 2003; Conner et al., 1999; Domingo, 2007; O'Neil et al., 1998; Dona et al., 2009).

Allergenicity

An increase in allergenicity levels has been established as one of the primary public health concerns in GM food (Pusztai et al., 2003). It is possible for a GM product to carry allergenic properties if the inserted gene is derived from a source with a known history of allergenicity. As such, if an allergy-inducing gene is taken from common allergenic foods such as soybeans, peanuts, or shellfish and inserted into a food that is not allergenic in its unmodified state, then it may be reasonable to assume that the novel food may be allergenic, and consumers must take precaution. In an analysis of the allergenic potential of GM soybeans with proteins from the Brazil nut, it was discovered that some individuals were allergic to the novel soybeans, even though they were not allergic to soybeans without the Brazil nut proteins (Nordlee et al., 1996).

When a gene is derived from a non-allergenic source and inserted into another organism, it cannot be guaranteed that the resulting GM crop will not carry allergenic potential (Pusztai et al., 2003; Prescott et al., 2005). As noted earlier, the number of inserted copies, the location of the genes, and other variables influence the food's allergenic levels. Furthermore, a new allergen may be developed in the resulting food or its allergenic expression may be increased to a state where it may cause an allergic reaction even when the unmodified food's allergenic properties are so low that they do not pose a health hazard (Pusztai et al., 2003; Prescott et al., 2005). In many cases, the allergenic properties of an inserted gene are unknown, which by definition, does not guarantee that the recipient organism will be allergen-free (Pusztai et al., 2003). Indirect methods are available to identify potential allergenic levels in GM food with genes derived from foods with unknown allergenicity; these methods have been described in another study (O'Neil et al., 1998).

Increased Pesticide Exposure

It is understood by many experts and organizations that there has been a reduction in the overall application of pesticides on some GM crops over the years. An example of this is *Bt* corn, which requires less pesticide application because it produces its own internal pesticide (Shelton et al., 2013). However, USDA data conflicts with these assumptions (Benbrook, 2012). According to USDA's National Agricultural Statistics Service (1997), there was a substantial increase in herbicide use between 1996 and 2011. The agency reported that 1.42 pounds of herbicides per acre were applied to soybeans in 2006 compared to 1.17 pounds in 1996. Herbicide use in cotton rose from 1.88 pounds per acre in 1996 to 2.69 pounds per acre in 2010. The application of herbicides increased

on herbicide-resistant soybeans, cotton, and corn compared to non-herbicide resistant varieties by 527 million pounds between 1996 and 2011. Herbicide-resistant soybeans accounted for 70% of this increase primarily due to the greater reliance on glyphosate (Benbrook, 2012), the active ingredient in Roundup, to manage pesticide resistance problems. Such increase in herbicide use may accelerate bioaccumulation and pose significant threats to human health, such as birth defects, nerve damage, cancer, and other ailments (EPA, 2012). Just recently, glyphosate was declared as a probable human carcinogen (WHO, 2015b).

To address the current issue of increased pesticide resistance in weeds due to the continued use of Roundup on GM crops over time, EPA approved the herbicide Enlist Duo™ on October 15, 2014 (EPA, 2014). Enlist Duo is a mixture of two herbicides: 2,4-D and glyphosate. 2,4-D was one of two herbicides used during the Vietnam war, and has been associated with non-Hodgkin's lymphoma (Zahm et al., 1990), soft tissue sarcoma (Kogevinas et al., 1995), and Parkinson's disease (Tanner et al., 2009). Enlist Duo was produced specifically for application to corn and soybeans genetically engineered to tolerate this herbicide. These crops would be grown in farms and Enlist Duo would be applied to these crops, killing the surrounding weeds but producing no harm to the crops. Due to the current use of Roundup and near-future use of Enlist Duo, increased pesticide residue is expected in soybeans (EPA, 2014), revisiting the issue of public health, increased pesticide exposure, and bioaccumulation. Children exposed to pesticides have an increased risk of developing health problems due to their continuing biological development (EPA, 2012). Social behavioral problems (Ribas-Fitó et al., 2007), neurodevelopmental delays (Eskenazi et al., 2007; Handal et al., 2007; Ribas-Fitó et al.,

2003; Torres-Sánchez et al., 2007) and impaired motor skills (Guillette et al., 1998) have resulted due to exposure to organophosphate pesticides in children.

Environmental and Ecological Hazards of Growing Genetically Modified Food

Two distinct concerns have been raised relating to environmental and ecological hazards of growing GM food: superweeds (Rohr & McCoy, 2010) and the pending approval of AAS by the FDA (FDA, 2012). The resistance to Roundup developed by superweeds has prompted farmers to use more of this herbicide on GM crops, which translated to increased farming costs and additional farming tasks (Benbrook, 2012). The approval of AAS may set the stage for not only questionable health risks (Matheson & FDA, 1999), but also ecological risks if the transgenic fish were to escape into the wild (FDA, 2012).

Emergence of Superweeds

The increased use of glyphosate has been a direct result of the emergence of superweeds in farms (Benbrook, 2012). These weeds, over time, develop resistance to glyphosate, and gradually require more application of the chemical to eliminate them. Due to increased toleration of glyphosate by herbicide-resistant crops, the product can be applied throughout the growing season as opposed to specific time periods for conventional crops. Indeed, farmers have responded by increasing herbicide application rates and applying additional herbicide active ingredients, creating deep tillage for the burial of superweed seeds, and conducting manual removal of these weeds. Such interventions increase the costs of farming (Benbrook, 2012).

The first glyphosate-resistant weed emerged in Australia in 1996 (Benbrook, 2012); Monsanto scientists argued in several reports that the evolution of glyphosate-resistant superweeds was unlikely, indicating that glyphosate has been used for over 20

years with the absence of resistant weeds (Padgett et al., 1995; Bradshaw, Padgette, Kimball, & Wells, 1997). However, Dr. Ian Heap from the International Survey of Herbicide-Resistant Weeds issued a warning in a 1997 presentation recommending that rather than relying solely on Roundup for weed control, proven resistance-management practices and non-chemical weed control methods should be used in conjunction with the product (Rohr et al., 2010). More recently, weed scientists and other professionals in related industries argued for incorporating integrated pest management systems and less reliance on Roundup to extend the usefulness of the product (Mortensen, Egan, Maxwell, Ryan, & Smith, 2012; Duke, 2011; Harker et al., 2012; Owen, 2011). Without such a change, a crisis in weed management is expected along with environmental, public health, and economic consequences (Benbrook, 2012).

Heap (2012) indicates that over two-thirds of the 70 glyphosate-resistant weed combinations have been documented in the U.S. alone since 2005. This demonstrates the rapid evolution of these weeds. Over 14 million acres are now infested throughout the U.S. (Heap, 2012). However, this number appears to be an underestimation (USDA National Agricultural Statistics Service, 1997; Gressel, 1996). As discussed in the previous section, Enlist Duo was approved to address the issue of increased weed resistance to Roundup (EPA, 2014). However, given the fact that weeds eventually became resistant to Roundup, EPA is anticipating the eventual weed resistance to Enlist Duo in the future (EPA, 2014).

AquAdvantage® Salmon

At this time, there are no GM animals approved for human consumption. However, AquaBounty's AAS is currently being reviewed by the FDA to assess its safety

for human consumption and potential environmental impacts. The GM salmon is primarily designed to reduce the time-to-market; a gene from the Chinook salmon is inserted into AAS to induce growth all year as opposed to only in specific months during the year (FDA, 2012). Thus, the GM fish arrives at fully grown size at a much faster rate than its unmodified version, substantially reducing the time a farmer raises the fish. In a study by AquaBounty, the mean body weight of a AAS population was 261.0 grams (0.58 pounds) compared to their non-transgenic counterparts weighing in at 72.63 grams (0.16 pounds). The organization's rationale for supporting the production of AAS was determined by the increasing demand for fish. Nearly 50% of the demand is for fish grown via aquaculture. Indeed, the world consumed approximately 243 billion pounds of fish, about 114 billion of them coming from commercial aquaculture in 2006. In light of this increasing demand, in addition to declining stocks and diminishing capture of fish, AquaBounty supports the expansion of aquaculture and sees potential in the production of AAS (FDA, 2012).

To minimize potential environmental impacts in the event that AAS is approved by the FDA, AquaBounty has established various biological barriers within the fish at the DNA level. In case of escape, these barriers may prevent the disruption of native non-transgenic salmon populations and the establishment of competition in wild Atlantic salmon ecosystems. AquAdvantage salmon will be engineered to be triploid (have three sets of chromosomes), sterilized, and all female. By this design, according to AquaBounty, reproduction of AAS is nearly impossible and would pose no threat to wild salmon populations (FDA, 2012 & AquaBounty Technologies, Inc., 2014). However, the FDA's Environmental Draft Assessment for AAS, which includes an analysis of a study

conducted by AquaBounty, indicates that 14 out of 20 batches of eggs did not result in 100% sterilization (FDA, 2012). Consequently, stringent quality control measures of eggs, including phenotypic and genotypic examination may be critical to ensure that the eggs chosen meet the required specifications to minimize impacts of biodiversity of wild salmon populations in case of escape.

Regarding physical containment of AAS, various security measures at the breeding facility in Prince Edward Islands, Canada will be implemented including a fence surrounding the buildings. Bars will be placed on windows, various types of door locks will be used, security cameras will be installed, and security personnel will be hired to patrol the facility during non-business hours, among other measures (FDA, 2012). Once breeding occurs and eggs are produced, these eggs will be transferred to a facility in the Republic of Panama to raise the fish to market size. Once raised to market size, the fish will be transferred to the U.S. and sold in markets (FDA, 2012). However, because the eggs are not handled by solely one agency in one location, these scenarios may set the stage for improper handling of eggs at any point in time during egg production, transfer of eggs, or growing of the fish.

Regardless of the FDA's stance that GM food is safe to consume per substantial equivalence (FDA, 1992), the agency admits that potential issues exist not only with GM fish, but also with GM food in general. The agency states that the current technology creates difficulty in stabilizing inserted genes which may result in uncontrolled expression of those genes and may even alter other genes, possibly affecting food safety (Matheson et al., 1999).

Social and Economic Impact of Growing Genetically Modified Food

The unintentional contamination of conventional farms with GM seeds has been a prime concern among farmers. Genetically modified seed contamination has resulted in numerous instances of increased cost to farmers (Center for Food Safety, 2013a; GM-Free Cymru, 2007a; Food & Water Watch, 2013), the U.S. economy (GM-Free Cymru, 2007a), and U.S. exports (Greenpeace, 2007). In addition, due to the increasing awareness among the public regarding GM food, various initiatives by non-profit organizations have been introduced to label such foods. In 2002, Oregon became the first state to attempt to label GM food with the introduction of Measure 27 (Oregon Secretary of State, n.d.), which ultimately failed to pass. Ever since the first measure introduced in California, Proposition 37 in 2012, the movement to label GM food has taken the interest of major supermarkets (Trader Joe's, 2014; California Right to Know, n.d.; Robb & Gallo, 2013), public health and medical organizations, the organic food industry (California Right to Know, n.d.), and other countries (U.S. Department of State, Bureau of Economic and Business Affairs, 2012; Office of California Senator Barbara Boxer, 2013; USDA Foreign Agricultural Service & Mousa, 2012).

Genetically Modified Seed Contamination

A serious concern has been raised by food safety and environmental organizations (Center for Food Safety, 2013a; Food Democracy Now!, 2013; Organic Consumers Association, 2013; Greenpeace, 2013) regarding the implementation of open air field trials of GM seeds in farms that grow GM crops. It is especially concerning when these trials are being conducted near farms that strictly grow conventional crops; these farms are at high risk for becoming unknowingly and unintentionally contaminated with GM material. It has been noted that conventional farms can be contaminated with GM

material from farms more than several miles away (Center for Food Safety et al. vs. Thomas J. Vilsack et al. and Forage Genetics, et al., 2012). Contamination typically occurs due to poor quality control measures, cross-pollination, and post-harvest mixing (Greenpeace, 2007). For example, improper seed cleaning of machinery, negligent seed mixing, spillage during transport, and the fertilization of conventional plants by pollen from GM plants carried by the wind can cause these scenarios (Center for Food Safety et al. vs. Thomas J. Vilsack et al. and Forage Genetics, et al., 2012).

Numerous events have occurred in the past that resulted in unintentional GM seed contamination in farms growing conventional crops. Bayer CropScience was the center of attention for several years when it was discovered that long-grain conventional rice was contaminated with three varieties of Liberty Link GM rice in three separate instances; the rice was designed to resist the application of the herbicide glufosinate (GM-Free Cymru, 2007a). On August 18, 2006, U.S. government officials announced that the Liberty Link GM rice variety LL601, which was not approved for human consumption anywhere in the world (Greenpeace, 2007), was found in rice marketed as conventional. At the time of the announcement, the contaminated rice had already been exported to many countries and was on international store shelves. Subsequently, countries around the world began testing U.S. imported rice for GM material; many tests indicated positive results for LL601. Swift action was taken by international markets, including nineteen European countries, the United Arab Emirates, Kuwait, and the Philippines to remove the rice from store shelves, and halted U.S. imports of long-grain rice (Greenpeace, 2007). Consequently, U.S. rice prices plummeted, which financially affected U.S. farmers (GM-Free Cymru, 2007a), costing them $1.2 billion (Food & Water Watch, 2013), affected the

U.S. economic climate (GM-Free Cymru, 2007a), and tarnished the image of the U.S. as a reputable exporter (Greenpeace, 2007).

On March 4, 2007, a second contamination incident was identified when the GM rice variety LL62 was found in farms in southern U.S. states (GM-Free Cymru, 2007b). Twenty percent of 500 rice samples tested positive for trace amounts of LL62. It is estimated that the contamination occurred sometime in 2004 and had not been discovered beforehand due to the lack of GM testing on rice (GM-Free Cymru, 2007b).

In a separate instance, the USDA's Animal and Plant Health Inspection Service (2013) announced on May 29, 2013 that an investigation was being conducted when a farmer in Portland, Oregon discovered, with the assistance of Oregon State University scientists, that an unapproved and illegal version of GM wheat, designed to resist the application of glyphosate, had contaminated his farm. During this time, no GM wheat varieties had been approved for sale in the United States. However, Monsanto conducted GM wheat field trials between 1998 and 2005 in 16 different states including Oregon. The USDA has confirmed that the strain of GM wheat found in the Portland farm matches the strain that was field-tested by Monsanto during this time period. The USDA launched a formal investigation to determine how the farm became contaminated and the source of the GM wheat variety (USDA Animal and Plant Health Inspection Service, 2013).

As a result of the Oregon farm contamination, several countries, including Japan, South Korea, and some from the European Union, called off importation of U.S. wheat or required its testing before being imported (Center for Food Safety, 2013b). Due to declining wheat prices and increased growing costs to maintain the integrity of wheat, the

Center for Food Safety (2013b) announced on June 6, 2013 that it had filed a class action lawsuit against Monsanto on behalf of Pacific Northwest wheat farmers, the overarching company that owns the affected farm. The FDA is currently investigating a second incident of GM wheat found in Montana (USDA Animal and Plant Health Inspection Service, 2014).

Genetically Modified Food Labeling

The first statewide labeling initiative was Oregon's Measure 27 in 2002 (Oregon Secretary of State, n.d.), which did not pass. The second major labeling initiative for GM food surfaced in California with the introduction of Proposition 37 in 2012 (California Right to Know, n.d.). The proposition's main purpose was to empower the consumer on making informed food choices as described on "Yes on 37 For Your Right to Know if Your Food Has Been Genetically Engineered". Proposition 37 was a major California campaign that launched the monumental grassroots movement of labeling GM food in California: "Proposition 37 is a common-sense November ballot measure that will help consumers make informed choices about the food they eat" (California Right to Know, n.d.). With an extensive online presence, aggressive campaigning, collaboration with thousands of volunteers and 2,000 organizations, including environmental, health, and farming groups, faith-based organizations, and food manufacturers and retailers, the campaign was able to collect nearly one million signatures in a 10-week period for the support of the proposition. Organizations that supported the measure included the Center for Food Safety, Consumers Union, American Public Health Association, California Nurses Association, Organic Consumers Association, and Food Democracy Now!, among others (California Right to Know, n.d.).

However, not all organizations, food retailers, and food manufacturers were in favor of the proposition. Organizations and individuals that opposed the measure claimed that it conflicted with science, favored special interest groups, would increase taxpayer costs, and would raise food prices because food manufacturers would have to modify their packaging with GM food labels and would have to source conventional ingredients, which may be more costly (No on 37: Coalition Against the Deceptive Food Labeling Scheme, n.d.). Monsanto spent over $8.1 million dollars in lobbying, public relations, and other activities to help defeat the measure. DuPont, a science-driven chemical company that also manufactures genetically modified seeds, spent over $5.4 million. Among food manufacturers, Pepsi Company spent over $2.1 million, Coca-Cola spent $1.6 million, Nestlé spent $1.4 million, and ConAgra Foods spent $1.1 million to prevent the passing of the measure (California Right to Know, n.d.). It is evident that large organizations, such as Monsanto, other science and biotechnology firms, and the food and beverage industry have adequate financial resources to defeat such initiatives compared to non-profit organizations, natural food manufacturers, and individual health and environmental advocates. In total, $45.6 million was raised to oppose the campaign compared to $8.9 million in support of the measure. Such a wide gap in spending was a leading contribution to the initiative's defeat at 53% for the opposition and 47% in favor (Flynn, 2012).

After the defeat of California's Proposition 37, other states followed suit in initiating measures, and some even passing them, to label GM food within their borders. For example, the state of Washington introduced Initiative Measure No. 522 on June 29, 2012 to require labeling of certain GM foods. Results of the November 2013 ballot

indicated defeat of the measure with 45% of the votes in favor and 55% against (Kuei-Jung, 2013). More recently, initiatives in Oregon (Oregon Live, 2014) and Colorado (Politico LLC, 2014) also failed to pass. Connecticut became the first state to pass legislation requiring labeling of GM food (State of Connecticut, 2013) and Maine became the second (State of Maine Legislature, 2014). However, the legislation language for both states indicates a contingency for labeling, and thus the laws have not yet taken effect. Vermont became the third state (The Vermont Legislative Bill Tracking System, 2014), and is set to require GM food labeling within the state starting in July 2016 without contingencies (University of California, Los Angeles, 2014).

Washington senator Maralyn Chase has expressed concern regarding economic impacts due to the lack of GM food labeling (Concerning the Disclosure of Foods Produced Through Genetic Engineering, 2013). For example, because unlabeled GM corn exists, many European Union and Pacific Rim countries no longer import any corn from the U.S. In 1994 and 1995, European Union countries depended on the U.S. to supply them with 82% of their corn needs. By 2005, importation of U.S. corn into these countries halted completely due to the development of GM corn varieties (Concerning the Disclosure of Foods Produced Through Genetic Engineering, 2013).

Many international bodies have implemented labeling regulations for GM food. Sixty-four countries around the world already require labeling of GM food including developed nations, such as Japan, Australia, New Zealand, Russia, China and the entire European Union (Office of California Senator Barbara Boxer, 2013). Some countries implemented moratoriums or partially banned these foods. Peru, for example, declared a 10-year moratorium on December 9, 2011 on the entry of GM food into the country (U.S.

Department of State, Bureau of Economic and Business Affairs, 2012). In addition, Saudi Arabia has banned the importation of GM seeds (USDA Foreign Agricultural Service et al., 2012) and Hungary has halted the cultivation of GM crops within its borders (USDA Foreign Agricultural Service & Nemes, 2012).

Due to increasing awareness among the public regarding GM food, some food retailers have pledged to listen to consumers regarding these foods and act accordingly. Trader Joe's, a national grocery store chain that focuses on healthier foods, does not use GM ingredients in any of their branded products (Trader Joe's, 2014). Similarly, Whole Foods Market announced in 2013 that by 2018, all products in their stores would be labeled if they contain GM ingredients (Robb et al., 2013).

Past Qualitative Studies

In a study conducted in seven European countries (The Netherlands, Slovenia, Spain, Sweden, The United Kingdom, Poland, and Greece) (King's College London, 2008), results support several concerns previously described. For example, participants in The Netherlands, Sweden, The United Kingdom, and Poland expressed that consumers should be made aware if foods they are buying are GM to facilitate consumer choice, which would be accomplished by labeling. Regarding perceived health risks, participants expressed concern relating to fears of increasing food allergies. This concern stems from the notion that gene technology is relatively new and future potential health consequences are difficult to foresee.

Participants in all countries were concerned about unforeseeable environmental consequences, particularly cross-contamination and the development of pest resistance. Although most countries focused on the possible negative aspects of GM food, focus

groups in The Netherlands, Spain, Sweden, and Greece discussed the possible benefit of producing more food to reduce famine and secure more food for the growing world population.

Summary

This qualitative study follows the principles of HBM, which focuses on perceived benefits of performing a health behavior. In this study, the health behavior is purchasing and consuming food that is not GM. Qualitative studies involve the use of natural settings to study the phenomenon in question. Data analysis consists of identifying common themes that emerge from the data.

Three main topics emerged from the literature: substantial equivalence, differences between cross-breeding and genetic engineering, and pleiotropic effects. Substantial equivalence indicates that there is no difference between conventional and GM food. Cross-breeding allows the transfer of genes across related species, while genetic engineering allows the transfer of genes across unrelated species. Pleiotropic effects introduce the possibility of yielding unintended plant characteristics.

Two primary health concerns about GM food include the potential for them to become allergenic, and the bioaccumulation of pesticides in humans as a result of pesticide overspraying on GM crops. Other concerns include the emergence of superweeds, the contamination of farms growing conventional crops by GM material, and the potential for reproduction of AAS with native fish populations.

The public has taken interest in labeling food products that contain GM ingredients. This interest has resulted in the introduction of numerous bills and ballots in several states. Currently, three states have passed GM food labeling laws: Connecticut,

Maine, and Vermont. Past qualitative studies have found that individuals are concerned about topics found in the literature, including allergenicity of GM crops, cross-contamination, and propagation of characteristics of GM animals to native populations.

CHAPTER III:

METHODOLOGY

Institutional Review Board

The study proposal, including the recruitment flyer, a copy of the informed consent form, and the questionnaire was submitted by the principal investigator (Dr. Dodge-Francis) to the University of Las Vegas' Institutional Review Board (IRB) at the Office for Research Integrity – Human Subjects for review. Because the study posed minimal risk to participants, the study qualified as exempt research. Notification of approval was given to the principal investigator in June 2014.

Site of Study

Data collection took place at the main University of Nevada, Las Vegas (UNLV) campus. The urban research university was founded in 1957 (UNLV, 2014) and lies at the heart of Las Vegas, a world-class tourist destination. As of 2014, the university had over 28,000 students and nearly 3,000 staff members (UNLV, 2014).

Approval to hold data collection sessions in a classroom was obtained from the School of Community Health Sciences. Two data collection sessions were held in July and one in September 2014. Before each session, tables and chairs in the classroom were arranged in a way conducive to qualitative data collection. Refreshments were provided to participants.

Research Methods

The rest of this chapter focuses on the methods used to carry out this study, including the research question, sampling methods, the data collection and analysis process, data storage, and strategies used to ensure validity and reliability.

The Research Question

The research question for this study was "What are the perceptions of genetically modified food among natural food shoppers in Southern Nevada?"

Sampling

Because the purpose of this study was to understand perceptions of GM food among natural food shoppers, the individuals that were recruited for this study included those that, to some degree, avoid consuming GM food. Individuals that expressed concern regarding GM food but did not intentionally avoid it did not qualify for the study. To be eligible for the study, individuals were required to:

- Seek and purchase food with the USDA's organic seal with the intention of avoiding GM ingredients. USDA regulations do not permit GM ingredients in organic food (USDA Agricultural Marketing Service, 2014),

  and/or
- Seek and purchase food with the Non-GMO Project's seal which indicates that the food is free from GM ingredients,

  and
- Be at least 18 years old

A criterion sample design was conducted to recruit nine participants for the study. Participants were recruited by physically posting flyers on UNLV message boards throughout the campus and establishments where consumers of organic and/or conventional food were found (e.g., natural food stores and restaurants). Flyers indicated that participants were needed for a group discussion if they seek the USDA organic seal and/or the Non-GMO Project's seal when purchasing their food. The flyers also indicated

the incentive for participation, the co-investigator's name (Christian Murua-Aceves), phone number, and email address. Once an individual expressed interest in the study by calling or emailing the co-investigator, he introduced himself and verified that:

- The individual lived in Southern Nevada (Lincoln, Nye, Clark, or Esmeralda county)
- The individual was at least 18 years of age
- The individual seeks and purchases conventional (non-GM) food by seeking the USDA's organic seal and/or the Non-GMO Project's seal on the product packaging
- The individual was willing to travel to Las Vegas for the focus group if he or she did not live in the city

If the individual was eligible for the study, the co-investigator proceeded to provide further details:

- The purpose of the study
- Estimated length of the focus group
- The incentive for participation, a $15 gift card for Whole Foods Market

Before the conclusion of each call, the co-investigator asked the participant for his or her first name, contact phone number, and email address.

Data Collection

Two focus groups and one interview were conducted for this study, which encompassed a total of nine participants. Upon the initial recruitment of five individuals for the first focus groups, the principal investigator and co-investigator agreed on a day

and time for the discussion. Once an agreement was made between the principal investigator and co-investigator, the participants were notified of the day, time, and location. The same procedure was followed for the second focus group. In addition, an interview was conducted. The original intention was to conduct a third focus group with three participants instead of an interview. However, one participant cancelled the night prior to the focus group and the other did not attend. A summary of participant demographics is shown in Table 1. A theme relating to diet emerged, which explains the reasoning to include the "diet" column.

Table 1. Demographics of study participants.

Participant	Gender	Age	Diet*
Focus Group 1			
Participant 1	Male	49	Omnivorous
Participant 2	Female	46	Vegetarian
Participant 3	Female	18	Vegan
Participant 4	Male	33	Vegetarian (most of the time)
Participant 5	Female	23	Vegetarian
Focus Group 2			
Participant 6	Female	26	Omnivorous
Participant 7	Male	46	Vegan (most of the time)
Participant 8	Female	32	Vegan (most of the time)
Interview			
Participant 9	Male	34	Omnivorous

*A vegetarian diet excludes meat, poultry, seafood, and sometimes eggs and/or milk.
A vegan diet excludes meat, poultry, seafood, and all animal derivatives.
An omnivorous diet has no specific restrictions.

The principal investigator conducted the first focus group, while the co-investigator conducted the second focus group and the interview. Upon arrival of the participants at the discussion and verification that all participants had completed informed consent forms, both investigators introduced themselves (see Appendix A for the data collection discussion guide). The facilitator for each group proceeded with the

purpose of the study. The participants were made aware that the discussion would be recorded for analytic purposes. The recording device was activated, and discussion began by following the list of questions that the principal investigator and co-investigator developed (see Appendix B). All participants were given equal opportunity to provide insights and opinions. Incentives were distributed at the conclusion of each discussion. No participants decided to exit any of the discussions early.

Data Analysis

The data were transferred from the recording device to the co-investigator's personal computer for analysis. The co-investigator listened to the audio recordings and transcribed them in Microsoft Excel 2007, which allowed him to organize and sort the data by theme, participant name, participant comments, and other variables. Microsoft Excel also has important functions to assist in facilitating data analysis, such as the search feature, highlighting of text, and the insertion of comments. One Excel file was created for each discussion. However, data analysis took into account all themes combined from all discussions for the identification of themes.

Data Storage

The audio recordings and transcription files were stored in the co-investigator's password-protected computer during transcription and data analysis. After analysis of the data, audio files were given to the principal investigator to store for up to five years in the event that reference to the data is needed. The co-investigator erased the audio recordings from his computer after copies were given to the principal investigator. Informed consent forms will also be stored in the principal investigator's office for up to five years. Once the data are ready to be disposed of, paper documents will be taken to an office supply

store to be shredded, and digital files will be permanently deleted from the principal investigator's computer.

Validity and Reliability

Several strategies were employed to ensure study validity and reliability. One such strategy taken was establishing methodological coherence. Methodological coherence ensures that a proper research approach is taken based on the research question, which increases data quality (Morse, Barrett, Mayan, Olson, & Spiers, 2002). However, the production of quality data does not necessarily indicate that the data will be analyzed appropriately.

To account for possible deficiencies in data analysis and to increase the validity of study results, the triangulation strategy was also applied. Triangulation "...increases validity by incorporating several viewpoints and methods" (Yeasmin & Rahman, 2012). Triangulation was applied in two ways: by the principal investigator's examination of the transcripts and data analysis results produced by the co-investigator to gain a second point of view, and by the use of two distinct data collection methods- focus groups and interviews. Social influence, "...a process in which individuals modify others' behaviors, thoughts, and feelings" (Cartwright, 1959; Lewin, 1951), may have occurred at the focus groups, causing some participants to respond to questions in a socially desirable way. Social influence was not possible at the single interview conducted because the participant was interviewed without input of others, thus increasing the validity of the results.

Lastly, conducting three data collection sessions rather than fewer may have eventually led to the point of saturation. Saturation is described as the point when "...no

new information is emerging..." (Grbich, 2013) among all study participants. Reaching the point of saturation is ideal in qualitative studies because it helps to ensure that most or all possible themes have been captured, and provides the cue that no new information will be gained from more data collection sessions.

Summary

Due to the nature of this study, IRB approval was needed to conduct it. The research question was "What are the perceptions of genetically modified food among natural food shoppers in Southern Nevada?" Nine individuals were recruited for the study.

Two focus groups and one interview were conducted at UNLV on three separate days. After conducting all three data collection sessions, data analysis began for the identification of themes. Data will be stored by the principal investigator for up to five years in the event that retrieval is needed. Once the data are ready to be disposed of, paper documents will be taken to an office supply store to be shredded, and digital files will be permanently deleted.

To ensure study validity and reliability, several strategies were employed including methodological coherence, triangulation, and attempts to reach saturation by conducting three data collection sessions.

CHAPTER IV:

RESULTS

Overall Findings

The following three main themes were identified: vegetarian and vegan diets, increasing consumption of whole foods and reducing processed foods, and having the right to know if food contains GM ingredients. Each main theme is discussed in more detail in each theme's specific section. Runner up themes identified included the general topic of healthy eating, the importance of conducting food research, and concerns about pesticides in food. Table 2 lists the three main themes and three runner up themes.

Table 2. Main and runner up themes identified.

Themes Identified
Main Themes
Vegetarian and vegan diets
Increasing consumption of whole foods and reducing processed foods
Right to know if food contains genetically modified ingredients
Runner up Themes
Healthy eating
Importance of food research
Concerns about pesticides in food

Based on participant responses that follow, the research question, which sought the perceptions of GM food among natural food shoppers in Southern Nevada, was addressed adequately.

There was a wide variation of knowledge across participants about GM food. All participants had a basic understanding of the genetic engineering process. When asked what first came to mind when hearing the words "genetically modified food", some participant responses included the following:

> "Scientists messing around with seeds to either stop the bugs from eating the crops or getting more out of their crops so in turn feeding more people..." (Participant 1, 2014)

> "Two things that don't belong together...you're putting the genetic structure of another organism into something that is probably fine by itself." (Participant 7, 2014)
>
> "Yeah, you know, genetically modified food, first thing that comes to mind just the uh, what's going on with the genetics of the actual plant; knowing that there is some alteration of the genetics of a plant to provide whatever desired outcome..." (Participant 9, 2014)

Participant 1's comment of "messing around with seeds" along with the two other participant responses are directly referencing WHO's definition of genetic engineering, indicating the alteration of the genetic structure of foods in a manner that does not occur in nature (2014).

An unexpected finding was that six out of nine participants indicated that they were at least partially vegetarian or vegan. Although there are several variations of vegetarian diets, in general, vegetarians do not consume meat or seafood (Academy of Nutrition and Dietetics, 2014), but still consume animal by-products such as milk and eggs. A vegan diet relies solely on a plant-based diet, which includes fruits, vegetables, legumes, grains, nuts, and seeds (American Heart Association, 2014), avoiding all animal products including eggs, milk, and honey. Individuals often adopt these diets due to health, environmental, and/or animal welfare concerns. Participants that cited practicing, at least partially, a vegetarian or vegan diet began doing so prior to learning about GM food.

Theme 1: Vegetarian and Vegan Diets

Six participants reported following a vegetarian or vegan diet at least part of the time. Participant 3 reported always following a vegan diet, Participants 7 and 8 reported following a vegan diet most of the time, Participants 2 and 5 reported always following a vegetarian diet, and Participant 4 reported being vegetarian most of the time.

Participants were asked when they first heard about GM food. Participant 3 reported adopting a vegan diet, followed by conducting further research on how to improve her health through dietary changes, which led to her discovery of GM food:

> "I became a vegan my sophomore year of high school...and I wanted to think about my health and what I can do to change my diet...I just did my own research...and...saw how GMO foods mess with your gut flora...I was shocked at how it was just so everywhere...if you look in the ingredients..." (Participant 3, 2014)

Another participant also reported becoming vegetarian before learning about GM food, which led to more shopping at health-oriented grocery stores:

> "When I was in high school, I was vegetarian but not because of GMO...before I started becoming a vegetarian, I did the transition of eating less chicken and cutting out the red meat and then just fish. That's when I really looked into GMO and I started going to more places like Sprouts and Whole Foods." (Participant 5, 2014)

The USDA's National Agricultural Statistics Service (1997) has previously reported increasing rates of pesticide use in certain crops and Benbrook (2012) has reported increased pesticide exposure as a public health concern. The literature also indicates increased toxicity levels (UCSC, 2005; Miller et al., 1999; Pusztai et al., 2003; Conner et al., 1999; Domingo, 2007; O'Neil et al., 1998; Dona et al., 2009) and the development of unintended allergenic properties (Pusztai et al., 2003) in GM food as potential concerns.

These are possible reasons why Participant 3 and Participant 5 decided to make changes to their diets.

When asked about what participants do to avoid GM food in restaurants, Participant 8 noted that restaurants that cater to vegans and vegetarians are aware that this population is already concerned about what they are eating, which motivates restaurant owners to source suitable ingredients. In addition, Participant 8 touched on the culture aspect, indicating that she and her husband (Participant 7) have an "ethical" food system that they follow:

> "I think it helps that we're also mostly vegan. We have our own ethical-like food system that we use. But generally, when you're going to a restaurant that caters to vegans or vegetarians, they're already doing a lot of the research for you because they know that you're already concerned about what you're eating." (Participant 8, 2014)

Theme 2: Increasing Consumption of Whole Foods and Reducing Processed Foods

Because a high percentage of soybeans, corn, and cottonseed are genetically modified as reported by the Center for Food Safety (2014a) and USDA Economic Research Service (2013), participants were aware that they are bound to encounter some of these ingredients in restaurant foods, thus focusing more on home-cooked meals. As documented by Benbrook (2012), a primary concern of consuming GM food is increased pesticide exposure. Indeed, all nine participants reported focusing more on preparing home-cooked meals and either reducing or eliminating eating at restaurants, or eating only at trusted restaurants. When going to restaurants, Participants 1, 6, and 9 reported being somewhat careful, Participants 2, 7, and 8 reported being very careful, and Participants 3, 4, and 5 reporting eating out rarely or not at all. Two participants that do not eat out responded with the following quotes:

> "I never really eat out. I mean, sometimes like in Disneyland...they have this neat place called Mother's Market and a vegan grocery store and they don't have any GMO products, so we usually just go there..." (Participant 3, 2014)

> "We stopped eating outside...I like it a lot eating at home because I know what I am actually cooking...I feel better." (Participant 5, 2014)

The following quote reiterates Participant 7's and his wife's (Participant 8) preference for whole foods, reducing processed foods, and the importance of research:

> "We're pretty careful about where we eat...avoiding fast food almost entirely. When we were traveling in Oregon, it's all farm to table. Vegas is kind of a challenging town because it's a very corporate city, and you know you're dealing with the industrial food system...there are some good local restaurants...that we like to go to...the food is very high quality...sometimes you just have to do a little bit of research...and it pays off if you're willing to do a little bit of work." (Participant 7, 2014)

When participants were asked how they verify that food they purchase in grocery stores is not GM, they indicated that they mostly purchase whole foods and limit or do not purchase processed foods:

> "But I've completely almost stopped buying processed foods so I don't worry about it [eating GM food] that much anymore...outside the rare box of macaroni and cheese...it's pretty much a whole food..." (Participant 2, 2014)

Theme 3: Right to Know if Food Contains Genetically Modified Ingredients

Participants were asked what they thought about a law that mandates labeling GM food in grocery stores. All participants except Participant 1 explicitly stated that foods that have GM ingredients should be labeled. Having the right to know if food contains GM ingredients was important to Participants 2, 3, 5, 7, and 9 which coincides with all seven recent GM food labeling initiatives that have focused on the consumers' right to know if foods they are buying contain GM ingredients (California Right to Know, n.d.; Kuei-Jung, 2013; Oregon Live, 2014; Politico LLC, 2014; State of Connecticut, 2013; State of Maine Legislature, 2014; The Vermont Legislative Bill Tracking System, 2014).

One participant felt upset and deceived because she thought she was feeding her kids healthy food until she heard about GM food:

> "So I just...I was...I was mad to the point where I just wanted to like, yell at someone because I've always tried really hard to feed my kids healthy foods...I *thought* I was giving them healthy foods...I started reading on how it's [GM food] linked to obesity and how it's linked to all these cancers...there's nothing okay about people not telling us what our food could do to us...and for scientists to do things to food and then not tell us. I mean, we do have a right to know. I don't think it's right." (Participant 2, 2014)

Another participant emphasized the importance for people to know what they are eating, responding with the following:

> "And yeah, so everyone should be very aware of what they're putting in their body...your body is your temple; your body is what you need to keep sacred because this is where you live...this is what's giving you life. And you're not treating it as well as you'd really want to, but you're not even aware of what you're eating. You don't even know the stuff that it [GM food] has." (Participant 5, 2014)

A third participant added to the discussion by saying that companies care about money, not public health:

> "I think people should have the right to know what's in their food...they don't want you to know what's in your food...it's the almighty dollar in the end for them...companies really don't care about individuals' health...they care about big money." (Participant 8, 2014)

The concerns of Participants 2, 5, and 8 echoes the main purpose of state initiatives introduced in the past few years which is to empower the consumer about the food choices they make (California Right to Know, n.d.; Kuei-Jung, 2013; Oregon Live, 2014; Politico LLC, 2014; State of Connecticut, 2013; State of Maine Legislature, 2014; The Vermont Legislative Bill Tracking System, 2014).

Summary

Three main themes emerged from the data: vegetarian and vegan diets, increasing consumption of whole foods and reducing processed foods, and having the right to know if food contains GM ingredients. Runner up themes identified include the general topic of healthy eating, the importance of conducting food research, and concerns about pesticides in food.

An unexpected finding was that six of nine participants reported practicing a vegetarian or vegan diet at least part of the time. Some participants reported limiting eating at restaurants and stated the importance of cooking at home with whole foods and minimizing the use of processed foods. Labeling of GM food was also important to most participants, citing that they should have the right to know whether food has been GM.

CHAPTER V:

DISCUSSION AND IMPLICATIONS FOR FUTURE RESEARCH

Discussion

The results of this study have revealed that natural food shoppers' perceptions of GM food play an important role in the behaviors surrounding grocery purchases and frequency and type of restaurants visited. The principal concern among participants relates to health, but some may also relate to environmental and animal welfare concerns given that six of nine participants indicated practicing a vegetarian or vegan diet at least part of the time. In particular, there appeared to be a culture among participants surrounding topics of eating a nutritious diet emphasizing whole foods, although preservation of the environment and reducing or eliminating the consumption of animal products may have also played a role in participant behaviors. For example, two participants mentioned having "ethical" food purchasing practices, an indication that animal welfare and the reduction of unnecessary animal suffering may be important to them.

According to Marlow et al. (2009), a non-vegetarian diet emits a larger environmental footprint compared to a vegetarian diet. Specifically, the study found that, from a farming perspective, a non-vegetarian diet requires 2.9 times more water, 2.5 times more energy, 13 times more fertilizer, and 1.4 times more pesticides than did the vegetarian diet. These findings are based on advances in agricultural technologies, such as mechanization and irrigation, along with the use of pesticides and fertilizers. The findings by Marlow et al. (2009) may reflect the reasoning for some participants' shift to a vegetarian or vegan diet.

A study by Ganiere, Chern, and Hahn (2006), which represented participants in 44 states, revealed that among the "extreme opponents" group, 93.3% of participants

were extremely unwilling to consume and/or purchase any GM products and 56.7% thought that GM food is extremely risky for human health. In addition, vegetarians were more likely to fall into the "extreme opponents" group. These results are consistent with the present study's findings. Another study found that vegetarians "have lower BMI, a lower plasma cholesterol concentration, and a lower mortality from ischemic heart disease" (Key, Davey, and Appleby, 1999) which is in line with the present study's results that being vegetarian or vegan correlates with a healthier diet.

The topic of "whole foods" not only appeared to indicate foods that are not processed (e.g., whole onions in their natural state), but foods that are also unmodified on some level, including not being genetically altered. As Lewin (1999) and Klug et al. (2002) explain, the process of genetic engineering comprises of direct DNA manipulation involving the insertion of genes from different organisms into food. In the context of this study, the participants no longer considered GM food as "whole." The preference for home-cooked meals among all participants suggests that there are many unknowns about foods in restaurants, including whether ingredients in these foods have been GM.

There appeared to be no issues among the participants on how to identify GM food in grocery stores. However, food shoppers that are less knowledgeable about ingredients that are likely to be GM may find difficulty in identifying such ingredients because GM food labeling is currently not required. Knowledge of the U.S. food system and/or food labels (e.g., USDA organic seal, Non-GMO Project Verified seal, commonly modified ingredients) is often required to understand what foods were or were not produced using genetic engineering. Similar to the results of the present study, findings of another study (Ganiere et al., 2006) indicated that participants designated as "moderate

opponents" of GM food considered labeling as extremely important and supported mandatory labeling. Mandatory labeling initiatives in seven states have been recently introduced, with three passing (State of Connecticut, 2013; State of Maine Legislature, 2014; The Vermont Legislative Bill Tracking System, 2014), which will provide the information that natural food shoppers in these states may seek.

Based on the results of this study, it is salient that food shoppers that attempt to avoid GM food strongly favor labeling regulations that would allow them to distinguish between conventional and GM food. Study participants often cited that it is their right to know whether food was produced through genetic engineering. These findings are consistent with participant views in The Netherlands, Sweden, The United Kingdom, and Poland (King's College London, 2008). Current FDA regulations do not mandate GM food to be labeled as such. Nevertheless, recent history has shown that a number of states, excluding Nevada, have pushed for GM food labeling, albeit with limited success. Labeling of GM food has already been implemented in 64 countries (Office of California Senator Barbara Boxer, 2013) and natural food shoppers in Nevada may be waiting for the U.S. to follow suit.

Implications for Future Research

Participants in this study have expressed concerns regarding the consumption of GM products and a preference for whole, healthy foods, which has led them to prepare their own meals at home and/or eat only at trusted restaurants. Participant concerns may stem from increased pesticide exposure from GM food, allergenicity, other unknown concerns, and/or because of the lack of rigorous scientific evidence that demonstrates that GM foods are safe to consume.

Given the increased awareness and concerns natural food shoppers may have regarding GM food, it may be recommended for restaurants to begin offering organic or non-GM options made with healthy and wholesome ingredients. In addition, because six of nine participants considered themselves vegetarian or vegan at least part of the time, providing options suitable for individuals with these diets that meet non-GM standards may open the door for more patrons. The question whether restaurants may face operational or fiscal challenges in making changes to their menus remains, which could be addressed in future studies targeting restaurant owners.

Investigating the decisions of food manufacturers to not voluntarily label their products as having GM ingredients would provide insight from manufacturers' points of view. Whole Foods Market has taken steps to initiate GM food labeling in their stores by 2018 (Robb et al., 2013) and Trader Joe's has committed to exclude GM ingredients in their branded products (Trader Joe's, 2014). Results from future studies targeting other grocery stores in Nevada regarding their views on GM food labeling in their stores may determine whether legislation for such labeling will be introduced in the state as a result of concerned citizens.

Study Limitations and Bias

As with all research, this study encountered a number of limitations. The first limitation was related to participant recruitment. A sample size of nine is not sufficient to generalize the results of this study to the greater population of Southern Nevada. Although it appeared that saturation was reached, there was no method for the researchers to confirm this. The two participants that committed to attending the second focus group but were not able to attend could have provided insightful information that did not arise from the identified themes.

A second limitation was that the principal investigator conducted the first focus group, while the co-investigator conducted the second focus group and the interview. A set of standard questions was asked to all participants. However, each investigator might have asked different follow up questions. The principal investigator conducted the first focus group as training so that the co-investigator followed through with proper procedures for data collection for the second focus group and the interview.

A third limitation was the possibility of social influence between participants. Social interaction is complex, and it is possible that some focus group participants agreed on some topics brought by other participants because they did not want to be viewed as out of place with the rest of the group. Such a limitation could be addressed by conducting interviews instead of focus groups, which may eliminate responses due to social influence.

In regards to bias, the co-investigator shares many of the same beliefs and practices as the participants, which may have influenced several aspects of the study,

including literature review findings, the questions asked to participants, themes that emerged, and/or the interpretation of the data.

Conclusion

This study explored the views, opinions, attitudes, and behaviors of natural food shoppers in Southern Nevada. In this study, natural food shoppers referred to individuals that intentionally avoid, to some degree, consuming GM food. The three main themes identified were vegetarian and vegan diets, increasing consumption of whole foods and reducing processed foods, and having the right to know whether food contains GM ingredients. The theme of vegetarian and vegan diets was an unexpected finding. Six participants reported following a vegetarian or vegan diet at least part of the time.

All participants reported focusing on home-cooked meals using whole foods and reducing the purchase of processed foods, which is a direct reflection of the participants' health concerns of consuming GM food. Participant behaviors regarding eating at restaurants varied. While all participants noted being careful about where they eat, two explicitly stated that they stopped eating at restaurants.

Participants in this study repeatedly stated that they should have the right to know if the food they are consuming contains GM ingredients. According to the participants, GM food labeling would provide them and other natural food shoppers with the information they seek to make informed decisions about the foods they purchase.

APPENDIX A – DATA COLLECTION DISCUSSION GUIDE

1. Name tags and informed consent
    a. Make nametags
    b. Distribute informed consent forms and have participants read and sign them
    c. Collect signed forms

2. Introduction to the researchers

3. Introduction to the study
    a. We want to know your views, opinions, attitudes, and behaviors regarding GM food
    b. This is an informal discussion
    c. You will receive a $15 gift card to Whole Foods Market for your participation
    d. Any questions?

4. Introduction to the participants
    a. Tell us about yourself

5. Discussion Begins
    a. Start audio recorder
    b. Begin discussion and follow question guide

6. Discussion Ends
    a. Stop audio recorder
    b. Thank the participants and distribute gift cards and informed consent copies

APPENDIX B – DATA COLLECTION QUESTIONS

1. When did you first hear the words "genetically modified food"?
2. What has influenced you to avoid genetically modified food?
3. If you had to rank on a scale from 1 to 5, five being the highest priority, how important is it to you that the food you purchase is not genetically modified?
4. What do you do when you eat at a restaurant?
5. What percentage of the foods that you purchase are not genetically modified?
6. What do you find to be more beneficial: conventional food or genetically modified food?
7. How do you verify that the food you purchase in grocery stores is not genetically modified?
8. What are your thoughts regarding labeling genetically modified food as a standard?
9. How does your food budget affect the purchasing of food labeled as organic and/or not genetically modified?
10. Do you think that your health has improved because you avoid genetically modified food?
11. What are your final thoughts regarding genetically modified and conventional food?

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Professional Memberships and Presentations

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