

**BUILDING A SUSTAINABLE MEAT INDUSTRY FROM THE GROUND UP:  
THE ANALYSIS OF FRESH CHARACTERISTICS OF VACUUM PACKAGED  
GROUND BEEF, CHICKEN, AND PORK AND THE IMPACT OF AGRICULTURE  
LEADERSHIP PROGRAMS USING RIPPLE EFFECTS MAPPING**

by

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## Abstract

Sustainability has been a popular topic among many industries in recent years, and agriculture is no exception. Commonly referred to as a three-legged stool, sustainability stands upon legs of social, economic, and environmental sustainability. For agriculture to be a sustainable industry, each of the three legs must be sustainable themselves. The meat industry could address each of the sustainability legs throughout different areas of the industry. Economic and environmental sustainability can be addressed through the prevention of food waste due to spoilage. The issue of food waste is both an economic and environmental problem due to the wasted monetary input to produce unused goods, along with wasted materials. Food waste, that occurs due to spoilage, can be prevented by new packaging technologies that use thermo-formed vacuum packaging to extend shelf life. Using thermo-formed vacuum packaging on three different ground proteins (beef, pork, and chicken), the first study examined fresh characteristics of ground meats during a 45-day simulated retail display. Results presented indicate that the use of thermoforming vacuum packaging can be used to extend the shelf life of ground proteins, reducing food waste, and supporting economic and environmental sustainability. In the meat industry, social sustainability can be best achieved through the creation of leaders and advocates for the beef community. A second study evaluated impacts of the Young Cattlemen's Leadership Program (YCLP), which trains future generations of leaders in agriculture. Its effectiveness was assessed with a mixed-methods survey using Ripple Effects Mapping. Based upon descriptive statistics, results indicate that the YCLP program enhanced participant knowledge and catalyzed multiple community engagement. Results indicated that YCLP promotes social and organizational sustainability, leading to a more sustainable beef industry.

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**The literature review is formatted to fit the style and guidelines of the Journal of Animal Science.**

## **CHAPTER 1**

### **MEAT SPOILAGE AND PACKAGING METHODS**

#### **ABSTRACT**

Across the meat industry there are several types of proteins that are often preferred by consumers. A common denominator that all protein manufacturers share is the desire to prolong shelf-life or storage periods. A longer shelf life allows for more profit from the retail stance, less food waste, and a safer product for consumers. The shelf life of a fresh or cooked protein product can be influenced by multiple external factors, from refrigeration temperature to the material of the packaging for the product. Different forms of packaging include Polyvinyl-Chloride (PVC) Overwrap Packaging, Modified Atmosphere Packaging (MAP), and Vacuum Packaging (VP). Selection of packaging methods not only influence shelf-life, but also meat color due to oxygen permeability of the packaging material. Perceptions of meat color can affect the preference that consumers may have for different types of packaging and ultimately influence their buying decisions. Different packaging types are available to meat manufacturers based on several factors, but often influenced by production costs. To determine an appropriate packaging method, there must be an understanding of meat spoilage, consumer perception and preferences, environmental, and economic impact of packaging materials.

#### **INTRODUCTION**

As the meat industry continues to provide large amounts of protein to a growing population, technologies must be refined to prevent excess food waste. Food waste commonly occurs due to the product spoiling before consumption and can occur anywhere throughout the production chain of the meat industry, from manufacturer to a consumer's fridge. Methods of

eliminating food waste begin with not over-producing meat supply, but can extend to educating consumers and retailers on how to prevent food waste (Kulikovskaja and Aschemann-Witzel, 2017). An alternative method to eliminating food waste is through different forms of packaging, such as vacuum packaging, which can result in an extended shelf life and, in-turn, reduce food waste.

With food waste, a primary concern throughout the agricultural industry are the efforts to improve sustainability and conservation of resources and communicating these efforts to the global population. Sustainability, in a modern sense has three legs, or aspects, to it. These aspects include social, economic, and environmental sustainability. The use of vacuum packaging can be used as an aid in the efforts to increase sustainability across each of these aspects.

Using vacuum packaging, a protein product's shelf life is extended, and there is a decrease in the need for consumers to over-buy products. The reduction in consumer over-buying of protein products increases economic sustainability. Some of the negative views that consumers associate with meat production are due to environmental impacts (Font-i-Furnols, Luis Guerrero, 2014). Reducing food waste is theorized to decrease greenhouse gas emissions, which would not only improve environmental sustainability but may result in more positive consumer perceptions of meat production (Salemdeeb et al., 2017). Positive consumer perceptions are critical to continuation of meat consumption and the social sustainability of the industry.

Vacuum packaging also aids in the color stability of meat products. Although beef is not a bright-cherry red color, due to the lack of oxygen in packaging, the color of the product is stable for an extended shelf-time (Youn Jeong and Claus, 2011). Meat discoloration is a large contributor to food waste with approximately 194.70 million kg of beef per year being discarded

due to discoloration, in the United States alone (Ramanathan et al., 2022). This amount of food waste has significant economic and environmental impacts. Ramanathan (2022) completed an evaluation of three retail stores across the United States and found that through decreasing food waste due to discoloration by 1%, in the evaluated stores alone, several positive environmental impacts could occur. These environmental impacts include the conservation of resources such as water and energy through reducing their uses by 23.95 L and 96.88 billion MJ, respectively (Ramanathan et al., 2022). This study also found that economic loss due to discoloration of beef products, which is approximately \$3.73 billion dollars a year within the United States, would be limited by utilizing methods that encourage color stability (Ramanathan et al., 2022). With vacuum packaging as a tool in meat storage, improvement in color stability can alter food loss and the economic and environmental sustainability aspects of the meat industry are supported.

Environmental sustainability may also be reached through a reduction in the amount of packaging materials used. For many consumers a common kitchen appliance is a FoodSaver® or another type of vacuum sealer. A common practice is for consumers to take their poly-vinyl chloride (PVC) Overwrap or modified atmosphere (MAP) Packaged product purchased from the retailer and then re-package the product using an at-home vacuum sealer. This is done so that the consumer can either freeze the product or simply use it later without the worry of quick spoilage. Although a helpful practice for consumers and for extending shelf-life, this creates a complete waste of the original packaging. However, using vacuum packaging as the first form of packaging prevents unnecessary waste. The materials used in vacuum packaging are favorable for recycling in contrast to Styrofoam trays, which is formulated using expanded polystyrene (EPS). Materials used in vacuum packaging can be easily recycled by consumers while EPS, which is not biodegradable, must be further processed by large-scale facilities (Pauer et al., 2020;

Tapia-Blácido et al., 2022) Using recyclable materials not only increases environmental, but also social sustainability due to public perception. Modern consumers are searching for more environmentally conscious products, which includes packaging (Tapia-Blácido et al., 2022). Limiting the use of Styrofoam aids the perception of the meat industry to the public eye. As previously stated, increasing the acceptance of meat industry practices to consumers also increases the ability of the meat industry to sustain itself through years to come.

Vacuum packaging methods used on fresh protein products, such as beef, chicken, and pork, can become the solution to the issues of spoilage, shelf-life, and sustainability that the meat and agricultural industry are currently facing. The examination of past and current research regarding vacuum packaging is the pathway to formulating future research that is beneficial to the meat industry, and global consumers. The following review of research aims to:

- Present the current issues, specifically spoilage surrounding fresh protein packaging methods.
- Explore consumer influences on fresh protein purchases.
- Discuss packaging abilities and future growth within the meat industry.

## **GROUND PROTEIN SPOILAGE**

### *Shelf Life vs. Retail Case Life*

The current meat industry has reported a reduction in live cattle, and the need to feed the approximately 7.8 billion people across the globe is more critical than ever (USDA, 2022). To adequately feed the population, it is necessary to reduce the amount of meat that goes to waste due to spoilage or other reasons that may deter consumer purchase including color preference (Pellissery et al., 2020). Many consumers are initially turned away from buying a product based upon the visual factors, such as meat color (Wang et al., 2021). The amount of time that meat can

remain without dangerous levels of bacterial growth is known as shelf life (Tørngrer et al., 2018). The time in which meat does not have any remarkable visual surface change and is still considered appropriate in the eyes of the consumer is known as the case life of the product (Delmore, 2009).

### *Causation and Prevention of Spoilage*

Meat spoilage occurs for a multitude of reasons, including but not limited to temperature abuse, bacteria growth, and enzymatic reactions (Dave and Ghaly, 2011). Protein products are considered spoiled once they are producing off-colors, odors, or flavors that are undesirable to the consumer (Gill, 1982). Throughout the course of centuries, technological evolution has worked to extend the shelf life of meat through various methods of preservation, from freezing to irradiation (Xiong, 2017). When a protein product is spoiled there is an increase in spoilage organisms such as *Enterococcus*, *Salmonella*, and *Staphylococcus* (Dave and Ghaly, 2011).

Meat spoilage can be prevented using microbiological, physical or chemical intervention methods, which inhibit microbial growth and limit enzymatic reactions that cause spoilage (Dave and Ghaly, 2011). Research into the need for oxygen availability for spoilage microorganisms has resulted in the use of oxygen scavengers to absorb oxygen and limit spoilage of the protein product (Cruz et al., 2012). There are other paths that are considered more holistic in preventing meat spoilage, such as using natural antioxidants including honey and rosemary (Johnston et al., 2005; Horbańczuk et al., 2019). Antioxidants can prevent lipid oxidation and can be chemically sourced as synthetic antioxidants to prevent spoilage (Zhou et al., 2010). If the addition of other ingredients into the protein is not desired, meat spoilage can be prevented through packaging methods (Tørngrer et al., 2018). The use of vacuum packaging removes oxygen from the entirety of the package, creating an undesirable environment for bacterial growth and extending shelf

life, becoming the preferred packaging from a food safety and sustainability standpoint (Rao and Sachindra, 2007).

#### *Spoilage Indicators —Lipid Oxidation and pH*

Meat spoilage is indicated by microbiological factors, such as bacterial growth, physical factors such as visual appearance, pH, odor, and chemical factors including lipid oxidation (Dave and Ghaly, 2011).

The value of pH is used to measure the level of free hydrogen ions present, determining whether a product is acidic or basic based upon a low or high pH respectively (Clemson University, 2022). Following slaughter, the glycogen in muscles is converted to lactic acid resulting in an acidic pH (Husin et al., 2020). A pH of approximately is ideal 5.5 for beef, with a pH of 5.7 being the maximum pH for desirable quality (Meat Standards Australia, 2011). Pork and chicken products can have an average pH of 5.7 while still maintaining a desirable quality (Rhao et al., 1976; Jankowiak et al., 2021). The pH of meat products can be used to indicate spoilage but also are a large factor in meat quality (Monin, 1998). As meat spoils the pH levels rise, due to the enzymatic hydrolysis by proteases known as cathepsins (Liu et al., 2019). The breaking down of proteins within the muscle results in the production of alkaline substances, creating a less acidic environment. As pH rises, the water holding capacity of the meat product increases and creates a more favorable environment for bacteria growth (Jankowiak et al., 2021). Bacterial growth results in more protein decomposition, due to microorganisms using the protein available as a nutrient source, and continue rise of pH value (Liu et al., 2019). Effects of meat quality due to increasing pH, in addition to increased water holding capacity, include darker colored meat and decreased tenderness resulting in a lower quality meat product (Jankowiak et al., 2021).

Another indication of meat spoilage is lipid oxidation, which can lead to sour flavor and rancid aroma (Guyon, et al., 2016). The changes occur during lipid oxidation due to the chemical process of fatty acids binding to oxygen, resulting in the breakdown of meat (Dave and Ghaly, 2011). Thiobarbituric Acid Reactive Substances (TBARS) Assay measures the level of lipid oxidation within the protein sample that is being analyzed (Ghani et al., 2017). The substances that react with Thiobarbituric Acid (TBA) are known as TBARS and are indicative of oxidative spoilage, such as lipid oxidation (Guillén-Sans and Guzmán-Chozas, 2010). A higher value that results from TBARS Assay Analysis indicates a larger amount of oxidation which in turn shows that the protein sample is further along in the spoilage process (Guillén-Sans and Guzmán-Chozas, 2010).

#### *Meat Color Change*

As meat spoils and lipid oxidation values increase, undesirable color changes develop over time (Wang et al., 2010). Although color changes occur in all protein products, the changes are considered more visible in beef products such as steaks, roasts, and ground beef due to a greater concentration of myoglobin (Schweihofer, 2014). This noticeable change in color occurs due to the chemical reactions of oxidation, oxygenation, and reduction of myoglobin within the meat (Gatellier, et al., 2015). The chemical reactions that affect myoglobin result in transitions through biochemical states of myoglobin. These biochemical states consist of deoxymyoglobin where meat appears as a purple color, oxymyoglobin where meat appears bright red, and metmyoglobin where meat appears brown (Mancini and Hunt, 2005). The chemical state of metmyoglobin is unable to bind any more oxygen molecules, therefore inhibiting the product from returning to a red color (Troy and Kerry, 2010). The preferred color of consumers purchasing beef protein products is a bright, cherry red, which occurs in the oxymyoglobin state



(Carpenter et al., 2021). In order to appeal to consumer preferences, the process of “bloom” is commonly used in retail settings, in which the meat is intentionally exposed to oxygen to form oxymyoglobin, producing a bright red color that appeals to consumers (Jacob, 2020).

## **CONSUMER COLOR PERCEPTION**

### *Consumer Meat Color Preferences*

Studying consumer preferences of meat color is critical in determining the type of packaging to use on a protein product, due to the meat color or discoloration being a buying factor for consumers (Feuz, et al., 2020). Studies of consumer preferences have concluded that meat color preferences differ based on the protein product, such as beef, pork, or chicken (Carpenter et al., 2001). The findings identified that consumers prefer a bright red color of meat in beef products and a light pink surface color for pork and chicken products (Troy and Kerry, 2010). The preference of these meat colors makes it difficult for producers to sell vacuum packaged items, due to the purple color of the meat being perceived by consumers as unacceptable coloration (Lynch et al., 1986).

### *Color Differences in Vacuum Packaging and Modified Atmosphere Packaging*

Different types of packaging are available to producers within the meat industry, including poly-vinyl chloride overwrap (PVC), modified atmosphere packaging (MAP), and vacuum packaging (Wang et al., 2018). There are several reasons a producer may choose a specific type of packaging, such as shelf life, consumer preference of meat color, and packaging familiarity (Troy and Kerry, 2010).

Since the color of protein products heavily influences buying decisions, the determination of how much oxygen the product should be exposed to is an important factor in choosing packaging methods (Troy and Kerry, 2010). PVC Overwrap is a traditional type of packaging

used within a retail setting, because the meat is on the shelf in the consumer preferred oxymyoglobin state (Wang et al. 2021). However, since the meat has more exposure to oxygen in this packaging, there is a tendency for products like beef to experience browning at an accelerated rate (Wang et al., 2010).

The response to this issue is MAP, which flushes the package with a mixture of gases prior to sealing (Greibitus et al. 2012). This gas mixture is typically composed of oxygen and carbon dioxide at a standard percentage of 70 to 80% and 20 to 30% respectively (Tørngren et al., 2018). The use of nitrogen is encouraged to be introduced into this gas flush in order to allow for a lower percentage of oxygen within the environment, slowing lipid oxidation and discoloration (Kim et al., 2010). Following an examination of shelf life, MAP fails to provide the extended shelf life that vacuum packaging does (Marcinkowska-Lesiak et al., 2015).

The process of vacuum packaging protein products involves the complete removal of oxygen from the package and then tightly sealing the packaging to prohibit any oxygen from entering (Siedeman and Durland, 1983). This form of packaging provides the longest shelf life for protein products when compared to PVC and MAP (Tørngren et al., 2018). With that in mind, the protein product is put on the shelf in the deoxymyoglobin state, resulting in a purple appearance, which is safe but not appealing to consumers (Lynch et al., 1986)

#### *Difference in Oxygen Permeability of Film Types*

Color changes in meat occur at different rates due to the amount of oxygen that is reaching the protein product, which can be controlled by the permeability of the packaging, or how much oxygen is able to pass through the film (Tomasevic et al., 2017). PVC packaging uses film that is oxygen permeable, meaning that oxygen flows through the film very easily resulting in a faster rate of discoloration (McMillan, 2017). MAP allows for less oxygen to enter by using

non-permeable films, but the use of oxygen in the gas flush can cause premature browning (McMillan, 2017).

The films used for vacuum packaging can either be oxygen permeable or a complete oxygen barrier, which is determined by the desired purpose (McMillan, 2017). Industry technologies, such as thermoforming vacuum packaging, can switch out what films are used on a product. This allows for varying levels of oxygen permeability to be used, which can also differ between the top and bottom of the package (Banús et al., 2021). For ground protein products, such as ground beef, pork, or chicken, the most common film permeability is that of a complete barrier film, so that minimal oxygen enters the packaging, leading to an increased longevity of acceptable meat color (Tomasevic, et al., 2017).

## **PACKAGING ABILITIES**

### *Cost of Different Types of Packaging*

The ability for a producer to decide which packaging type that they would like to use is heavily influenced by the price and efficiency of the packaging type (Jeyamkondan, 2000). PVC Overwrap is commonly used not only because of its familiarity, but also due to the low cost of materials needed (Anada et al., 2017). Vacuum packaging requires the purchase of new technologies, such as thermoforming machines. It also carries an increased risk of consumer dissatisfaction due to the coloration of the product (Chen et al., 2013). Food technology neophobia (FTN) is a phenomenon that occurs when consumers are opposed to advancements and new technology that may be used in food, whether that be food production or packaging (Wendt and Weinrich, 2023). Wendt and Weinrich (2023) found that consumers with lower levels of FTN are more likely to accept new packaging methods, such as vacuum packaging. In contrary, consumers that have high levels of FTN are unlikely to accept vacuum packaging due

to the use of new technologies (Wendt and Weinrich, 2023). To advance meat packaging technologies, FTN must be understood to effectively increase consumer confidence.

### *Sustainability of Packaging*

Within the meat industry, the rising concern of sustainability begins with live animals and goes completely through the production chain, ending with food waste (Dejekic, 2015).

Sustainability can be increased with specific forms of packaging, such as vacuuming packaging which decreases food waste due to an increase in shelf life (Tørngren et al., 2018). This shelf life increase not only allows for the product to be in the retail setting for a longer period, but also in the consumers' home.

Vacuum packages also decrease food waste its ability to freeze protein products with reduced risk of freezer damage. This is due to the non-permeable films not allowing for the formation of water vapor within the package (Schmidt and Lee, 2009). This advantage allows consumers to store protein products for a prolonged amount of time, reducing food waste due to spoilage in the fridge setting.

An additional method of increasing sustainability through packaging is the recyclability of the packaging itself. PVC requires the use of a Styrofoam tray along with the PVC film itself, both of which are unable to be recycled in most facilities due to the nature of their polymers (Anada et al., 2017; Lou et al., 2011). Vacuum packaging does not use any type of Styrofoam, and research within the industry continues to make strides in films that are more recyclable (Pauer et al., 2020). These films include Ethylene Vinyl Alcohol Copolymers (EVOH) and PolyAmide (PA), which can be recycled and have a less of a negative environmental impact, all while still providing an oxygen barrier to limit premature spoilage (Bugnicourt et al., 2013). The

use of these films through vacuum packaging has provided improvements in sustainability and shelf-life for protein products.

## **CONCLUSION**

The issues that the meat industry is facing regarding spoilage, shelf life, and sustainability will only become more pertinent in the future. The only way to mitigate these issues is by offering a solution that addresses each issue. This solution is vacuum packaging meat products. Vacuum packaging extends the shelf-life of a product, through both the limitation of oxygen transmission and in turn spoilage due to microorganisms. The use of vacuum packaging also increases all aspects of sustainability, social, environmental, and economical, by limiting both material and food waste. Advancements in packaging technologies in general will contribute to solutions required to meet global food waste challenges and pressures for more sustainable food production. Vacuum packaging has proved the ideal method for packaging fresh protein products, especially for extended storage times. Future research is needed to continue to improve the shelf-life, spoilage, and sustainability of meat and food products when using technologies such as vacuum packaging.

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## **CHAPTER 2**

### **LEADERSHIP DEVELOPMENT WITHIN AGRICULTURE**

#### **ABSTRACT**

Leadership development programming is incorporated into many businesses and organizations throughout the world, from small start-up businesses to multi-billion-dollar companies and educational institutions. Although it is one of the largest industries in the world, and one that the human population depends on the most, stakeholder grassroots organizations within agriculture are often lacking intentional leadership programs. The latter have proved successful in multiple settings and are viewed as critical to the expansion of modern agriculture. As the agriculture industry and world around it continues to evolve, it is important that leaders are developed to continue adaptive growth and sustainability of agriculture. With the significant investment that organizations make toward development of individuals be it conferences, workshops, created in-house professional development programs, it is critical to assess returns on their investment. A critical aspect of evaluation of program effectiveness is evaluation of individual participant improvement as well as community or organizational impact. The implementation, continued evaluation and improvement of leadership programming within the agricultural industry are pivotal keys to solving challenges associated with a growing global population, countering media misinformation about animal agriculture and ensuring a safe, wholesome, abundant and economically affordable supply chain.

#### **INTRODUCTION**

Within the agricultural industry, there are stakeholder organizations, such as American Farm Bureau Federation (AFBF), National Cattlemen's Beef Association (NCBA), National

Institute for Animal Agriculture (NIAA), and breed associations available to producers that provide a sense of community and educational resources regarding production, but many lack professional development programs. Leadership programs are beneficial to many communities and organizations, with their success measured by qualitative values (Boyd, 1991). As research methods and technology continues to improve, the ability to analyze leadership development programs based upon quantitative values is more readily available. Quantitative analysis of leadership development programs includes a measurement of determined benefits on an individual such as productivity, self-esteem, and perceived leadership skills and allows for the impact of determined benefits to be better understood (Hayward, 2011). Applying quantitative analysis has facilitated continued success of leadership development programs on individuals in several settings, including educational organizations, healthcare facilities, and larger scale businesses (Simpson et al., 2022; Asimionesei et al., 2021; Hayward, 2011). On the other hand, qualitative analysis such as Ripple Effects Mapping allows for a representation of the community impact of leadership development programs (Nobels et al., 2022). The results of both analyses demonstrate the benefits and necessity of leadership development programs, including those designed for agricultural producers.

Although many organizations provide resources to agricultural producers, there are a minimal amount of formal leadership development programs within these organizations. Leadership development programs require an investment of resources, such as finances and time. The return on investment (ROI) demonstrates the benefits of program implementation. In a case study reported by Rivera (2022), a multi-million dollar business estimated an increase of \$19.4 million in business value, through the implementation of leadership development programs.

Being even larger than a multi-million dollar business, the agricultural industry would likely see great benefits and exponential ROI from the use of leadership development programs.

Many resources are available to children and youth to pique interest in agriculture such as 4-H and FFA, but these programs do not extend into young adulthood. To shape the youth involved in agriculture, there are programs available at a national level. However, the availability of programs that are open to young adults seeking to be leaders within the agricultural industry are limited. Current programs available to young adults include the AFBF's Young Farmer and Ranchers Program (AFBF, 2023), NCBA's Young Cattlemen's Conference (NCBA, 2023), as well as state-wide organizations such as the Texas and Southwest Cattle Raisers Association Young Leadership Series (TSCRA, 2023), and Alabama Cattlemen's Association (ACA) Young Cattlemen's Leadership Program (ACA, 2023). An Advanced Training for Animal Agriculture Leaders program was recently developed by the NIAA to empower animal agriculture leaders to positively affect the future of animal agriculture in the U.S. and around the world (NIAA, 2023). Implementation of these programs addresses the starkly apparent need for an increase in leadership development programs created for young producers throughout the United States. Targeting younger producers is a "bottom-up" approach to leadership development, which allows for the formation of young leaders to grow and interact with their communities, in contrast to matured producers that already have their place within the community (Karagianni and Montgomery, 2017).

Young Cattlemen's Leadership Program (YCLP) originally developed through a partnership between Auburn University Animal Sciences and the Alabama Cattlemen's Association (ACA; Mulvaney, 2020) is one of the leadership development programs available to young adults within the cattle production sector of agriculture. Previous analysis of YCLP has

proved the program structure to be beneficial in shaping new leaders for the beef community (Mulvaney, 2020). As the YCLP continues annually, assessment regarding the success and need for young-adult agricultural leadership programs is growing more important. In order to better understand the necessity of a young-adult leadership program and their benefits, the discussion of current research aims to:

- Introduce the current issues that the agriculture industry is facing.
- Examine and evaluate common leadership program methods & effects.
- Discuss the use of leadership programs within the agricultural industry to encourage & build the next generation of producers.

## **OPPORTUNITY FOR IMPROVED LEADERSHIP**

### *Growing Global Population*

As measured in early 2023, there is a current global population of population 7.9 billion people and a United States population of 333 million people (United States Census Bureau, 2022). This number is only expected to rise, and most global & human analysts estimate the global population to reach 9.8 billion people by the year 2050 (UN DESA, 2017). This number has stuck concern into the minds of many, specifically those responsible for feeding the global population. Farmers and ranchers across the world work tirelessly to feed people around the world daily, and their sustainability is an ongoing challenge. As the population continues to grow the need for significant changes in technological advancements and production management is more present than ever.

There is an increase in infrastructure needed to accommodate the growing global population, which includes but is not limited to the construction of new housing developments, cities, highways, and schools (Palei, 2014). The source of these developments often involves the



purchasing and repurposing of rural land (Mu'adi et al., 2020). Over the course of the last 7 years, the number of farms in the United States has experienced a 3.38% decrease in land previously being used for farmland (USDA, 2022). The occurrence of a decrease in land available for farming places a large amount of stress on the agriculture industry, as it works to feed the exponentially growing global population (Mu'adi et al., 2020). The use of leadership development programs within the agricultural industry could better educate producers on how to lead their businesses effectively and efficiently. Being equipped with this knowledge could be of great aid when faced with growing demand.

### *Misunderstandings of the Agricultural Industry*

As the agricultural industry works to feed the world, another issue the industry is faced with is that of misunderstandings throughout society. The misunderstandings commonly associated with the agricultural industry are associated with misinformation that is distributed to the public through multiple communication modalities. The opportunity for misinformation is more available than ever and can be featured on several social media apps which include Instagram, Snapchat, Facebook, Twitter and many others (Morris and James, 2017). Instagram is one social media platform among many, and recent statistics report approximately 500 million users that actively use the platform daily (Weiderhold, 2019), which greatly increases the chance of coming across misinformation as well as the rapid spread of misinformation (Xu et al., 2020).

Although some misunderstandings can be easily clarified, many times the communication of misinformation results in a rise in animal rights activist groups, or simply misinformation that these activism groups can spread (Broad, 2016). Some consumers will change their buying decisions to selective diets, such as veganism and vegetarianism, or searching for what is considered a sustainable or eco-friendly label on products including, “no-antibiotics”, “non-

gmo”, “raised without hormones”, “grass-fed & finished” (Godden, 2016). Although these products are usually marketed at a premium, consumers are willing to pay higher prices for these labels (Rihn et al., 2021). Some consumers make buying decisions based on factors such as what they consider to be more sustainable or safer for consumption, which is a perception of grass-fed and finished beef (Lim et al., 2021). As demand for grass-fed beef increases, there is a need for a greater inventory of cattle (Hayek and Garrett, 2018). These emergent buying habits, while offering niche market opportunities, can place stress upon farmers attempting to appease new trends among consumers, specifically with the rising popularity of grass-fed beef. Adaptation to changing societal and consumer expectations or norms can be facilitated by leadership programing (Barriere et al., 2002). In addition, misinformation regarding the agricultural industry may not be able to be completely stopped, but developing leaders within the industry with enhanced communication and advocacy skills can help to mitigate miscommunications among society.

#### *Demographics of The Current Agriculture Producer Population*

A common image of farmers and ranchers within the United States, can be determined by a quick internet search using key words “American Farmer” and browsing through stock images. The images produced are that of an older male and are not a stereotype, but in-fact the reality of most producers nationwide (USDA, 2019). In the 2017 USDA Agricultural Census, which was published in 2019, the demographics regarding agricultural producers were collected including age, sex, and race (USDA, 2019). The national average age for the producers of the United States is 57.5 years old and just under 10% of producers are young producers, which is determined by the producer being under 35 years old (USDA, 2019). As time goes on, these producers only continue to age and the population that they feed continues to grow.

A common reported statistic is that less than 2% of the United States population are farmers and ranchers (Farm Bureau, 2021). Based upon the population of the United States and the number of producers, this statistic equates to only 1% of the nation's population being agricultural producers (United States Census Bureau, 2022; USDA, 2019). The population that is feeding our nation is an incredible minority and is declining in numbers each year (USDA, 2022). To sustain agriculture and global food production, there must not only be an increase in producers but a new generation of leaders. A new generation of leaders would sustain agriculture through management of efficient and sustainable production, as well as effective communication regarding the importance of agriculture to society.

## **LEADERSHIP PROGRAMS IN AGRICULTURE**

### *Agricultural Leadership Programs*

Use of leadership development programs in the realm of agriculture are common in rural areas and among the youth (USDA, 2022). Commonalities within the educational frameworks of these programs include exposure and development of critical thinking, problem solving, communication skills, and simulated group exercises (Dalakoura, 2010). For adult leadership development programs, there are a several programs available online, however there is a limitation of adult agricultural leadership programs available on a national, state, and local level (Kaufman et al., 2012). As the need for agricultural leadership programs has increased there has been an effort to make statewide agricultural leadership programs more available, and while there has been success in the establishment of programs, there is not availability in every state (Black, 2006).

Youth leadership development programs surrounding agriculture are incredibly important for the formation of the next generation of agricultural producers. Some state-wide programs,

such as Alabama's Youth Leadership Development Program are available to youth residing in participating cities but are limited when it comes to agricultural education and development (YLDP, 2019). Common programs available to the youth that encompass a focus of agricultural development include but are not limited to Future Farmers of America (FFA) and 4-H, which offer both local and national level membership. Both FFA and 4-H offer leadership development for those from elementary age to teenagers (4-H, FFA, 2022).

#### *Future Farmers of America (FFA) and 4-H*

FFA is a school-based program which offers memberships to students that are enrolled in agriculture courses, and have memberships available at the local, state, and national level, priding themselves on being the largest student-led organization in the nation (FFA, 2022), which provides leadership development for students. With over 850,000 student members as part of 8,995 local FFA chapters in all 50 states, Puerto Rico, and the U.S. Virgin Islands, FFA creates opportunity for life-long impact (FFA, 2022).

Since 4-H is not limited to students enrolled in agricultural courses, there are more members at approximately 6 million members nation-wide (4-H, 2022). This open enrollment allows for membership to be spread across rural and urban demographics, where agricultural courses may not be available to all children (4-H, 2022). The National Association of Extension, 4-H Youth Development Professionals are a group of educators that work specifically to develop youth involved in 4-H into future leaders (4-H, 2022).

#### *Bridging the Gap— Cattlemen and Cattlewomen Organizations*

Throughout programs such as FFA and 4-H, there are ample leadership development opportunities and educational opportunities regarding agriculture available to the youth of the nation. Although general agricultural leadership development programs are a great asset to the

youth, many look to follow in generational footsteps of cattlemen and cattlemen that came before them. There is a notable educational gap from the participation in youth organizations to becoming a successful cattle raiser with a role in agriculture. For current cattle raisers there are many statewide organizations and national organizations, but the resources available to young adults and budding producers on a state level are limited (NCBA, 2022). As young adults age out of youth programs and look to pursue careers of cattle raising, they are left with little guidance regarding becoming a leader in the cattle industry.

Some cattle raising organizational leadership programs available to younger individuals include the National Cattlemen’s Beef Association (NCBA) Youth Cattlemen’s Conference (YCC) which is aimed specifically at young adults ranging from ages 18 to 50. YCC only allows for one participant nomination per state and notes historic success of members who complete the program, based upon further involvement within the community (NCBA, 2022). Other programs stem from cattle breed organizations, such as Certified Angus Beef (CAB), Beefmaster Breeders United, and American International Charolais Association (AICA). Respective programs with these organizations include the CAB Youth Beef Leaders Seminar, Junior Beefmaster Breeders Association, and Char Focus Youth Conference (CAB Cattle, 2022; Beefmasters, 2022; Charolais USA, 2022). Unique leadership opportunities available to cattlemen include Miss Charolais USA and Miss American Angus, for those involved in associations such as AICA and the American Angus Auxiliary (Charolais USA, 2023; American Angus Auxiliary, 2023). The development of programs designed for young adults creates the opportunity to bridge the gap between youth leadership development programs, such as FFA and 4-H, and becoming a successful producer within the agriculture industry.

## **BUILDING FUTURE LEADERS**

### *Leadership Development Program Models*

The development of future leaders begins with the use of leadership programs, that individuals can go through to become effective leaders. For a leadership program to be effective, the basic concepts that a leader is comprised of must be determined and may include excelling in problem solving skills, communication, and putting results first (Feser et al., 2014). A successful component of leadership programs is first evaluating oneself and becoming self-aware of individual behaviors and motivators (Tekleab et al., 2008). Following this self-assessment and evaluation, goals for improvements can be set. Leadership development programs are goal-based and can be used to effectively mold individuals into increased human capacity (Eseryel, 2002).

A well-known model for leadership development programs is known as the Social Change Model (Astin and Astin, 1996). This model was created in 1994, with the focus on higher education and developing students as leaders. The model focuses on three components which include: the individual, the group, and the community. Each component is examined to understand how they can benefit one another. A key aspect of the program is that leadership is a process, and not a task that can simply be accomplished (Astin and Astin, 1996).

Competency models can be used to better understand what is needed to be gained from leadership development programs. The Center for Creative Leadership (CCL) is a global provider of executive education and transformational leadership development. Research based approaches and materials are used to develop people into more effective leaders as individuals, teams, organizations, and cultures (CCL, 2023). The Leadership Challenge programming uses case studies to unpack "The Five Practices of Exemplary Leadership" and is based on research of Kouzes and Posner (John Wiley & Sons, Inc., 2023). Employee competency can be defined as a

combination of their knowledge, skills, and abilities (Kaikhosroshvili, 2023). Once organizations and businesses can identify where employees or members are lacking in competency, leadership development programs can be shaped to fill needs. Using this model allows for employees to be effectively trained and developed into leaders, based upon what they personally need the most assistance with (Kaikhosroshvili, 2023).

Within a leadership development program, there is a standard model of assessment and then evaluation known as the Vicerere Model, which creates a flow of individuals facing questions regarding issues within themselves, their current organization or business, and the role that they are in or would be willing to do (Cacioppe, 1998). Following an assessment, evaluation of current leadership abilities is performed, and the goals of the leadership program are established, which are critical to determining which kind of leadership program to continue on with (Cacioppe, 1998). This is a common method of evaluation used at the executive level within business and allows for the demonstration of improvement over time (Vicere et al., 1992).

Different types of leadership programs may include team-building and critical thinking exercises, or self-reflection and exposure of current management methods (Cacioppe, 1998). Another common method for leadership development programs is the use of seminars and motivational speakers (Smidt et al., 2009). Regardless of the method of leadership program delivery, for a program to be successful there must be a relationship formed with participants (Rosch and Schwartz, 2009).

#### *Evaluation of Leadership Training —KirkPatrick*

To determine if a leadership program is successful, there must be some sort of ending evaluation of participants to determine the success and effectiveness of the program. A common method of evaluation of leadership programs is the Kirkpatrick Model. The Kirkpatrick Model

was developed by Dr. Donald Kirkpatrick and begins with four steps of evaluation, which are reaction, learning, behavior, and results (Kirkpatrick, 1998). These evaluation steps are used by consulting the individuals that participated in the leadership program and collecting their responses to relevant questions following the four steps. The final two steps in evaluation using the Kirkpatrick Model focus on the effects of the program that can be seen on a personal and organizational level (Kirkpatrick, 1998).

#### *Common Effects of Leadership Building Programs*

Leadership development programs can have effects in several different arenas, whether that be personal life, business environment, organization, or efficiency in a workplace (Clarke, 2013). Previous studies have confirmed that regardless of the environment or size of a business, the use of leadership development programs can have a positive impact on business performance either through a financial aspect, efficiency aspect, or both (Amagoh, 2009).

The Baldrige Performance Excellence Program annually recognizes a business or organization that meets their standards, and awards the Malcolm Baldrige Quality Award (NIST, 2021). The qualification criteria of this award have been used to put the success of leadership programs into perspective and has seven categories, including but not limited to leadership, strategy, management, and workforce (Schaefer, 2013). Through evaluation it has been found that the participation in leadership development programs has a positive effect on overall quality in terms of the seven categories of Baldrige Criteria (Hirtz et al., 2015).

Although agriculture may not be commonly thought of as a business, the industry is indeed a multi-billion-dollar business (USDA, 2022). The business of agriculture is needed to keep the global population nourished, and growth as a business is necessary as the population



grows. The use of leadership development programs has proved effective in many different business settings and can be applied to the business of agriculture (Yukl, 2008).

## **RESEARCH METHODOLOGIES IN LEADERSHIP**

### *Community Capital Framework*

Common goals of leadership programs revolve around the central idea of improving the community through strengthening leaders. However, the goal of community improvement is subjective, meaning that improvement may have a different appearance in the eyes of different people. A method for evaluating communities is the Community Capital Framework (CCF), which was developed by Flora & Flora in 2004, and analyzes improvement based upon qualitative values (Mattos, 2015). The qualitative values focus on the assets of a community and are based upon seven areas of capital which are as follows: natural, cultural, human, social, political, financial, and built (Mattos, 2015). An ideal community that is thriving is typically balanced, or seeking balance, across the seven capitals and not overly investing in one over the other (Beaulieu, 2014). Investing time into one area of capital can improve multiple areas simultaneously, resulting in balance and community improvement (Beaulieu, 2014). Leadership training is a prime example of one capital investment, human capital, resulting in positive changes across multiple capital areas, such as financial, political, and social capital (Flora et al., 2005). The community must be analyzed using CCF prior to the implementation of and programs in order determine which areas of capital need investing so that the proper improvement projects can be selected, and balance can be maintained (Mueller et al., 2020). With the proper use of CCF in community analysis, the effectiveness of leadership programs in agriculture can be measured and proper adjustments to programs can be implemented where needed.

### *Ripple Effect Mapping*

As previously discussed, measuring the effectiveness of leadership development programs can be performed in a multitude of ways. Ripple Effects Mapping (REM) is considered a qualitative measurement and is used to determine the impacts of a leadership development program in contrast to individual success (Nobles et al., 2022). REM recognizes that individual success is the key to having an impact on communities but focuses more so on the changes occurring in communities due to leadership development programs. The process of Ripple Effects Mapping involves the active participation of those that were involved in the leadership development program. These participants are encouraged to reflect on their own experience, and the impacts that they may have. The reflection takes place in four parts, appreciative inquiry, participatory approach, interactive group interview and reflection, and finally mind-mapping. The third and fourth steps encourage the participants to think deeper about the impacts their success may lead to on a community and broader scale (Washburn et al., 2020). CCF is commonly incorporated into REM using framed reflection questions that not only prompt participants, but set up the framework and coding of community impacts (Bloom, 2021)

The mind-mapping step of REM involves the literal sketching of a map that branches from a large community impact into multiple smaller impacts, creating the visualization of ripple effects. In 2020, Washburn and others used REM to evaluate the effectiveness of a community-based health education initiative. Using the standard REM protocol, they not only found the program to be successful but also that REM was the most practical tool for analysis. Researchers explain that REM is the best analysis option due to its innate ability to demonstrate wide-scale impacts on the community. REM also demonstrated that those who did not participate in the program were able to benefit from the program because of the community impacts (Washburn et

al., 2020). Both conclusions are critical for community funded projects, in that the community can reap the benefits even from a few participants. In the lens of leadership development programs, REM is a great analysis tool because of its ability to demonstrate wide-spread effects and promote the continuation of such programs.

## **CONCLUSION**

Improved leadership processes enable organizations to anticipate and adapt to change more effectively as well as create solutions to complex problems critical for sustainability. Investment in leadership development creates competencies which enable organizations to maintain loyalty and trust of their stakeholders. Agriculture is a necessary industry in many aspects, whether that be through providing raw materials to build homes and business or feeding and nourishing the global population. To keep the business of agriculture improving, there must be developmental programs that intentionally build future leaders. As the average age of producers continues to rise, a new generation of producers is desperately needed. However, the industry cannot expect producers to have complete knowledge of what it takes to be successful right out of the gate. Some producers may be completely new to agriculture and wanted to follow a passion, while others may have participated in FFA or 4-H but do not have a complete understanding of how to operate a farm or ranch as a producer themselves. These young people that the industry is calling on to be new producers must be given the tools to be successful and influential leaders within their communities and the industry. Whether a crop farmer, cattle raiser, or anything in between, leadership programs can have positive effect on the agricultural industry. These development programs are specifically needed for young adults, to build a strong foundation and instill confidence within the business of agriculture.

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**This Chapter is formatted to fit the style and guidelines for the MDPI Publisher Journal of Foods.**

## CHAPTER 3

### FRESH CHARACTERISTICS OF GROUND BEEF, CHICKEN, AND PORK CAN BE ALTERED WITH VACUUM PACKAGING

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## Abstract

The storage period of fresh ground meat products can be a vital influencer to consumer purchases at the retail grocer. As advancement in packaging technologies occur, case life studies are necessary to analyze fresh characteristic changes that may occur during a simulated display period. The adoption of new meat packaging technology such as thermoforming provides the meat industry a resource for extending the refrigerated storage periods of fresh meats. Therefore, the objectives of this research were to evaluate ground meat storage duration of beef, chicken, and pork. Ground meat was packaged in a thermoformed pouch of 454 g blocks and displayed in refrigerated conditions for 45 days.  $L^*$  values decreased ( $p < 0.05$ ) over storage time for beef, whereas pork and chicken remained lighter throughout the storage period. Redness values were greater ( $p < 0.05$ ) for beef and pork whereas yellowness was greater for chicken ( $p < 0.05$ ) throughout the storage time. Lipid oxidation was greatest ( $p < 0.05$ ) in ground beef on day 45, but the least ( $p < 0.05$ ) on day 0 in pork and chicken. The pH for the beef and pork samples increased ( $p < 0.05$ ), however chicken samples had no change in pH. Data suggests that the use of thermoforming packages is advantageous for increasing the shelf life of ground beef, pork, and chicken.

Keywords: Beef, Chicken, Instrumental Color, pH, Pork, Retail Case Life

## 1. Introduction

The storage of fresh meat during retail display has been investigated extensively for variations in surface color [1-3]. Previous efforts in research of fresh meat color have evaluated storage conditions of fresh ground and whole muscles store in gas atmospheres, traditional poly-vinyl chloride overwrapped, vacuum skin or vacuum packaging [4-5]. Ground meat derived from whole-muscle trimmings is a popular source of protein for consumers to purchase at the retail counter [6]. As more manufacturers become familiar with vacuum packaging and utilizing thermoforming roll stock machines, the amount of research surrounding storage life of meat products packaged using this format will increase. The process of thermoform packaging consists of a forming layer and a non-forming layer. The forming layer is formed into a pouch using heat and pressure. Once formed, the pouch can be filled with meat or food products.

Visual surface color is a large factor when consumers are selecting which meat products to buy in a retail setting [7]. Traditionally ground beef, pork, and chicken is packaged using PVC overwrap packaging which exposes the proteins to more oxygen than that of vacuum packaging. This is where vacuuming and thermoform packaging experiences its downfall. Oxygen exposure is a critical component for the visual surface color of the meat since oxygen binding results in the transition of myoglobin. Due to the oxygen exposure that PVC overwrap provides, myoglobin binds to oxygen, resulting in oxymyoglobin which is typically referred to as a bright, cherry red color. When oxymyoglobin is oxidized, the result is metmyoglobin which creates a brown meat color [8]. Vacuum packaging limits the oxygen available to the surface of the meat by having a lower oxygen transmission rate than PVC overwrap [9]. As a result, deoxymyoglobin, or a dark, purple tinted meat color develops. Previous research indicates that consumers prefer a visual

surface color that is presented in the oxymyoglobin state rather than that of the deoxymyoglobin state [7].

Retail case studies have indicated that vacuum packaging can be a successful method in extending the fresh color stability of meat during retail display periods [10]. Studies conclude that total plate counts of various spoilage organisms declined by day of storage, whereas PVC overwrapped products did not experience a decline [10-11]. A common spoilage organism for meat products are microbes in the *Pseudomonas* genus, which thrives in aerobic conditions [12]. Due to the restriction of oxygen within the vacuum package, the environment for aerobic microorganism growth, such as *Pseudomonas*, is limited. [11]. Consumers are not aware of and are not buying based upon total plate count, but rather they are buying based upon visual surface color [13]. There is a need for studies that analyze the visual surface color of vacuum packaged ground products during simulated storage periods. Color values reflect what consumers would see in a retail setting and base their buying decisions on [14]. The objectives of this study were to analyze the influence of thermoforming packaging on instrumental surface color, pH, purge loss, proximate analysis, and Thiobarbituric Acid Reactive Substance (TBARS) during a simulated 45-day retail display period.

## **2. Materials and Methods**

### *2.1 Raw Materials*

Beef, pork, and chicken trimmings were sourced from the Auburn University Lambert-Powell meat laboratory. Raw, fresh, trimmings were ground once through a 9.525mm plate (SPECO 400, Schiller Park, IL, USA) using a commercial meat grinder (Model 4346, Hobart Corporation, Troy, OH, USA). Coarse grinds of beef, chicken and pork were ground once through a 3.18mm plate (SPECO 400, Schiller Park, IL, USA). After grinding, ground meats

were individually portioned into 454g bricks using a vacuum stuffer (Model-VF608plus, Handtmann, Biberach, Germany).

## 2.2 Packaging

After grinding, proteins were vacuum packaged using a commercial Reiser roll-stock form and film vacuum packaging machine (Optimus OL0924, Variovac, Zarrentin, Germany). Each brick (160mm × 135mm × 35mm) was packaged using a commercial packaging film (WINPAK, Winnipeg, MB, Canada), with a forming barrier film (OTR 0.4 cc/m<sup>2</sup>/24 hours; vapor transmission rate 3.3 g/m<sup>2</sup>/24 hours), and a non-forming film (OTR 1.0 cc/ m<sup>2</sup>/29 hours). After packaging and labeling, each protein was placed in a multi-decked, refrigerated 3-tiered display cases (Model 178GDC49HCB, Avantco Refrigeration, Lancaster, PA, USA) operating at 3.0°C ± 1.5°C. Packages were evenly distributed and rotated daily within the retail display case to simulate consumer movement in a retail setting.

## 2.3 Instrumental Fresh Color

Throughout the 45 days, instrumental color was measured three times at three different locations on each package (N = 15) through the packaging film using the HunterLab MiniScan XE Plus colorimeter, Model 45/ 0-L (Hunter Associates Laboratory Inc., Reston, WV, USA). Prior to color measurement the colorimeter was standardized using a black and white tile per Hunter Lab instrument calibration guidelines. Surface color was captured every 5 days at 15:30h, the mean was determined from the 3 color readings. Surface color was determined by using the illuminant A, with a 10° observation and an aperture of 31.8mm, to measure the lightness (L\*), redness (a\*) and yellowness (b\*) of each package. Hue angle (HA) was calculated using the equation  $\tan^{-1} (b^*/a^*)$ , chroma angle (CHMA) using the equation  $(a^{*2}+b^{*2})^{1/2}$  as well as Red to Brown ratio (RTB) using (630nm/580nm). Additionally, deoxymyoglobin (DMb= {2.375 × [1-

$(A473-A730)/(A525-A730) \times 100$ , metmyoglobin (MMb=  $\{1.395- [(A572-A730)/(A525-A730)]\} \times 100$ , and oxymyoglobin (OMb=  $100-[\%MMb-DMb]$ ), were calculated from relative spectral values according to the Meat Color Measurement Guidelines provided by the American Meat Science Association [15].

#### *2.4 Purge Loss, pH, and Proximate Analysis*

Packages were removed from display cases every 5 days for 45 days, starting at day 0. Each sample was weighed using an analytic balance (PB3002-S, Mettler Toledo, Columbus, OH, USA). Once the initial weight was recorded, proteins were removed from their packages, patted dry using a paper towel, and reweighed for the final weight. Purge loss was calculated as  $[(\text{packaged protein weight} - \text{protein weight}) \div \text{packaged protein weight} \times 100]$ . The pH was then measured twice on each sample using a pH meter (HI99163, Hanna Instruments, Woonsocket, RI, USA) equipped with a glass electrode. Using the 2-point standard buffers (Thermo Fisher Scientific, Chelmsford, MA, USA) the pH meter was calibrated using pH buffers 4.0 and 7.0. These values were recorded, and an average was calculated. Proximate analysis (protein, moisture, fat, and collagen) was measured on each protein using a near-infrared (NIR) spectrophotometer (Food Scan™, FOSS Analytical A/S, Hilleroed, Denmark), where data was determined using ISIScan™ Software [16].

#### *2.5 Thiobarbituric Acid Reactive Substance (TBARS)*

Approximately 2 g of the ground protein was homogenized with 8 ml of phosphate buffer (50mM, pH of 7.0 at 4°C) containing 0.1% EDTA, 0.1% n-propyl gallate, and 2 ml of trichloroacetic acid (Sigma-Aldrich, Saint Louis, MO, USA). Homogenized samples were then filtered through Whatmann No.4 filter paper. Each sample was duplicated, 2 mL clear filtrated aliquot was transferred into prepared 10mL borosilicate tubes. Two mL of trichloroacetic acid



(TBA) was added to each sample and boiled for 20 minutes. After boiling, tubes were placed in ice water for 15 minutes. Using a spectrophotometer (Turner Model–SM110245, Barnstead International, Dubuque, IA, USA), absorbance was measured at 533 nm and multiplied by 12.21 to obtain the TBARS value.

## 2.6 Statistical Analysis

Results were statistically analyzed using the GLIMMIX procedure of SAS (ver. 9.4; SAS Institute Inc., Cary, NC, USA) with weight and packaging being fixed effects. The least square means were generated, with the significant F-value being observed when  $p < 0.05$ . Using the pair-wise t-test (PDIF option), the least square means were separated.

## 3. Results and Discussion

### 3.1 Instrumental Fresh Color

Instrumental color is used to measure the visual appearance of the meat surface and reports using quantitative values represented by  $L^*$ ,  $a^*$ , and  $b^*$ . The  $L^*$ , or lightness values (Figure 1), for ground beef steadily decreased throughout the 45-day study. A decline in the surface lightness suggests that ground beef samples became darker over the course of the study, which was also reflected by the increasing metmyoglobin values ( $p < 0.05$ ) presented in Table 1. For ground pork,  $L^*$  values did not significantly begin to decrease ( $p < 0.05$ ) until day 15 (Figure 1). These values continued to decrease over the course of the 45-day study. In addition, metmyoglobin values (Table 1) increased at a rate that supported the  $L^*$  values ( $p < 0.05$ ). Analysis of ground chicken samples indicated that the  $L^*$  values did not significantly change over the course of the 45-day study (Figure 1). Metmyoglobin values of the ground chicken samples (Table 1) displayed a decrease ( $p < 0.05$ ) over the course of the display period. Previous

studies reported overall higher L\* values for vacuum packaged ground chicken and pork, than that of beef, which support the results of the present study [17-18].

Ground beef had higher a\* values than both chicken and pork, which would be expected due to higher myoglobin values in ground beef [19]. There is also the presence of an inverse relationship between L\* and a\* being as lightness increases in a product, the redness decreases [17]. With a\* measuring redness, a decrease in a\* values reflect a loss of redness and a transition to brown color. For ground beef and pork samples (Figure 2), the redness (a\*) slightly increased between day 0 and 10 before plateauing for the remaining 35 days of the study ( $p < 0.05$ ). However, ground beef samples had a greater increase in red to brown values (Table 1) than ground pork samples ( $p < 0.05$ ). This suggests that ground beef browns more quickly than ground pork, however the starting redness (a\*) value of ground beef is higher than that of ground pork. This is further supported by the oxymyoglobin levels, which are higher in ground beef when compared to ground pork indicating a more bright, cherry red product. Upon further analysis, ground beef and pork samples showed a decrease in oxymyoglobin values ( $p < 0.05$ ). The oxymyoglobin values, along with the significant decrease of deoxymyoglobin in ground beef samples and lack thereof in ground pork samples ( $p < 0.05$ ), support the redness to brown values that are reported for both proteins. Ground chicken samples did not have any significant changes in redness values (a\*) (Figure 2) throughout the study ( $p < 0.05$ ). As expected, redness values (a\*) presented lower values for ground chicken when compared to the ground beef and pork samples. These results indicate that ground chicken contains lower amounts of myoglobin, than beef and pork [18-19]. In contrast, the ground chicken experienced the inverse in regard to metmyoglobin, deoxymyoglobin, and oxymyoglobin values (Table 1). Metmyoglobin decreased ( $p < 0.05$ ), while deoxymyoglobin and oxymyoglobin values increased over the 45-day study ( $p$

< 0.05). Red to brown values experienced no significant change over the duration of this study ( $p < 0.05$ ).

The value of  $b^*$  (Figure 3) measures the level of yellowness in the sample. Ground beef did not experience a significant change; however, pork and chicken both showed a decrease in  $b^*$  values ( $p < 0.05$ ). In contrast, unlike  $a^*$ , the  $b^*$  values of ground chicken were higher than that of the ground beef and ground pork samples ( $p < 0.05$ ). It has been stated that ground chicken was expected to have a lower  $b^*$  value than beef [18]. A greater  $b^*$  value indicates that the ground chicken product was more yellow than those previously studied. The calculations for hue angle coincide with  $b^*$  because hue angle measures the change from red to yellow, with a larger value meaning a larger amount of change [15]. Hue angle values (Table 1) for ground beef, pork, and chicken decreased throughout the study ( $p < 0.05$ ).

Chroma calculations (Table 1) were used to analyze how vivid the surface color of the samples was throughout the study, with larger values indicating a more vivid color. Ground beef samples reported an overall increase in values and peaked around day 15 ( $p < 0.05$ ). Ground pork samples increased steadily in value ( $p < 0.05$ ) prior to reaching a plateau around day 20. Once again, ground chicken samples had inverse results and experienced a decrease in chroma value for throughout the study ( $p < 0.05$ ).

### *3.2 Proximate Analysis*

The Food Scan Analysis (FOSS) machine analyzed the composition of the meat samples (g/100g), including protein, fat, and moisture. Moisture was greatest ( $p < 0.05$ ) in chicken packages and the least ( $p < 0.05$ ) in ground beef packages (Table 2). Whereas protein was greater ( $p < 0.05$ ) in beef and pork than chicken throughout the entire storage period (Table 2). Ground chicken did not experience any changes in fat or moisture but did have a decrease in

protein values ( $p < 0.05$ ). Values for proximate analysis of ground chicken was consistent with literature for protein and moisture but contained a higher fat content than that mentioned in previous research [20]. Another study reported similar values for the moisture and fat content of ground beef and pork, but had lower protein values than the data presented [21]

### *3.3 Purge Loss*

The measurement of purge loss quantifies how much moisture a sample of ground meat loses, or purges, over the course of the study. Purge loss values are reported as a percentage and previous research has recommended for that percentage to remain under 4.0%, but are considered ideal at 1.0 to 2.0% [22]. Values exceeding 4.0% could have negative impacts, specifically in terms of economic sustainability and consumer acceptance [22]. Purge loss values for this study exceeded the 1.0 to 2.0% range for all protein types. Ground beef and pork samples both had an increase ( $p < 0.05$ ) in purge loss throughout the 45 days (Table 1), which exceeded the recommended 4.0% on day 30 for ground beef and day 25 for ground pork. Values decreased below 4.0% on the following days; however, this was not a significant change ( $p < 0.05$ ).

Results for increasing purge loss over storage time were consistent with literature that analyzed the use of vacuum packaging for both beef and pork [17, 23]. Despite those reports, purge loss values that were found in a 35-day study were higher than those reported in this study [17]. The lower purge loss values in this study could be attributed to the use of a ground product with higher fat content rather than a lean muscle. Ground chicken samples also experienced an increase ( $p < 0.05$ ) in purge loss but had significantly smaller values ( $p < 0.05$ ) than that of the ground beef and pork samples, which never exceeded 3.0% (Table 1). This could be because ground chicken had more protein extraction during the grinding process, which resulted in a sticky, gelatin like product overall in comparison to ground beef and pork [24]. Protein

extraction is affected by several factors including muscle type and pH, with extraction increasing as pH increases [25- 26]. Ground chicken had the highest pH values across all protein types, which is further supported by studies that reported chicken to have more hydrogen bonds than beef [23]. A higher pH within a meat product is positively correlated to its water holding capacity (WHC), which retains more moisture and limits purge loss [27-28]. The higher pH of ground chicken indicates a higher WHC than ground beef and pork, which is supported by the lower purge loss values (Table 1). Furthermore, chicken contains a larger amount of ionic bonds when compared to beef and pork [25], providing a backbone for myosin [29], which is known for its binding strength [30]. This binding strength causes the sticky, gelatin like texture that is evident in ground chicken and limits the amount of purge loss that occurs over the course of 45-day storage.

### *3.4 pH*

The pH measurements determine the number of hydrogen ions present in the sample, which results in analyzing acidity of the sample. The pH of ground beef and ground pork decreased ( $p < 0.05$ ) throughout the duration of the 45-day study (Table 2). In a separate study, authors compared the effect of different packaging methods, such as ambient air, modified atmosphere packaging (MAP), and vacuum packaging on the shelf-life of ground beef [31]. To evaluate shelf life, authors examined the physiochemical traits of ground beef in different packaging methods, including pH [31]. The authors' results indicated that the pH of vacuum packaged ground beef significantly decreased ( $p < 0.05$ ) throughout a 20-day storage time and could be attributed to low oxygen levels and the growth of lactic acid bacteria [31]. This decrease of pH values in vacuum packaged ground beef, affirms the results of the present study [31]. In another study, the authors evaluated the shelf-life of ground pork based upon different

packaging methods, including vacuum packaging and MAP, and reported that the pH of pork in vacuum packaging decreased significantly over the course of 12 days of storage [32]. The authors also found no significant differences between the MAP and vacuum packaged pork products [32]. The pH values and trends are similar to the results of this study, although ground pork did not experience change ( $p < 0.05$ ) until day 20 of the 45-day storage time. The pH for the ground chicken samples (Table 2) did not experience a significant change ( $p < 0.05$ ). Moreover, all ground chicken samples had a higher pH than ground beef and ground pork samples over the duration of the study. A previous study has stated that chicken contains more hydrogen bonds and in turn, more hydrogen ions, than beef and pork, further supporting these findings [26]. Decreasing pH indicates an increasing amount of hydrogen ions, and a more acidic product.

### *3.5 Thiobarburtic Acid Reactive Substances*

Lipid oxidation is measured using Thiobarburtic Acid Reactive Substances (TBARS), whereas higher values indicate a greater amount of oxidation and increasing risk of spoilage. Lipid oxidation (TBARS) were greatest ( $p < 0.05$ ) on day 45 for ground beef and the least on day 0 for chicken (Table 2). Lipid oxidation provides a reference for deterioration of fresh meat quality and can be influenced by packaging materials, storage temperature, moisture, and fat quantities. When compared to similar studies using different types of packaging [33] indicate that the use of thermoforming limit lipid oxidation, thereby increasing shelf-life. When comparing packaging types within another study, the researchers found that vacuum packaged ground beef resulted in significantly lower TBARS than PVC Overwrap packaged ground beef, after only 7 days of storage [34]. Although not analyzed in this study, microorganism growth can also be used as an indicator of shelf-life. The use of a film with a lower oxygen transmission,

such as those used in thermoforming, slows the growth of aerobic microorganism growth in ground chicken [35]. These results indicate the positive impacts that thermoforming with a low oxygen transmission rate film has on shelf-life.

## **Conclusions**

Based on the results of this study, the use of thermoforming packaging for ground meat products may be solutions for storing ground meats longer than traditional oxygen rich packages. Quantitative values from this study, such as pH and TBARS point to thermoforming packaging as an effective method for increasing case life. Consumer education surrounding meat color and the role of myoglobin can aid in the acceptance of thermoforming packaging. Extended case life in thermoforming packaging also allows for consumers peace of mind that their food will retain its quality for a longer period, while also aiding their buying decision that are based upon color. Further research may extend to consumer color panels to evaluate perceived meat color and preferences of thermoforming packaged ground meat products, over an extended retail display period.

## **TABLES**



Table 1: Interactive effect for day of retail display × ground meat on calculated instrumental surface color values.

	DAY										SEM
	0	5	10	15	20	25	30	35	40	45	
<b>BEEF</b>											
CHMA <sup>1</sup>	22.50 <sup>g</sup>	25.78 <sup>c</sup>	27.23 <sup>ab</sup>	27.79 <sup>a</sup>	27.03 <sup>b</sup>	27.16 <sup>b</sup>	26.90 <sup>b</sup>	26.09 <sup>c</sup>	25.57 <sup>c</sup>	25.73 <sup>c</sup>	0.299
HA <sup>2</sup>	37.34 <sup>i</sup>	30.63 <sup>q</sup>	30.02 <sup>q</sup>	30.70 <sup>pq</sup>	31.81 <sup>o</sup>	31.59 <sup>po</sup>	32.43 <sup>no</sup>	33.32 <sup>mn</sup>	33.58 <sup>m</sup>	32.04 <sup>o</sup>	0.466
RTB <sup>3</sup>	2.09 <sup>i</sup>	3.02 <sup>a</sup>	2.93 <sup>bc</sup>	3.01 <sup>ab</sup>	2.87 <sup>c</sup>	2.90 <sup>c</sup>	2.66 <sup>d</sup>	2.52 <sup>ef</sup>	2.45 <sup>f</sup>	2.55 <sup>e</sup>	0.046
PRGL <sup>4</sup>	1.48 <sup>m</sup>	1.79 <sup>hijklm</sup>	2.07 <sup>ghijk</sup>	2.737 <sup>ef</sup>	3.23 <sup>cde</sup>	3.15 <sup>de</sup>	4.16 <sup>ab</sup>	3.91 <sup>abc</sup>	3.53 <sup>bcd</sup>	3.54 <sup>bcd</sup>	0.341
MMb <sup>5</sup>	29.76 <sup>g</sup>	16.93 <sup>q</sup>	18.55 <sup>p</sup>	23.24 <sup>lm</sup>	26.41 <sup>j</sup>	28.66 <sup>hi</sup>	28.24 <sup>hi</sup>	31.20 <sup>ef</sup>	31.67 <sup>e</sup>	32.91 <sup>d</sup>	0.411
DMb <sup>5</sup>	23.42 <sup>m</sup>	17.86 <sup>n</sup>	13.43 <sup>o</sup>	15.25 <sup>o</sup>	14.37 <sup>o</sup>	10.48 <sup>p</sup>	9.26 <sup>p</sup>	6.17 <sup>q</sup>	5.05 <sup>q</sup>	4.65 <sup>q</sup>	1.160
Omb <sup>5</sup>	19.49 <sup>i</sup>	8.68 <sup>kl</sup>	5.37 <sup>nop</sup>	6.72 <sup>lmn</sup>	7.69 <sup>klm</sup>	9.02 <sup>k</sup>	12.04 <sup>j</sup>	12.78 <sup>j</sup>	13.28 <sup>j</sup>	12.11 <sup>j</sup>	1.085
<b>PORK</b>											
CHMA	21.15 <sup>h</sup>	22.34 <sup>g</sup>	22.77 <sup>g</sup>	24.94 <sup>d</sup>	24.71 <sup>de</sup>	24.37 <sup>def</sup>	24.31 <sup>ef</sup>	24.09 <sup>f</sup>	24.23 <sup>ef</sup>	24.38 <sup>def</sup>	0.299
HA	41.49 <sup>h</sup>	37.01 <sup>ij</sup>	36.55 <sup>ijk</sup>	35.71 <sup>kl</sup>	35.11 <sup>i</sup>	35.79 <sup>kl</sup>	36.20 <sup>jk</sup>	36.76 <sup>ji</sup>	36.96 <sup>ji</sup>	35.74 <sup>kl</sup>	0.464
RTB	1.88 <sup>j</sup>	2.17 <sup>hi</sup>	2.19 <sup>gh</sup>	2.22 <sup>gh</sup>	2.23 <sup>gh</sup>	2.23 <sup>gh</sup>	2.27 <sup>g</sup>	2.24 <sup>gh</sup>	2.24 <sup>gh</sup>	2.27 <sup>g</sup>	0.046
PRGL	1.36 <sup>m</sup>	1.96 <sup>hijklm</sup>	2.31 <sup>ghij</sup>	2.47 <sup>fgh</sup>	2.69 <sup>efg</sup>	4.43 <sup>a</sup>	3.79 <sup>abcd</sup>	3.60 <sup>bcd</sup>	3.62 <sup>bcd</sup>	3.88 <sup>abc</sup>	0.341
MMb	25.54 <sup>k</sup>	14.71 <sup>r</sup>	17.36 <sup>q</sup>	23.45 <sup>i</sup>	22.43 <sup>mn</sup>	21.41 <sup>o</sup>	21.87 <sup>no</sup>	27.74 <sup>jk</sup>	27.94 <sup>i</sup>	28.88 <sup>h</sup>	0.411
DMb	67.89 <sup>gh</sup>	83.98 <sup>b</sup>	89.58 <sup>a</sup>	83.92 <sup>b</sup>	83.45 <sup>bc</sup>	81.23 <sup>c</sup>	77.49 <sup>d</sup>	73.54 <sup>f</sup>	69.30 <sup>g</sup>	67.93 <sup>gh</sup>	1.160
Omb	6.57 <sup>lmn</sup>	1.52 <sup>q</sup>	6.94 <sup>klmn</sup>	7.38 <sup>klmn</sup>	5.93 <sup>mno</sup>	3.85 <sup>op</sup>	4.02 <sup>op</sup>	3.26 <sup>pq</sup>	4.40 <sup>op</sup>	4.07 <sup>op</sup>	1.085
<b>CHICKEN</b>											
CHMA	20.54 <sup>i</sup>	20.29 <sup>ij</sup>	20.29 <sup>ij</sup>	20.26 <sup>ikj</sup>	20.09 <sup>ijk</sup>	20.01 <sup>ijk</sup>	19.99 <sup>ijk</sup>	20.02 <sup>ijk</sup>	19.86 <sup>jk</sup>	19.70 <sup>k</sup>	0.299
HA	71.62 <sup>a</sup>	68.19 <sup>g</sup>	69.15 <sup>ef</sup>	69.93 <sup>cd</sup>	68.43 <sup>fg</sup>	69.38 <sup>de</sup>	70.22 <sup>bcd</sup>	70.83 <sup>bc</sup>	70.90 <sup>ab</sup>	70.29 <sup>bcd</sup>	0.466
RTB	1.61 <sup>lk</sup>	1.70 <sup>k</sup>	1.68 <sup>k</sup>	1.58 <sup>l</sup>	1.65 <sup>kl</sup>	1.65 <sup>kl</sup>	1.63 <sup>kl</sup>	1.62 <sup>kl</sup>	1.61 <sup>kl</sup>	1.62 <sup>kl</sup>	0.046
PRGL	1.40 <sup>m</sup>	1.68 <sup>jklm</sup>	2.35 <sup>fghi</sup>	1.61 <sup>klm</sup>	1.70 <sup>jklm</sup>	2.02 <sup>ghijklm</sup>	2.42 <sup>fgh</sup>	2.18 <sup>fghijk</sup>	2.34 <sup>fghij</sup>	1.82 <sup>hijkl</sup>	0.341
MMb	35.59 <sup>b</sup>	28.34 <sup>hi</sup>	31.65 <sup>e</sup>	37.93 <sup>a</sup>	29.69 <sup>g</sup>	31.48 <sup>e</sup>	30.40 <sup>fg</sup>	34.09 <sup>c</sup>	34.13 <sup>c</sup>	32.52 <sup>d</sup>	0.411
DMb	50.75 <sup>l</sup>	74.40 <sup>ef</sup>	76.08 <sup>ed</sup>	70.04 <sup>g</sup>	65.90 <sup>h</sup>	62.32 <sup>i</sup>	59.72 <sup>j</sup>	56.02 <sup>k</sup>	55.05 <sup>k</sup>	54.97 <sup>k</sup>	1.160
Omb	40.99 <sup>h</sup>	53.80 <sup>f</sup>	54.92 <sup>ef</sup>	46.82 <sup>g</sup>	55.94 <sup>de</sup>	58.04 <sup>cd</sup>	60.33 <sup>b</sup>	59.74 <sup>bc</sup>	60.82 <sup>ab</sup>	62.82 <sup>a</sup>	1.085

<sup>1</sup>CHMA (chroma) measures the total color where larger numbers indicate more vivid color. <sup>2</sup>HA (Hue Angle) represents the change red to yellow. The larger numbers indicate a greater shift from red to yellow. <sup>3</sup>RTB (red:brown) is calculated as 630nm/580nm, which represents the change in color from red to brown. <sup>4</sup>PRGL (purge loss) presents the amount of purge that was lost. This is calculated from the dried protein from the initial weight. <sup>5</sup> Using the spectral vales percentages were calculated of oxymyoglobin (OMB), deoxymyoglobin (DMB) and metmyoglobin (MMB).

<sup>a through q</sup> Within a column and row, means lacking a common superscript differ ( $p \leq 0.05$ )

Table 2: Interactive effect of day of display × ground meat on qualitative meat composition and lipid oxidation values

	DAY										SEM
	0	5	10	15	20	25	30	35	40	45	
<b>BEEF</b>											
pH	5.91 <sup>cd</sup>	5.28 <sup>ghij</sup>	5.24 <sup>hijk</sup>	5.60 <sup>ef</sup>	5.45 <sup>fgh</sup>	5.03 <sup>klm</sup>	5.07 <sup>jklm</sup>	4.93 <sup>m</sup>	4.96 <sup>lm</sup>	5.14 <sup>iklm</sup>	0.123
Fat <sup>1</sup>	21.57 <sup>hi</sup>	22.64 <sup>fg</sup>	23.23 <sup>ef</sup>	23.05 <sup>f</sup>	25.46 <sup>a</sup>	21.93 <sup>gh</sup>	24.13 <sup>cd</sup>	24.60 <sup>19bc</sup>	23.77 <sup>86de</sup>	24.95 <sup>ab</sup>	0.368
Protein <sup>2</sup>	50.13 <sup>a</sup>	50.13 <sup>a</sup>	50.14 <sup>a</sup>	50.13 <sup>a</sup>	50.15 <sup>a</sup>	50.14 <sup>a</sup>	50.14 <sup>a</sup>	50.15 <sup>a</sup>	50.14 <sup>a</sup>	50.14 <sup>a</sup>	0.159
Moisture <sup>3</sup>	64.49 <sup>l</sup>	65.39 <sup>jk</sup>	66.80 <sup>defgh</sup>	65.31 <sup>kl</sup>	67.80 <sup>bc</sup>	65.25 <sup>kl</sup>	66.03 <sup>hijk</sup>	66.68 <sup>defghi</sup>	66.12 <sup>ghijk</sup>	66.23 <sup>fghij</sup>	0.453
TBARS <sup>4</sup>	2.85 <sup>efghijk</sup>	2.84 <sup>fghijk</sup>	3.01 <sup>bcde</sup>	3.08 <sup>abc</sup>	3.16 <sup>ab</sup>	3.10 <sup>abc</sup>	2.97 <sup>cdefg</sup>	2.99 <sup>9bcdef</sup>	2.88 <sup>efghi</sup>	3.18 <sup>a</sup>	0.082
<b>PORK</b>											
pH	5.93 <sup>cd</sup>	5.60 <sup>ef</sup>	5.82 <sup>de</sup>	6.01 <sup>bcd</sup>	5.52 <sup>fg</sup>	5.25 <sup>hijk</sup>	5.16 <sup>jklm</sup>	5.13 <sup>jklm</sup>	5.18 <sup>ijkl</sup>	5.42 <sup>fghi</sup>	0.123
Fat	19.72 <sup>jk</sup>	19.60 <sup>jk</sup>	21.03 <sup>i</sup>	20.16 <sup>j</sup>	20.06 <sup>j</sup>	21.97 <sup>gh</sup>	20.05 <sup>j</sup>	19.91 <sup>j</sup>	19.03 <sup>k</sup>	19.59 <sup>jk</sup>	0.368
Protein	50.08 <sup>a</sup>	50.07 <sup>a</sup>	50.11 <sup>a</sup>	50.07 <sup>a</sup>	50.06 <sup>a</sup>	50.13 <sup>a</sup>	50.08 <sup>a</sup>	50.08 <sup>a</sup>	50.04 <sup>a</sup>	50.04 <sup>a</sup>	0.159
Moisture	66.47 <sup>efghi</sup>	67.17 <sup>bcde</sup>	67.88 <sup>b</sup>	65.87 <sup>ijk</sup>	67.37 <sup>bcd</sup>	67.02 <sup>bcdef</sup>	66.57 <sup>defghi</sup>	66.97 <sup>cdefg</sup>	66.00 <sup>hijk</sup>	66.98 <sup>bcdefg</sup>	0.453
TBARS	2.70 <sup>k</sup>	2.71 <sup>k</sup>	2.81 <sup>ghijk</sup>	2.73 <sup>jk</sup>	2.81 <sup>ghijk</sup>	2.80 <sup>hijk</sup>	2.99 <sup>defhi</sup>	2.76 <sup>ijk</sup>	2.95 <sup>cdefgh</sup>	2.80 <sup>hijk</sup>	0.082
<b>CHICKEN</b>											
pH	6.34 <sup>a</sup>	5.99 <sup>bcd</sup>	6.19 <sup>ab</sup>	5.96 <sup>bcd</sup>	6.08 <sup>bc</sup>	6.11 <sup>abc</sup>	5.91 <sup>cd</sup>	6.08 <sup>bc</sup>	6.10 <sup>abc</sup>	6.13 <sup>abc</sup>	0.123
Fat	3.80 <sup>l</sup>	3.81 <sup>l</sup>	4.04 <sup>l</sup>	3.85 <sup>l</sup>	3.81 <sup>l</sup>	3.77 <sup>l</sup>	3.65 <sup>l</sup>	3.69 <sup>l</sup>	3.69 <sup>l</sup>	3.62 <sup>l</sup>	0.368
Protein	23.39 <sup>b</sup>	22.90 <sup>c</sup>	22.24 <sup>e</sup>	22.76 <sup>cd</sup>	22.60 <sup>cd</sup>	22.66 <sup>cd</sup>	22.75 <sup>cd</sup>	22.65 <sup>cd</sup>	22.90 <sup>cd</sup>	22.55 <sup>de</sup>	0.159
Moisture	73.73 <sup>a</sup>	74.03 <sup>a</sup>	73.74 <sup>a</sup>	74.26 <sup>a</sup>	73.87 <sup>a</sup>	74.07 <sup>a</sup>	74.05 <sup>a</sup>	73.70 <sup>a</sup>	73.95 <sup>a</sup>	73.94 <sup>a</sup>	0.453
TBARS	2.74 <sup>k</sup>	2.80 <sup>hijk</sup>	3.06 <sup>abcd</sup>	2.87 <sup>efghi</sup>	2.88 <sup>efghij</sup>	2.87 <sup>efghij</sup>	2.88 <sup>efghij</sup>	2.77 <sup>ijk</sup>	2.81 <sup>ghijk</sup>	2.82 <sup>ghijk</sup>	0.082

<sup>1</sup>Fat percentage (g/100g) <sup>2</sup>Protein percentage (g/100g) <sup>3</sup>Moisture percentage (g/100g) <sup>4</sup>Measured lipid oxidation, with larger values indicating a greater amount of oxidation. <sup>a-m</sup> Within a column and row, means lacking a common superscript differ ( $p \leq 0.05$ )

## **FIGURES**

Figure 1: Interactive impact of simulated retail display day  $\times$  ground meat for instrumental lightness ( $L^*$ ) values. Bars lacking common letters differ ( $p \leq 0.05$ )

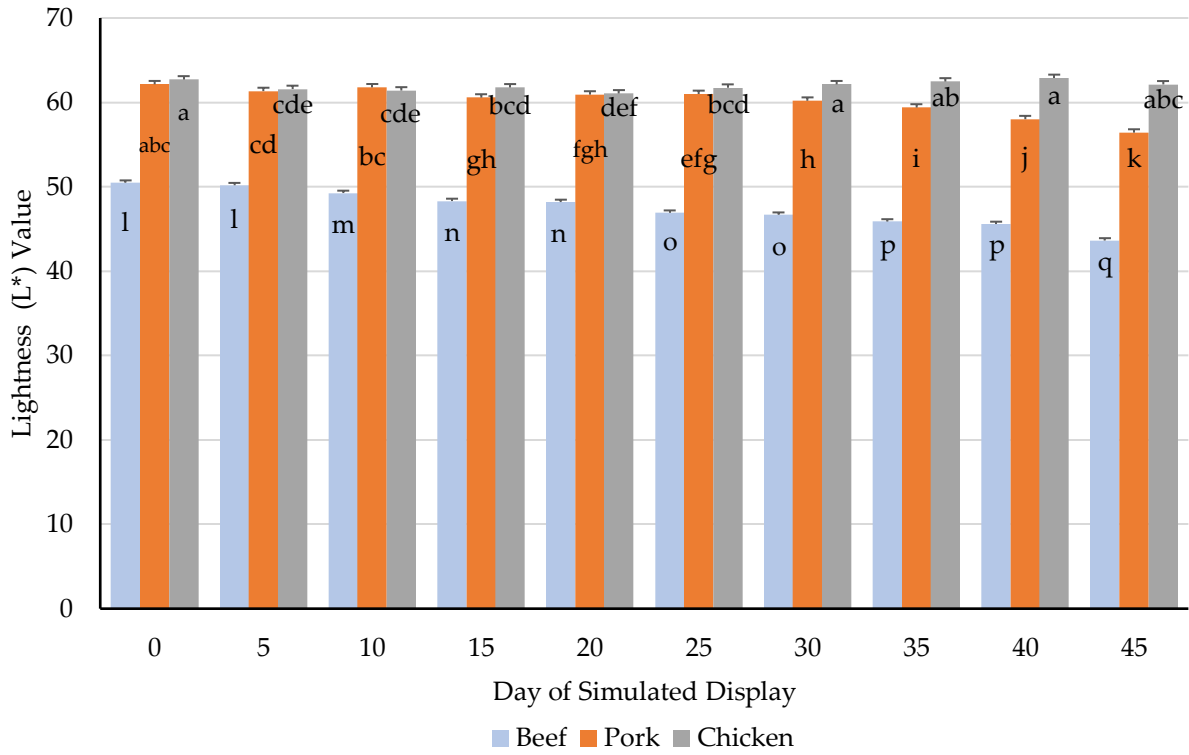


Figure 2: Interactive impact of simulated retail display day  $\times$  ground meat for instrumental redness ( $a^*$ ) values. Bars lacking common letters differ ( $p \leq 0.05$ )

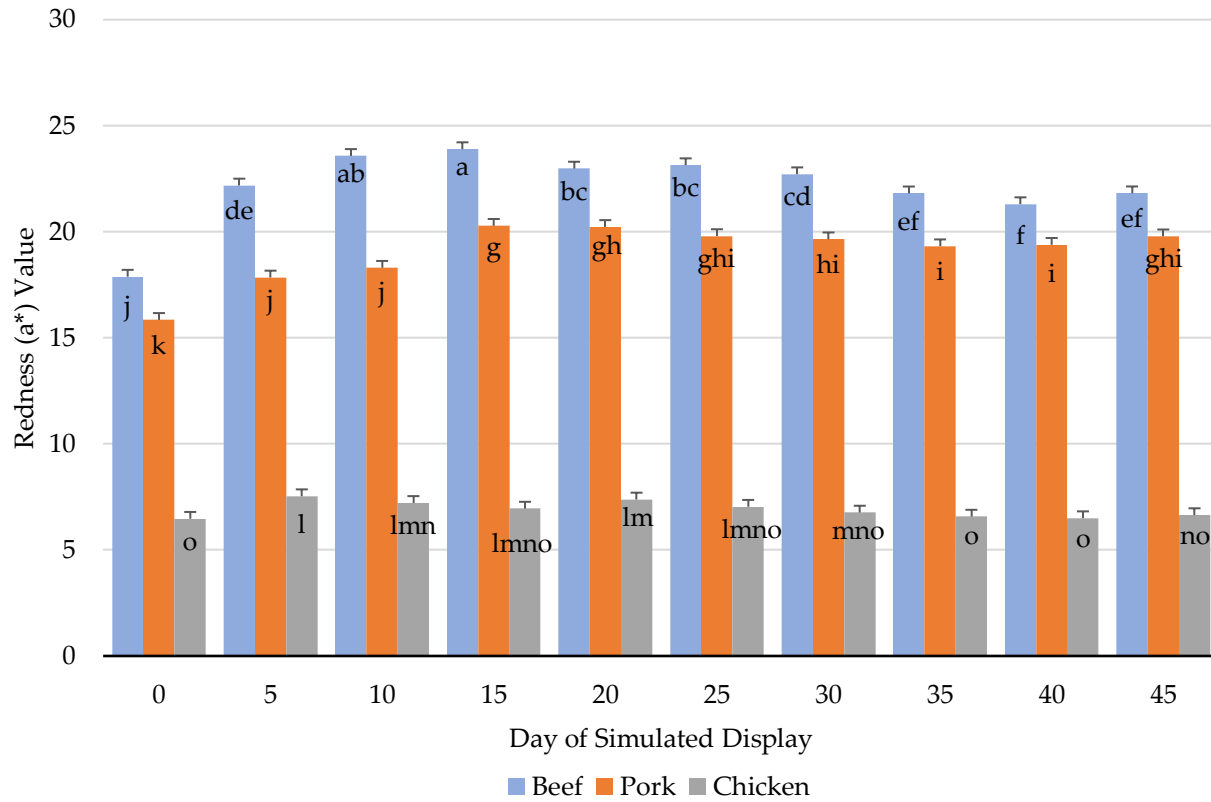
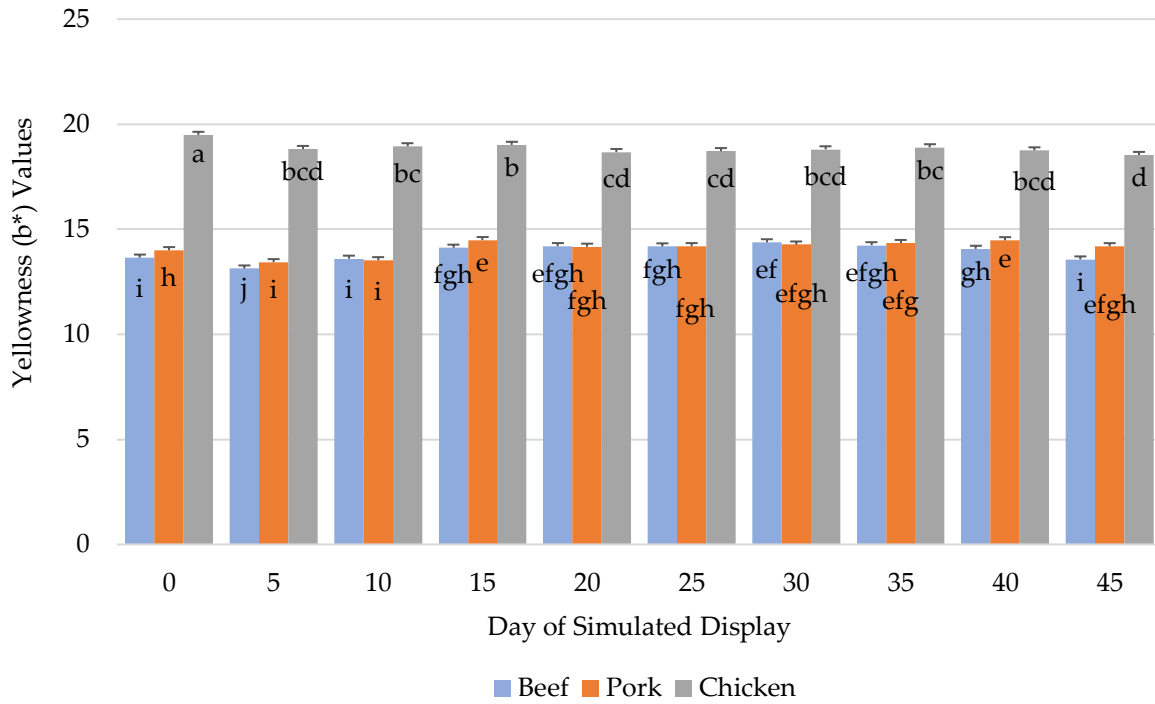


Figure 3: Interactive impact of simulated retail display day  $\times$  ground meat for instrumental yellowness ( $b^*$ ) values. Bars lacking common letters differ ( $p \leq 0.05$ )



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**This Chapter is formatted to fit the style and guidelines for the Journal of Leadership  
Education**

## CHAPTER 4

### **Impact of the Young Cattlemen's Leadership Program Using Ripple Effects Mapping**

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## **Abstract**

Leadership development programs within the agricultural industry are crucial to the sustainability of agriculture. The use of leadership development programs in the beef industry, such as Young Cattlemen's Leadership Program (YCLP) promotes the creation of a pipeline of new leaders. YCLP guides participants through leadership training exercises including real-world experiences, project planning, communication, and other challenges. While assessment of the effects of training on individuals is common, there is difficulty in measuring the impacts of leadership development programs beyond the individual, which can present challenges in determining the success of a program. A mixed methods approach provides useful insight to success and can be achieved through the integration of Ripple Effects Mapping (REM) and elements of a Community Capitals Framework within a customized survey. REM provides qualitative data that demonstrates the impacts of a leadership development program, and supplemental questions are used to obtain quantitative data. To evaluate program impacts, a survey was distributed via email to former YCLP participants. Short answer qualitative responses were coded for major reoccurring themes and subjected to frequency analysis. Quantitative data were analyzed for descriptive statistics. Results from both qualitative and quantitative data indicate beneficial effects of YCLP on both a personal development as well as communities.

**Keywords:** Agriculture, Leadership Development, Community Capitals, Beef Community

## **Introduction and Problem Statement**

Leadership development programs are not used to simply develop one person into an effective leader for the sake of their own benefit, but to develop a leader that will apply their sharpened skills with communities at-large (Day, 2000). Incorporating leadership development programs into businesses has proven success in terms of productivity and enhancing efficiency (Clarke, 2013). With improvement in productivity, efficiency and culture, retention of employees can be improved (Crestcom International, 2021). The economic success of the agricultural industry can also be improved by leadership development programs. In a report published by Cornell College of Agriculture and Life Sciences (2021), companies with leadership development programs in place experienced a 24% increase in profit margin compared to those without programs (Van De Valk, 2021). As the global population continues to grow and depend on agriculture to nourish them, leadership development programs may be key to building future generations of agricultural producers (von Braun, 2010).

Use of leadership development programs in the agricultural sector allows for individuals to share knowledge with surrounding producers and create a broader impact to those that may not have participated in the program (Washburn et al., 2020). To better understand the community impact, a method of evaluation must be determined and put into practice (Black & Earnest, 2009). Ripple Effects Mapping (REM) and Community Capitals Framework (CCF) are commonly used alongside one another to create a structured evaluation of leadership program effects on different aspects of the community (Chazdon et al., 2017).

Evaluation of leadership development programs is as diverse as there are programs, and yet has been performed successfully in many business settings (Nobles et al., 2022). Assessment guidance can be found throughout the web including government resources (OPM, 2023). Using

a learning model that combines workshops built around the model for social change with practical beef industry networking experiences over the course of one year, YCLP creates a program that avoids any “disjointed leadership,” which can be caused by a gap in motivations, skills, and the transfer of skills of those participating in the leadership development program (Astin, 1996; Mulvaney, 2020; Moldoveanu & Narayandas, 2019). The designed framework of YCLP consisted of six-two day sessions with a focus on goal setting and the individual domain of leadership development within the Social Change Model (SCM; Astin and Astin, 1996), interaction with state and organizational policy-makers and beef community stakeholder tours. Later sessions followed a similar design with progression into learning exercises in the group and community domains of the SCM, interaction with industry and community leaders, networking and stakeholder tours. Leadership concepts were presented through engagement and experiential rich pedagogies which included assessments, case analysis and simulation exercises. The final session involved attendance at the Alabama Cattlemen’s Association state convention including graduation and a recognition ceremony. Based upon previous survey analysis, YCLP has proven successful for individual growth as leaders (Mulvaney, 2020). Using REM and CCF oriented questions in researcher developed surveys, a more in-depth evaluation of community impact due to participation in YCLP was explored as part of this study.

## **Theoretical and Conceptual Framework**

### **Ripple Effects Mapping**

Ripple Effects Mapping (REM) is commonly used to evaluate the effectiveness of leadership development programs. The procedure of REM begins with participants self-evaluating changes in themselves, their involvement and change in the community contributed by participation in the program (Chazdon et al., 2017). The REM involves a reflection of

program participant insights of community impacts following completion of YCLP. Community related impacts help determine the success of the program. The most traditional setting for REM is performed in-person and involves participants gathered around a large sheet of paper, physically writing out the mapped effects (Welborn et al., 2016). Due to the nature of the state-wide program that is YCLP, the in-person setting was unable to be used. Consequently, the REM process was modified to be used with surveys. The REM procedure is mimicked by using survey questions that begin with self-evaluation and then expand into self perceived community impacts structured by CCF (Bloom, 2020).

### **Community Capitals Framework**

Community Capitals Framework (CCF) is used to determine the impacts of a program on the surrounding community (Flora et al., 2004). Macqueen and others (2001) investigated the meaning of community by survey methodology. Responses to the question “What does the word community mean to you?” were subjected to cluster analysis to identify similarities in the description of community. Results revealed that community can be characterized as a group of people who are linked by common values and perspectives, social connections, and tend to engage in collaborative action in geographical locations or organizational settings. Community was defined similarly by participants yet experienced differently by people with diverse backgrounds. CCF is divided into seven different capitals, which are as follows: natural, built, financial, social, human, political, and cultural. Each capital in CCF represents what aspects of a community that can be invested in (Beaulieu, 2014). In an effort to limit survey length, only four of the seven capitals were focused on in the present study. These four categories were chosen based upon the insight that questions would give regarding community impacts of YCLP. Natural, built, and financial capitals were not included in survey evaluation but are understood as



the following concepts. Natural capital is based upon the community environment and natural resources. Built capital refers to the infrastructure of a community. Financial capital is the investment of funds back into the community (Mattos, 2015). The latter four capitals that were focused upon for the present study were as follows: social, human, political, and cultural capital. Social capital refers to organizational involvement from community members and was critical for analysis due to its ability to have positive impact on other community capitals (Emery & Flora, 2005). Human capital, which could be impacted by improvements in social capital, involves the development of individual skills and competencies that can be used to better the community. Political capital is the understanding of laws, policy, and regulations and how law-governing officials influence others, as well as participants having this ability. Lastly cultural capital is how the individual gains a better understanding and appreciation for cultures, heritages, traditions and diversity that are not their own (Mattos, 2015). An improvement in each capital is indicative of community impact within the respective capital. The use of CCF provides insight into how the community is developing because of the program (Jacobs, 2007), which in this case focuses on YCLP.

### **Purpose**

The purpose of this study was to better understand the influence of YCLP on the individual and their community. Prior to data collection, the following objectives were outlined for the survey as follows:

1. Describe the overall impact of YCLP on participants individually and their contributions to their communities.
2. Describe common themes reported by YCLP alumni regarding experiences following program participation.

3. Evaluate overall effectiveness of YCLP on the individual participant and community, based upon a selected Community Capitals Framework.

### **Methods**

A mixed-methods survey was created via Qualtrics (Version 2022, Provo, Utah, US) to individuals that had completed the Alabama Cattlemen's Association (ACA) Young Cattlemen's Leadership Program (YCLP). These individuals will subsequently be referred to as YCLP alumni. The last recorded email addresses of YCLP alumni were obtained from ACA, and the Qualtrics survey link was sent out via email, which successfully delivered to 142 YCLP alumni. The survey questions were reviewed and approved as exempt (Protocol #21-280 EX 2106) by an institutional review board.

Development of survey questions were guided by REM and CCF. In 2007, Chazdon and others evaluated the University of Minnesota Extension program using CCF and created definitions for Extension outcomes and impacts related to each capital (Chazdon et al., 2007). Using these definitions and application to Extension, survey questions addressing each community capital were created. In addition to CCF guided questions, REM was also used to encourage participants to share how YCLP has impacted other areas of their lives. REM questions were guided by Chazdon and others' (2017), which provides insight and instruction regarding how to successfully use the tool of REM within group evaluation (Chazdon et al., 2017). Questions included Likert Scales, select-all-that-apply, and short response options. Many Likert Scale questions were based upon a 5-point scale; however, questions regarding how involvement changed used a 4-point scale. A 3-point scale was used to gauge overall community involvement following YCLP involvement. The use of a 5-point scale for Likert Scale questions was based upon the symmetrical 5-point Likert Scale, whereas for involvement questions, a 3-

point or 4-point scale was used due to these questions gauging a change in involvement (Joshi et al., 2015). The 3-point and 4-point scales were used due to selection options beginning with a “neutral” option of no change in involvement (Joshi et al., 2015; Lundstron and Lamont, 1976). Select-all-that-apply questions were used to investigate individuals’ participation in organizations and time spent volunteering within the community in relation to YCLP. Finally, short answer questions asked participants to list moments where the tools learned in YCLP were put to practice. Individuals were asked not to identify themselves or use identifying factors when answering.

Survey data collection occurred for 18 weeks, spanning from October 2022 to February 2023 with periodic reminder email prompts. The survey link was then closed, and data were available for analysis. Prior to analysis, raw data were cleansed to removed incomplete responses. Due to the small sample size, descriptive statistics were used as quantitative analysis using SPSS (Version 29.0). The open-ended questions soliciting written responses were coded in ATLAS.ti (ATLAS.ti, Web Version, 2023) for community capitals (Chazdon et al.,2017). Coding was performed with an expert panel and based upon a first and second cycle coding method, with the first cycle being descriptive coding and the second being theoretical coding (Saldaña, 2016).

## **Results**

The demographics collected to better understand sample population. are presented in Table 1. Class I of YCLP occurred in the years 2014-2015 and the most recent surveyed class, Class VIII, graduated in 2022. The targeted age for YCLP participants is age 22-40, so it can be estimated that YCLP alumni are in the age range of 22-49 years old. Although the goal was to collect samples from each class, there were no completed responses from Class VI YCLP alumni.

**Table 1**  
*Demographics of YCLP Survey Participants*

Category	Sub-Category	Full Sample	
		Frequency (N)	Percent (%)
Gender	Male	26	96.3
	Female	1	3.7
Marital Status	Married	23	85.2
	Never Married	1	3.7
	Married with Children	3	11.1
Beef Cattle Production Involvement	Own No Cattle	2	7.4
	Own Less Than 50 Head	12	44.4
	Own 51-200 Head	10	37.0
	Own Greater Than 200 Head	3	11.1
YCLP Class	Class I	4	14.8
	Class II	2	7.4
	Class III	1	3.7
	Class IV	4	14.8
	Class V	5	18.5
	Class VI	0	0
	Class VII	4	14.8
	Class VIII	7	25.9
Ethnicity	African American	1	3.7
	Native American	2	7.4
	White	24	88.9
Time in Current Community	1-5 Years	7	25.9
	Greater than 5 Years	20	74.1

Data collected from the survey were divided into blocks dependent on the focus of the questions. This resulted in descriptive statistical analysis of three, five-point Likert-Scale blocks of intrinsic motivations ( $M = 3.775$ ,  $SD = 1.193$ ), social and human capital ( $M = 4.13$ ,  $SD = 1.039$ ), and evaluation of current self ( $M = 4.06$ ,  $SD = 0.841$ ). There were also three blocks used for descriptive statistics of the four-point Likert Scale questions, including perceived effects on the beef industry ( $M = 3.00$ ,  $SD = 0.926$ ), political capital ( $M = 2.25$ ,  $SD = 0.980$ ), and cultural capital ( $M = 2.85$ ,  $SD = 1.026$ ).

Table 2 presents the block of intrinsic motivations, which sought to analyze if YCLP

alumni were motivated by the program, why participants may have decided to partake in YCLP and if topics regarding social change have stuck with YCLP alumni. These statements had the lowest level of agreement of the 5-point Likert Scale questions ( $M = 3.75$ ,  $SD = 1.193$ ). The statement “I was motivated by components of YCLP that contained applications of leadership theories to real life situations” was measured to be the highest level of agreement among participants ( $M = 4.33$ ,  $SD = 1.144$ ). In contrary, the statement “prior to YCLP, I had very little impact on the community in which I live” had the lowest level of agreement ( $M = 2.67$ ,  $SD = 1.301$ ) indicating that participants were fairly involved in their communities prior to YCLP participation.

**Table 2**  
*Descriptive Statistics for Intrinsic Motivations of YCLP Alumni*

Item	<i>M</i>	<i>SD</i>
I was motivated by components of YCLP that contained applications of leadership theories to real life situations.	4.33	1.144
I remember talking about the model for social change and impacts on a community during the YCLP Program.	3.96	1.126
Prior to YCLP, I had very little impact on the community in which I live.	2.67	1.301

*N = 27, M = Mean, SD = Standard Deviation*

*M = 3.75, SD = 1.193*

*1 = strongly disagree, 2 = somewhat disagree, 3 = neither agree nor disagree, 4 = somewhat agree, 5 = strongly agree*

Six items based upon social and human capital were presented to YCLP alumni within the survey. Further along in the survey, there were two items that stimulated self-evaluation. Since these items reflect the framework of social and human capital, the statements are also presented within Table 3 for a total of eight items. This block had the highest level of agreement among the 5-point Likert Scale questions ( $M = 4.11$ ,  $SD = 0.993$ ), demonstrating that social and

human capital experienced the largest amount of impact due to YCLP. Table 3 also displays the items presented to YCLP alumni within the context of the survey. The item with the most agreement was the statement “I believe that people should volunteer within their community” ( $M = 4.70, SD = 0.823$ ), and the least agreeable item was “because of YCLP I am a more active member of my community” ( $M = 3.70, SD = 1.235$ ). Again, possible reasons for low levels of agreement for the latter statement could be due to the high community involvement of participants prior to YCLP or a perception that other development programs also contribute to their involvement. This idea is supported by the results of the 3-point Likert Scale question that inquired about community involvement. When asked “since participating in YCLP, has your amount of community involvement: 1 = decreased, 2 = remained the same, 3 = increased,” values indicated that participants experienced an increase in involvement or levels that remained the same with a slight favor of the “remained the same” option ( $M = 2.74, SD = 0.447$ ).

**Table 3***Descriptive Statistics for Social and Human Capital*

Item	<i>M</i>	<i>SD</i>
Because of YCLP I am a more active member of my community.	3.70	1.235
I believe that people should volunteer within their community.	4.70	0.823
As a result of YCLP, I have a better understanding about the needs and concerns of the community in which I live.	3.78	1.086
To be an effective leader in the community you must volunteer.	4.33	0.961
As a result of YCLP I am more aware of the importance for leadership and involvement in programs to enhance my community.	4.22	0.974
As a result of my experiences with YCLP, I feel more confident about my abilities to succeed in my involvement with other organizations.	4.07	1.107
I have a good understand of the strengths and resources for the community in which I live.	4.04	0.706
Due to YCLP, I can make a difference in the organizations of my community for which I am affiliated.	4.07	0.958

*N* = 27, *M* = Mean, *SD* = Standard Deviation

*M* = 4.11, *SD* = 0.933

*1* = strongly disagree, *2* = somewhat disagree, *3* = neither agree nor disagree, *4* = somewhat agree, *5* = strongly agree

A 4-point Likert Scale was used for perceived effects on the beef industry, political capital, cultural capital, and perceived improvements, respectively. Although these question blocks had differing wording for the scales, all scales had the same number association. Values for the 4-point scale can be generally described as, *1* = no effect, *2* = slight, *3* = moderate, *4* = high, in reference to change or affiliation. Of these blocks, the YCLP alumni's perceived personal improvements had the highest value of agreeability (*M* = 3.5, *SD* = 0.725), and political capital had the lowest value of agreeability (*M* = 2.25, *SD* = 0.980).

Table 4 begins the series of 4-point Likert scales, featuring the participants' perceived effects that they personally have on the beef industry. Participants reported higher values of

affiliation in the beef community ( $M = 3.37, SD = 0.884$ ), rather than recognition as a leader in the beef community ( $M = 2.63, SD = 0.967$ ). Although values were lower for leadership recognition in the beef community amongst participants, average response values still leaned toward some recognition as leaders rather than no recognition. Also, explaining a lower assessment is the observation that many ACA chapters are comprised of older individuals and may be resistant to acknowledging the need to create roles for young leaders within the organization.

**Table 4**

*Descriptive Statistics for Perceived Effects on the Beef Industry by YCLP Alumni*

Item	<i>M</i>	<i>SD</i>
To what extent are you affiliated with the beef community as a result of YCLP?	3.37	0.884
To what extent are you recognized as a leader within the beef community as a result of YCLP? <sup>1</sup>	2.63	0.967

*N = 27, M = Mean, SD = Standard Deviation*

*M = 3.00, SD = 0.926*

*1 = none/not at all, 2 = somewhat affiliated/recognized<sup>1</sup>, 3 = moderately affiliated/recognized<sup>1</sup>, 4 = highly affiliated/recognized<sup>1</sup>*

Political capital had the least amount of agreement ( $M = 2.25, SD = 0.980$ ), and items that were presented are featured in Table 5. Of these items, the most agreeable statement was “Please indicate how participation in your community changed after your YCLP experience” ( $M = 2.78, SD = 0.934$ ). The values for the statement align with previous questions regarding community involvement, indicating a slight to moderate change among participants. Also represented in the table below is the statement with the lowest agreement, “Please indicate how your level of involvement changed with groups on a national level because of YCLP” ( $M = 1.163, SD = 0.967$ ). These values indicate that participant involvement may have increased, but primarily on a local level and point to a need or opportunity to encourage involvement at national levels.



**Table 5**  
*Descriptive Statistics for Political Capital of YCLP Alumni*

Item	<i>M</i>	<i>SD</i>
Please indicate how your participation in the community changed after your YCLP experience.	2.78	0.934
Please indicate how your level of involvement changed with groups on a state level because of YCLP. <sup>1</sup>	2.33	1.038
Please indicate how your level of involvement changed with groups on a national level because of YCLP. <sup>1</sup>	1.63	0.967

*N = 27, M = Mean, SD = Standard Deviation*

*M = 2.25, SD = 0.980*

*1 = none/not at all, 2 = slight change, 3 = moderate change, 4 = drastically changed*

*1 = none/not at all, 2 = increased slightly<sup>1</sup>, 3 = increased moderately<sup>1</sup>, 4 = increased drastically<sup>1</sup>*

Only two items were considered based on cultural capital and had consistent values across items and for the block ( $M = 2.85$ ,  $SD = 1.026$ ). Participants indicated a higher increase in awareness to time ( $M = 2.89$ ,  $SD = 0.892$ ), than increase in appreciation of cultural differences ( $M = 2.81$ ,  $SD = 1.145$ ) as a result of YCLP participation. Both values can be seen in Table 6, with reported values and verbatim items asked in the survey. This is interesting as the cross-cultural diversity role play exercise BAFA BAFA was included in the trainings and an increase would be anticipated.

**Table 6**  
*Descriptive Statistics for Cultural Capital Impacts of YCLP Alumni*

Item	<i>M</i>	<i>SD</i>
Please indicate how much your appreciation of cultural differences increased due to your YCLP experience.	2.81	1.145
Please indicate how much your awareness for time value increased due to your YCLP experience. <sup>1</sup>	2.89	0.892

*N = 27, M = Mean, SD = Standard Deviation*

*M = 2.85, SD = 1.026*

*1 = no change, 2 = neutral, 3 = slight change in appreciation/awareness<sup>1</sup>, 4 = great/complete change in appreciation/awareness<sup>1</sup>*

The final set of items that included a 4-point Likert Scale were those questions regarding

perceived personal improvement ( $M = 3.5, SD = 0.725$ ). Participants reported a higher value of personal improvement ( $M = 3.56, SD = 0.641$ ) than professional improvement ( $M = 3.44, SD = 0.801$ ), although both values were reported at least some improvement (Table 7). Higher values may have been achieved with expansion of the time blocks for intentional leadership programming within the YCLP sessions.

**Table 7**  
*Descriptive Statistics for Perceived Personal Improvements of YCLP Alumni*

Item	<i>M</i>	<i>SD</i>
Please select a choice below to indicate the level of <b>personal improvement</b> that you experienced because of your YCLP participation.	3.56	0.641
Please select a choice below to indicate the level of <b>professional improvement</b> that you experienced because of your YCLP participation.	3.44	0.801

*N = 27, M = Mean, SD = Standard Deviation*

*M = 3.5, SD = 0.725*

*1 = did not change, 2 = neutral, 3 = some improvement, 4 = significant improvement*

Other questions inquired about changes in involvement, including the time that YCLP alumni spent volunteering in their community and organizational involvement. Questions asked to report answers as “prior to YCLP, following YCLP, or both prior to and following YCLP.” Figure 1 displays the volunteer hours that YCLP alumni reported in relationship to YCLP completion and is reported in frequency respected to the time block provided (*no hours, 1 to 3 hours, 4 to 6 hours, 7 to 9 hours, > 10 hours*). Results indicate that most individuals were volunteering within the community prior to YCLP, and this time increased following YCLP completion.

**Figure 1: Frequency of Volunteer Hours in Relation to YCLP Completion**

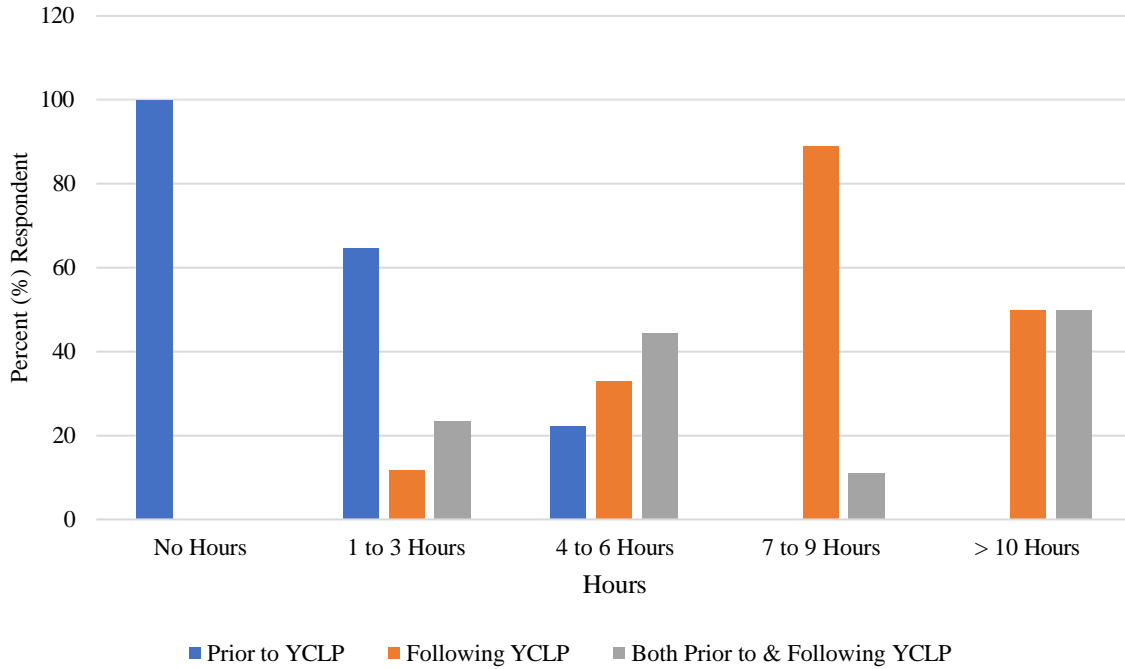
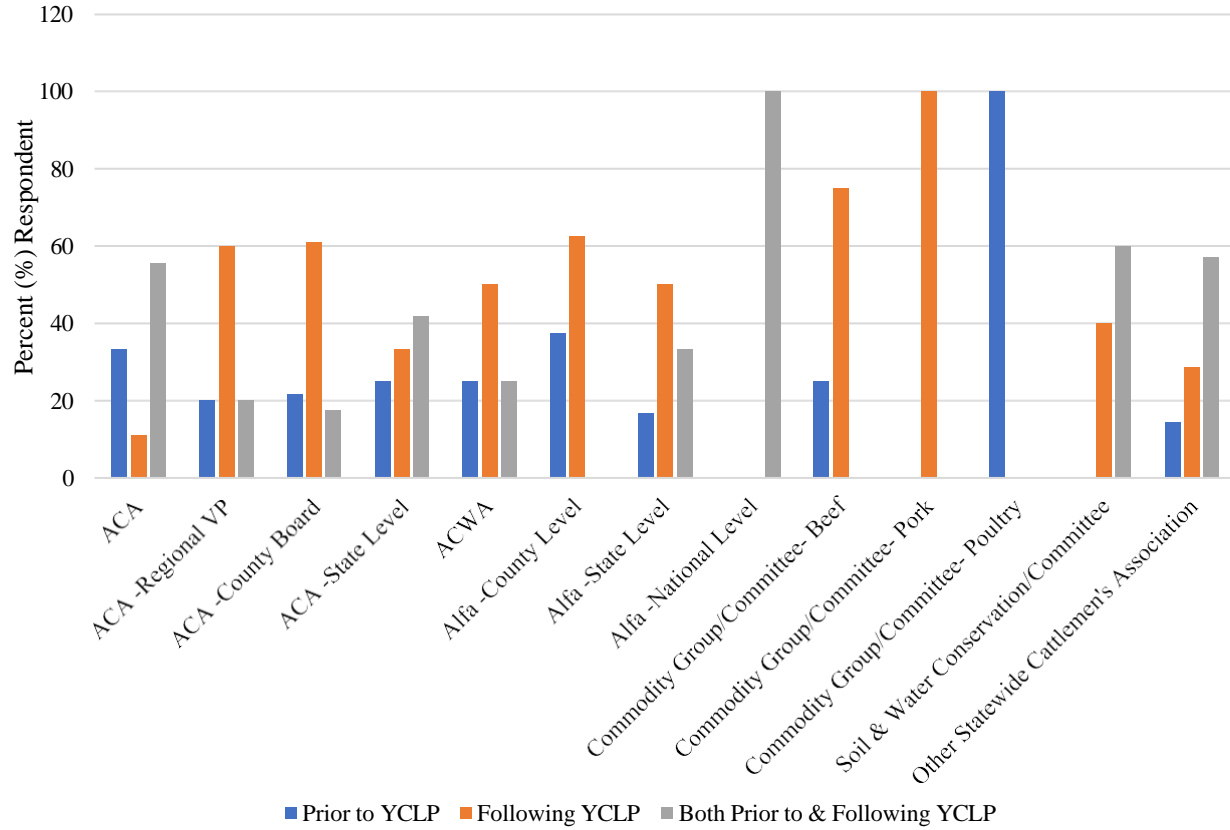


Figure 2 and 3 displays organizational involvement in relation to YCLP completion and is also reported in frequencies respective to each organization due to the nature of not every participant being involved in each organization listed. Results suggest an increase in organizational involvement following YCLP completion, as well as a continuation of involvement if the individual were to be involved prior to YCLP.

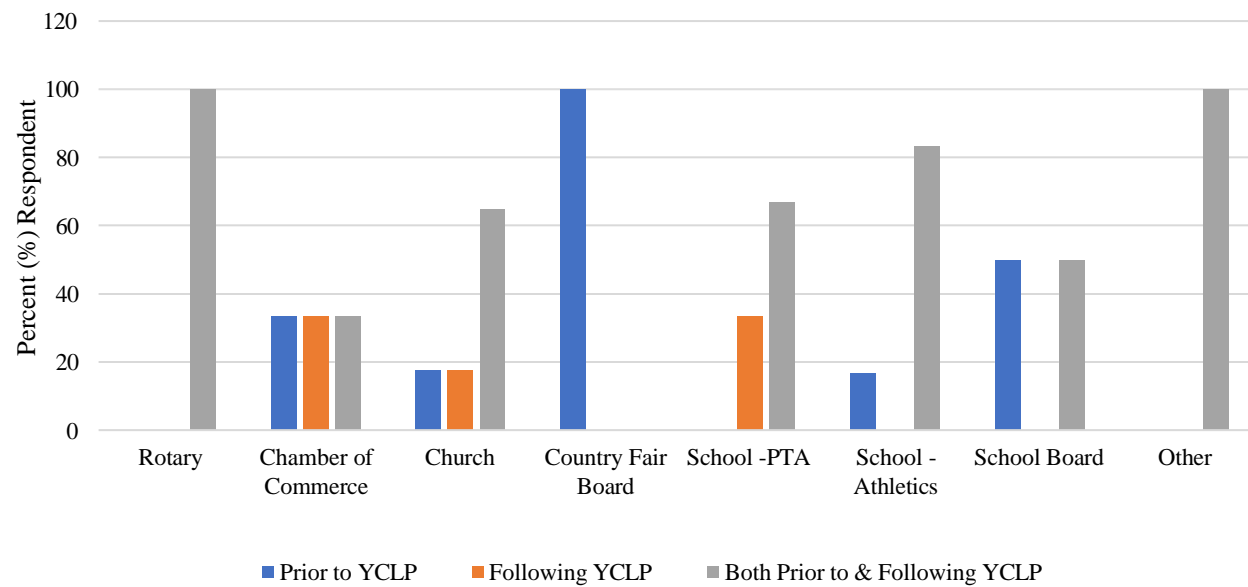
**Figure 2: Frequency of Agricultural Organizational Participation in Relation to YCLP**

Completion



**Figure 3: Frequency of Community Organizational Participation in Relation to YCLP**

Completion



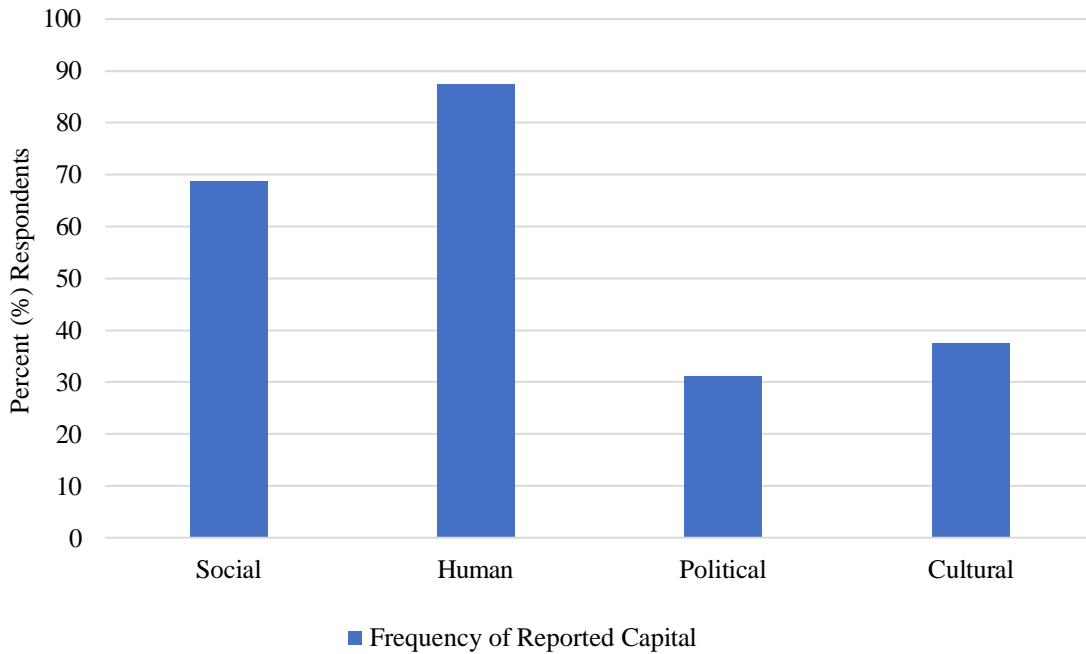
Survey participants were also asked a series of short-answer questions to stimulate REM, which were coded for qualitative analysis based upon CCF. Table 8 demonstrates what code words were used for each community capital that was analyzed, along with an example quote. Results for these questions were extensive in length, so frequencies for each capital are reported in Figure 4 which is immediately below Table 8.

**Table 8**  
*Qualitative Analysis of YCLP Alumni based upon Community Capital Framework*

Community Capital	Code Words	Example Quotes
Social	RELATIONSHIPS, NETWORKING, IMPRESSED, ENGAGEMENT, MANAGEMENT	“It’s a great program to teach/mentor the next generation of leaders in the beef industry.”
Human	PROFESSIONAL GROWTH, LEADERSHIP ROLE, GAINED KNOWLEDGE, OPPORTUNITIES, DETAIL FOCUSED	“Because of YCLP I’m more aware of the obstacles that my community faces and the state. Because of the awareness I’m able to help fight such challenges.”
Political	STATE, COUNTY, LOCAL, FEDERAL	“I was elected county board member for the cattleman’s association and from there to Vice President then to president and now to my second term
Cultural	SPOKESPERSON, GOAL-ORIENTED	“I’ve been able to perform with a broader realization of my day to day impacts, as well as a the ability to better understand and collaborate with those in other aspects of the cattle industry.”

Frequencies were calculated based upon the number of times the capital appeared within the 16-question series. An itemized list of questions can be found in the appendix. Social and human capital reported the highest frequencies (68.75%, 87.50%), which indicates a highly successful program due to impact that these capitals can have on others in the model for social change framework.

**Figure 4:** *Frequencies of Community Capitals Based Upon Qualitative Analysis*



To complete the survey, participants were asked about their overall YCLP experience which generated positive responses. Using a 5-point Likert Scale, YCLP alumni agreed with the statement that YCLP provides direct benefits to participants ( $M = 4.56, SD = 0.847$ ). When asked if there were any negative experiences that occurred because of YCLP, there were none reported. Finally, YCLP alumni were asked how important they feel that ACA continues YCLP ( $1 = not\ important, 4 = very\ important$ ). Responses were evident ( $M = 3.44, SD = 0.801$ ) that there is continued need for YCLP, and agriculture leadership programs of the like to continue.

### **Discussion and Conclusions**

Leadership is a debated abstract paradigm as many assume a level of understanding yet find difficulty in defining. Rost (1991) studied leadership over a 75-year period and reconstructed the view of leadership to be an “influence relationship process among leaders and followers who intend real changes that reflect their mutual purposes”. Kruse (2013) indicated that leadership is “the process of social influence which maximizes the efforts of others towards

the achievement of a goal”. There are many models or frameworks to use to develop skills and competencies embedded within the definitions. The Social Change Model of Leadership used in the YCLP is based on seven dimensions or values all beginning with the letter ‘C’ and three domains: individual, group/team, and community values. By emphasizing development in consciousness of self, congruence, commitment, common purpose, controversy with civility, collaboration, and citizenship, a result of the seven values combined accomplish a transcendent ‘C’ for change (Astin and Astin, 1996).

Kruse (2013) suggested investments in leadership development of young members of an organization are a catalytic driver for success of any organization. Leone (2019) used a case study to evaluate the importance of leadership training and its return on investment. In their study, it was evident that leadership training is not only beneficial to businesses, but also has a high return on investment. This high return on investment means that time and money spent on leadership training is outweighed by the benefits that can occur. The study also indicated that the longer a business may postpone leadership training, the more monetary loss could occur (Leone, 2019). When examining the agricultural industry as the business that it is, Leone’s (2019) evidence of return on investment with timely use of leadership training supports the need for young adult leadership programs within agriculture, such as YCLP. Since the inception of the program no formal assessment of the return on investment has been made to-date. However, members and elected leaders within ACA routinely convey the importance, value, support of and impact of the YCLP to the grassroots organization at the county, state, and national levels. Consistent with Leone’s analysis, YCLP survey participants reported satisfaction, gains in knowledge and skills, and behavioral change around key leadership behaviors resulting from the YCLP training. Additional assessment would be required to identify if the investment in YCLP

directly affected increased ACA membership and or financial status of the non-profit grassroots organization.

Quantitative results indicate that effects on social and human capital had the highest agreeability upon 5-point Likert Scales. These results are supported by the theory that investing time into one or two community capitals can lead to overall community improvement (Beaulieu, 2014). A separate study evaluated community-engaged learning impacts using REM with CCF themes (Muhlstein and McCann, 2019). The researchers reported similar results for community capital impacts with the highest impact being human capital, followed by social capital (Muhlstein and McCann, 2019).

Perceived effects on the beef industry were measured using a 4-point Likert Scale, but still saw high agreeability among participants. Increases in YCLP alumni assuming elected positional leadership roles within the levels of the ACA are encouraging and it is projected a YCLP alum will assume roles of state leadership in the future. The perceived improvement of effects on the beef industry agrees with literature that supports leadership development programs as an aid to business growth (Amagoh, 2009). Using an approach that provides quantitative results, allows for further insight into how a leadership development program can provide bottom line business benefits (Hayward, 2011).

Based upon qualitative CCF results, there was an improvement in the four capitals analyzed thereby supporting the value and success of YCLP, in both the individual and the community categories. Leadership development programs are an investment in human capital, and results presented here are supported by literature that indicates these investments can have an impact and improvement in other capitals (Flora et al. 2005). From this evaluation, positive community impacts were made due to the participation in the program, which aligns with other



studies (Beaulieu, 2014). A study performed to evaluate a community-based health program through REM found that participants experienced personal behavior changes and wanted to incorporate lessons that they had learned into their daily lives (Washburn et al., 2018). These results are consistent with the feedback of the YCLP survey of participants that indicated their YCLP participation impacted their personal and professional lives. Overall, the program continues to positively impact those individuals who participate, as well as the communities and organizations they are involved in.

The lack of responses from YCLP Class VI is surprising but may be due to the program sessions being set to occur during the peak of the COVID-19 Pandemic. Many sessions for this class were either shortened or occurred as distance learning via computer technologies. YCLP alumni may have not responded due to a possible lower quality of experience. Use of an interview methodology could be an approach to achieve higher participation. Distance training can be effective, but to maximize effectiveness there should still be face-to-face interactions which were very limited during this time frame (Powley, 1994). The larger amounts of responses from the most recent YCLP Class, Class VIII may also be attributed to COVID-19 but in a much different sense. These sessions took place when the world began to return to in-person meetings. Studies support that a crisis breeds opportunities to recognize leadership deficiencies, leading to an increase in leadership development program participation and better understood implementation (Kaul et al., 2020).

### **Recommendations**

To gain an in-depth evaluation of participants, the survey that was used was extensive and contained several short answer questions. However, the length of the survey resulted in survey fatigue and several incomplete responses (Galesic & Bosnjak, 2009; Deutskens et al.,

2004; Herzog & Bachman, 1981). The survey responses became more limited after the short answer questions were presented to participants. Many responses were unable to be used for data analysis due to incompleteness of the remainder of the survey. Future work aimed at a shorter survey design or recorded interview analysis is recommended so that more complete responses can be collected. Additional parameters to be assessed may be with specific impacts of YCLP participation on organizational growth in membership and level of activity of county chapters within ACA.

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## **APPENDIX I: MEAT ANALYTICS**

## **APPENDIX A**



## Thiobarbituric Acid Reactive Substances (TBARS)

### Chemicals:

Water – HPLC grade or distilled deionized water

Potassium phosphate (monobasic)  $\text{KH}_2\text{PO}_4$

Potassium phosphate (dibasic)  $\text{K}_2\text{HPO}_4$

Ethylenediaminetetraacetic acid (EDTA)

n-Propyl gallate (PG)

Trichloroacetic acid (TCA)

2-Thiobarbuturic acid (TBA)

1, 1, 3, 3, Tetraethoxypropane (TEP)

### Reagents:

50mM phosphate buffer – pH 7.0, shelf-life = 2 weeks

Prepare 50mM monobasic potassium phosphate solution – weight out 3.40g  $\text{KH}_2\text{PO}_4$ , place in a 500 ml volumetric flask, dissolve and bring to volume with distilled-deionized water (pH will be approximately 4.5).

Prepare 50mM dibasic potassium phosphate solution – weight out 8.71g  $\text{K}_2\text{HPO}_4$ , place in a 1 L volumetric flask, dissolve and bring to volume with distilled- deionized water (pH will be approximately 8.5). Prepare at least 4 L of the dibasic solution each time.

Using a 2 L beaker, combine approximately 500 ml of dibasic and 100 ml of monobasic solutions. Mix and monitor the pH of the combined solution as you continue to add more of each solution until the volume is in excess of 1 L. The pH of this solution will be slightly greater than 7.0.

Add 1.0g of EDTA and 1.0g of PG. Allow the solution to mix for one hour, as PG is extremely slow to dissolve.

### 30% TCA

Use extreme care when making, as TCA is corrosive (clean up any spills immediately). Weigh 300g of TCA into a 2 L beaker, add 1000 ml of distilled deionized water. If less is needed, weigh out 30g and add 100 ml of distilled deionized water.

### 0.02M TBA

Make fresh daily (250 ml is enough for 125 samples). Weigh out 0.7208g TBA, and place into a 250 ml volumetric flask. Add 250 ml of distilled deionized water. The use of low heat while mixing will accelerate the dissolving process, but use extreme caution as too much heat will destroy the solution

Store all reagents under refrigerated conditions, but do not store solutions in the coldest regions of the refrigerator as some of these solutions will freeze at low temperatures.

### **Analysis:**

General notes: Prepare and turn on water bath-set temperature at 100°C. It takes approximately 1h for the water bath to reach the desired temperature. If a sipper unit is being used, it is necessary to prepare at least 3 blanks and then run at least one working standard with each run.

For raw meat samples:

1. Weigh out 2.0g (1.95 to 2.05g) of minced meat into a labeled 50 ml disposable centrifuge tube. Record the exact weight of the sample.
2. Add 8 ml of prepared phosphate buffer to the tube.
3. Add 2 ml of TCA to the tube and homogenize for 20 to 30 secs.
4. Filter homogenate through a Whatman (No. 4) filter paper, collecting the clear filtrate into labeled tubes. (It is OK to stop at this point, but the tubes containing the filtrate must be sealed and stored in a refrigerator).
5. Remove 2 ml of the sample filtrate and place it into a labeled glass test tube. Prepare duplicate tubes for each sample at this point (i.e., tube "A" and tube "B").
6. Prepare three "Blank" tubes, using 2 ml of distilled-deionized water.
7. Prepare one "Standard" tube, using 2 ml of phosphate buffer. (Note: after this point, time is extremely critical. Make sure that the water bath is at the correct temperature and level prior to continuing).
8. Add 2 ml of TBA to each tube including the blanks and standard.
9. Cover tubes with aluminum foil and place them into the hot water bath for 20 min.
10. Remove tubes from hot water bath and place into the ice water bath for 15 min.
11. Read absorbance at 533 nm
12. Multiply absorbance by 12.21
13. Report TBARS as mg/kg of malonaldehyde.

### **Standards:**

1, 1, 3, 3 tetraethoxypropane (TEP)

Stock standard solution

0.02M solution-0.44g (0.5 ml) to 100 ml of distilled water ( $2 \times 10^{-5}$  moles/ml)

Working standard solution

Dilute 0.5 ml of TEP stock standard to 500 ml ( $2 \times 10^{-8}$  moles/ml).

Standards for standard curve

Dilute each of the following amounts of TEP working solution in 50 ml volumetric flasks with distilled water.

<u>TEP</u>	<u>Concentration of "Standard"</u>	<u>Absorbance</u>
1 ml (4.4 µg)	0.088 µg/ml	0.03
2 ml (8.8 µg)	0.176 µg/ml	0.06
4 ml (17.6 µg)	0.352 µg/ml	0.123
5 ml (22.0 µg)*	0.44 µg/ml	0.150
10 ml (44.0 µg)	0.88 µg/ml	0.30
20 ml (88.0 µg)	1.76 µg/ml	0.60
40 ml (176.0 µg)	3.52 µg/ml	1.20

\*This standard should have an Absorbance in the proximity of 0.150. Range may be 0.130 to 0.170, depending upon the accuracy of solutions and dilutions.

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## **APPENDIX B**

**Chapter 3: Photographs of Vacuum Packaged Ground Beef**

**Day 0**



Day 0  
Beef

**Day 20**



Day 20  
Beef

**Day 45**



Beef  
Day 45

## **APPENDIX C**

**Chapter 3: Photographs of Vacuum Packaged Ground Pork**

**Day 0**



**Day 20**



**Day 45**



## **APPENDIX D**



**Chapter 3: Photographs of Vacuum Packaged Ground Chicken**

**Day 0**



**Day 20**



**Day 45**



## **APPENDIX II: YCLP MATERIALS**

**APPENDIX II-A**

## Chapter 4: “The Impact of Young Cattlemen’s Leadership Program Using Ripple Effects”

### Survey Materials

The following questions are a part of research to better understand the ripple effect of the YCLP program. This ripple effect evaluation provides a mechanism of illustrating to stakeholders the impacts of this program, validating some of the effects of the program, and potentially creating stronger support and public value.

The research assesses community improvement credited at least in part to the YCLP. Again, part of the purpose of this research is to explore overall (individual, group, community, or regional) changes that have taken place since participating in the program. The researcher is using this survey in lieu of interviews to obtain information, details, and perspectives represented through this ripple effect (community capitals) survey.

By clicking the arrow below you are agreeing to participate and beginning this survey.

Please select the choice that best describes you.

#### Gender

- Male (1)
- Female (2)
- Prefer not to answer (3)

#### Marital/ family status

- Married (1)
- Never married (2)
- Married with children (3)
- Other (4) \_\_\_\_\_

Which of the following best describes your level of participation in beef cattle production?

- Own no cattle (1)
- Own or involved with less than 50 head (2)
- Own or involved with 51-200 head (3)
- Own or involved with greater than 200 head (4)

Which YCLP class did you belong to?

- Class I (2014-2015) (1)
- Class II (2015-2016) (2)
- Class III (2016-2017) (3)
- Class IV (2017-2018) (4)
- Class V (2018-2019) (5)
- Class VI (2019-2020) (6)
- Class VII (2020-2021) (7)
- Class VIII (2021-2022) (8)

Which of the following is your primary ethnicity?

- African American (1)
- Asian American (2)
- Hispanic (3)
- Native American (4)
- White (5)
- Other (6) \_\_\_\_\_

What is your current zip code?

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How long have you lived in you current community?

- Less than 1 year (1)
- 1-5 years (2)
- 5-10 years (3)
- More than 10 years (4)

What is your primary occupation?

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Since participating in YCLP, has your amount of community involvement:

- Decreased (1)
- Remained the same (2)
- Increased (3)

During YCLP participants took a MBTI Personality Test, please select the option that matches your results. If you would like to reference the personality types, please visit [www.humanmetrics.com](http://www.humanmetrics.com)

- INTJ (1)
- INTP (2)
- ENTJ (3)
- ENTP (4)
- INFJ (5)
- INFP (6)

- ENFJ (7)
- ENFP (8)
- ISTJ (9)
- ISFJ (10)
- ESTJ (11)
- ESFJ (12)
- ISTP (13)
- ISFP (14)
- ESTP (15)
- ESFP (16)

Please select the number that best indicates how strongly you agree or disagree with the following statements.

I was motivated by components of YCLP that contained applications of leadership theories to real life situations.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

I remember talking about the model for social change and impacts on a community during the YCLP Program.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Prior to YCLP, I had very little impact on the community in which I live.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Please select the number that best indicates how strongly you agree or disagree with the following statements.

Because of YCLP I am a more active member of my community.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree or disagree (3)
- Somewhat agree (4)
- Strongly agree (5)



I believe that people should volunteer within their community.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

As a result of YCLP, I have a better understanding about the needs and concerns of the community in which I live.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

To be an effective leader in the community you must volunteer.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

As a result of YCLP I am more aware of the importance for leadership and involvement in programs to enhance my community.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

As a result of my experiences with YCLP, I feel more confident about my abilities to succeed in my involvement with other organizations.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Please indicate the approximate number of hours you volunteer within your community per month, prior to and after participating in YCLP.

	Prior to YCLP (1)	Following YCLP (2)	Both Prior to & Following YCLP (3)
1-3 hours (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4-6 hours (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
7-9 hours (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10 or more hours (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I do not spend any time as a volunteer. (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please identify the top three leadership challenges you experienced since your YCLP participation.

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Please select the number that best indicates how strongly you agree or disagree with the following statements.

I have a good understand of the strengths and resources for the community in which I live.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Due to YCLP, I can make a difference in the organizations of my community for which I am affiliated.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

The following questions are appreciative inquiry-like questions. Without explicitly identifying yourself please answer the following questions.

Please describe a scenario in which you have used the information you received during the YCLP program.

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Please give an example of how have you been impacted personally and/or professionally, as a result of your involvement with YCLP.

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Is there anything that you are particularly proud to share about the impact gained from the YCLP program?

If applicable, please list any awards or recognitions that you have received following the YCLP program.

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As a result of participating in YCLP, how has your awareness, knowledge, or competencies changed?

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Which training elements or program activities are most associated with the changes you mentioned in answering the last question?

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What has been the most critical action or advocacy you have undertaken since participating in YCLP?

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How have you or organizations that you are involved with undergone sustained shifts in values, behaviors, cultures, or abilities to influence outcomes?

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You are halfway there! Thank you again for your time, the other half of the survey will continue after clicking the arrow.

To what extent are you affiliated with the beef community as a result of YCLP?

- None/Not at all (1)
- Somewhat affiliated (2)
- Moderately affiliated (3)
- Highly affiliated (4)

To what extent are you recognized as a leader within the beef community as a result of YCLP?

- None/ Not at all (1)
- Somewhat recognized (2)
- Moderately recognized (3)
- Highly recognized (4)

In regards to your affiliation with the beef industry and extent of your leadership, how has that impacted your community?

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What is different in your community as a result of you interacting with people and organizations?

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To what extent have organizations you have worked with, improved their capacity to thrive and carry out their mission because of your YCLP leadership training?

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What connections with others- new and/or deepened- have you made as a result of the YCLP program?

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What impressions do you have of the accomplishments other YCLP participants have made as a result of the YCLP program?

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Please answer the following questions regarding community involvement and awareness.

Please indicate how your participation in the community changed after your YCLP experience.

- None/Not at all (1)
- Slight change (2)
- Moderate change (3)
- Drastically changed (4)

Please indicate how your level of involvement changed with groups on a state level because of YCLP.

- None/ Not at all (1)
- Increased slightly (2)
- Increased moderately (3)
- Increased drastically (4)

Please indicate how your level of involvement changed with groups on a national level because of YCLP.

- None/Not at all (1)
- Increased slightly (2)
- Increased moderately (3)
- Increased drastically (4)

Please indicate how much your appreciation of cultural differences increased due to your YCLP experience.

- No change (1)
- Neutral (2)
- Slight increase in appreciation (3)
- Great increase in appreciation (4)

Please indicate how much your awareness for time value increased due to your YCLP experience.

- No change in awareness (1)
- Neutral (2)
- Slight increase in awareness (3)
- Complete increase in awareness (4)

Please indicate the organizations in which you were involved with prior to YCLP participation, and following participation (Select all that apply.)



	Prior to YCLP (1)	Following YCLP (2)	Both Prior to & Following YCLP (3)
Alabama Cattlemen's Association (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alabama Cattlemen's Association - Regional VP (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alabama Cattlemen's Association - County Board (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alabama Cattlemen's Association - State (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alabama Cattlewomen's Association (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alfa - County Level (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alfa - State Level (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Alfa - National Level (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Beef (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Corn (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Dairy (11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Fruit and Vegetable (12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Pork (13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Commodity Group / Committee - Poultry (14)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Soybean (15)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Wheat (16)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Commodity Group / Committee - Wine Producers (17)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Soil and Water Conservation / Committee (18)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rotary (19)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lions (20)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Jaycees (21)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Chamber of Commerce (22)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Boy Scouts (23)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Girl Scouts (24)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Church (25)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
County Fair Board (26)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Women for Agriculture (27)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School - PTA (28)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

School - Athletics (29)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
School Board (30)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other Statewide Cattlemen's Association (not AL) (31)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other (please specify) (32)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Please report your level of involvement regarding your activity in organizations at the local, state, and national levels including the board(s) of directors in which you are a current member of or have been a member of since you were in YCLP. Also, indicate the office(s) or committees that you might hold/ have held on those boards.

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Please list any governmental positions (elected or appointed) that you have held, or currently hold, since participating in YCLP.

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YCLP provides direct benefits to participants.

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Please indicate how important you feel it is for ACA to continue the YCLP program.

- Not important (1)
- Neutral (2)
- Important (3)
- Very important (4)

Please select a choice below to indicate the level of **personal improvement** that you experienced because of your YCLP participation.

- Did not change (1)
- Neutral (2)
- Some improvement (3)
- Significant improvement (4)

Please select a choice below to indicate the level of professional improvement that you experienced because of your YCLP participation.

- Did not change (1)
- Neutral (2)
- Some improvement (3)
- Significant improvement (4)

Please leave any other comment that you would like to make about YCLP's impact, as well as any recommendations for improvement regarding YCLP.

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Have you experienced any negative changes that occurred as a result of your participation in YCLP? If selecting yes, please explain.

Yes (1) \_\_\_\_\_

No (2)