EVALUATION OF THE OKLAHOMA BEEF COOKING SCHOOL

By

SARAH LILLEY OWEN

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Thesis Approved:

Dr. Barbara J. Brown

Thesis Adviser

Dr. Janice Hermann

Dr. Deana Hildebrand

Dr. A. Gordon Emslie

Dean of the Graduate College

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ABBREVIATIONS

ADA	American Dietetic Association
AHA	American Heart Association
AICR	American Institute for Cancer Research
ATSDR	Agency for Toxic Substances & Disease Registry
BaP	Benzo(*a*)pyrene
BSE	Bovine spongiform encephalopathy
CAFO	Concentrated animal feeding operation
CDC	Centers for Disease Control and Prevention
CHD	Coronary heart disease
CLA	Conjugated linoleic acid
CSFII	Continuing Survey of Food Intake by Individuals
CVD	Cardiovascular disease
EB	VA/CLA-enriched butter group
EPA	Environmental Protection Agency
^{o}F	Fahrenheit
FDA	Food and Drug Administration
FSIS	Food Safety and Inspection Service
g	Grams
HACCP	Hazard Analysis and Critical Control Point

HCA	Heterocyclic amines
HDL	High-density lipoprotein
IRB	Institutional Review Board
kg	Kilogram
LDL	Low-density lipoprotein
mg	Milligrams
NIH	National Institutes of Health
OBC	Oklahoma Beef Council
OBCS	Oklahoma Beef Cooking School
ODS	Office of Dietary Supplements
PAH	Polycyclic aromatic hydrocarbons
RDA	Recommended daily allowance
SA	Stearic acid
SAS	Statistical Analysis System
SB	Standard butter group
µg	Micrograms
USDA	U.S. Department of Agriculture
VA	Vaccenic acid
vCJD	variant Creutzfeldt-Jakob disease
VLDL	Very low-density lipoprotein
VO	Vegetable oil group

CHAPTER I

INTRODUCTION

Traditionally, American meals have centered on the consumption of meat. Beef is the most popular of the red meats (beef, pork, lamb, and veal) in the United States, representing 56% of all red meat consumed in 2004 (Davis & Lin, 2005). However, beef consumption in the United States has declined continuously since 1977 (Ollinger, et al., 2000) despite the fact that lean beef is a nutrient dense food that can improve diet quality and overall health. Negative health claims and beef being labeled as a "danger" food that contributes to cardiovascular disease, unfavorable lipid profiles, weight gain, and increased risk of developing certain cancers, have resulted in the avoidance of beef for some individuals.

Women tend to consume less beef than males. The 1994-1996 and 1998 Continuing Survey of Food Intakes by Individuals (CSFII) data found beef consumption varied significantly by gender, with males eating approximately 38 pounds more a year than females (Davis & Lin, 2005). The lower consumption of beef in the female population may be the result of negative opinions and feelings toward red meat. Reasons for aversion towards red meat in young females could be attributed to the slaughtering of the animal, undesirable appearance of red meat, texture, taste or smell, negative effects on human health, and weight gain (Kubberod, et al., 2006). The decline in beef

consumption may also be attributed to reduced time available for meal preparation, increased cost of beef, and/or lack of skill in preparing foods at home.

A general fallacy is red meat is not a healthful food because it is high in fat and cholesterol and high intakes are associated with increased blood cholesterol levels and cardiovascular disease (CVD). Patients with hypercholesterolemia are often advised by their physicians to reduce or exclude beef from the diet. The misconception that beef should be eliminated from the diet persists despite extensive research that has demonstrated that it is not the source of meat protein, but the amount and type of fat that negatively affects plasma cholesterol levels. Strong evidence exists that lean red meat does not raise total cholesterol or low-density lipoprotein (LDL) cholesterol levels (Li, et al., 2005; Scott, et al., 1994). One study found that a diet containing lean beef as the protein source had the same effect on plasma lipid levels in hypercholesterolemic men as the diet of chicken as the protein source when both meats were comparable in fat quantity (Scott, et al., 1994).

Partial substitution of carbohydrates in the diet with lean red meat has been associated with decreased systolic blood pressure in hypertensive adults (Hodgson, et al., 2006). Studies have also shown that a high-protein diet low in fat is an effective and healthy way to lose weight (Johnston, et al., 2004; Noakes, et al., 2005). One study conducted on overweight women addressed the conflicting recommendations regarding the consumption of red meat versus white meat, and weight loss. Weight loss was significant and similar for the group consuming beef and the group consuming chicken. Both diets resulted in significant reductions in body fat, total cholesterol, and LDL

cholesterol. The results indicated weight loss and improved lipid profiles could be attained regardless of the source of dietary protein (Melanson, et al., 2003).

Safety issues regarding the purchasing and consumption of beef have also attracted negative attention in terms of questionable safety of the food supply and foodborne illnesses. Even certain cooking methods commonly used for preparing meat, such as grilling, have gained public attention after being associated with the formation of carcinogenic chemicals that have been linked to the development of certain cancers (National Cancer Institute, 2004). Other issues that may contribute to individuals reducing or avoiding red meat are cost, belief that consumption of animals is unethical (Kubberod, et al., 2006), and the negative impact livestock has on the environment. Cattle emit methane, a potent greenhouse gas that contributes to global climate changes (U.S. Environmental Protection Agency [EPA], 2008). Methane emissions from cattle contribute nearly 30% of global methane emissions from human-related activities (EPA, 2008). Livestock grazing has been credited with severely damaging streambank areas and riparian zones, thus negatively affecting plant species, fish, birds, and other wildlife that depend on this small ecosystem (Belsky, et al., 1999; Pacific Northwest National Laboratory, 2008). Trampling from livestock destroys natural flood control by disrupting the natural barrier that prevents agricultural pollution from further contaminating the environment (Pacific Northwest National Laboratory, 2008).

Food preparation skills and time spent preparing meals influence eating habits and dietary intake. Women spend about 48 minutes a day on food preparation and clean up, while men spend about 15 minutes a day (Hamrick & Shelley, 2005). Lifestyle changes have affected time spent on preparing meals in the home. The increasing number of

women in the workforce and the increased number of single heads of households have resulted in less time to prepare meals at home, as well as increased interest in convenience foods (Walderhaug, 1999). Beef can be included in the diet using quick preparation methods and convenience products. The beef industry has identified this demand for convenient meals and provides a wide variety of easy-to-prepare beef dishes. However, these quick dishes may contain higher levels of fat, saturated fat, and sodium when compared to a similar meal prepared at home with fresh lean beef.

Improper storage, inadequate cooking temperatures, and unsanitary food handling and/or poor personal hygiene contribute to increased foodborne illness incidence (Walderhaug, 1999). Basic steps an individual can take at home to avoid a foodborne illness include proper hand-washing, washing utensils used on raw meat before being used on other foods, using a food thermometer, and storing leftovers properly.

Lean beef is defined as 100 grams (g) of beef (three-ounces is approximately 85 g) with less than 10 g of fat, 4.5 g or less of saturated fat, and less than 95 milligrams (mg) of cholesterol (Food Safety and Inspection Service [FSIS], 2003). Twenty-nine cuts of beef are categorized according to government guidelines as lean for a three-ounce serving (Cattlemen's Beef Board, 2008).

Beef is a source of high-quality protein that provides all the essential amino acids that the human body cannot synthesize on its own (U.S. Meat Export Federation, 2005). Beef is an excellent source of vitamin B12, zinc, selenium, and phosphorus, and a good source of iron, riboflavin, niacin, and vitamin B6 (U.S. Meat Export Federation, 2005).

Vitamin B12 is found in foods of animal origin only. Vitamin B12 is needed to maintain healthy nerve cells, red blood cells, and is needed to make DNA (Mayo Clinic,

2008a; Office of Dietary Supplements [ODS], 2006). Deficient amounts of vitamin B12 in the body can result in anemia, as well as abnormal neurologic and psychiatric symptoms (ODS, 2006). A three-ounce serving of beef provide 37% of the recommended daily allowance (RDA) for vitamin B12 (U.S. Meat Export Federation, 2005). The meat, fish, and poultry group is the primary contributor of vitamin B12 in the food supply and diet (Gerrior, et al., 2004).

Beef is an excellent source of zinc, which is needed by the body for wound healing, blood formation, and growth and maintenance of all body tissues (Gerrior, et al., 2004). Three ounces of beef provide 39% of the RDA for zinc (U.S. Meat Export Federation, 2005).

Selenium is a mineral that possesses antioxidative properties and prevents cellular damage (Gerrior, et al., 2004; ODS, 2004). It is primarily found in meats, seafood, and grain, but it can be found in a variety of foods (Gerrior, et al., 2004).

Phosphorus is crucial for the formation of bones and teeth, but is also important in the synthesis of protein, maintenance and cell repair, muscle contraction, kidney function, nerve conduction, heartbeat regularity, and ATP production (Medical Encyclopedia, 2007a). The meat and milk food groups contain the most phosphorus (Medical Encyclopedia, 2007a). A three-ounce serving of lean beef provides 20% of the RDA for phosphorus (U.S. Meat Export Federation, 2005).

Iron deficiency anemia is the most common deficiency in the United States, and infants, adolescents, and women of childbearing age are at the greatest risk for developing anemia (Gerrior, et al., 2004). Iron plays a role in oxygen transport, and is a crucial component of hemoglobin in blood and myoglobin in muscles (Gerrior, et al.,

2004). A deficiency in iron limits the delivery of oxygen to cells, resulting in fatigue, diminished work performance, and decreased immunity (ODS, 2007a). Iron can be a difficult mineral to consume adequate amounts of through dietary intake alone, especially for individuals with low or no red meat intake such as vegetarians. Women, who tend to eat less meat than men, require 18 mg of iron a day from the age of 19-50, while men of the same age only need 8 mg a day (ODS, 2007a). Iron from the diet is found in two forms: heme and non-heme iron. Heme iron is found in foods of animal origin such as meat, and is superior to non-heme iron in terms of absorption by the human body. Non-heme iron is found in plant foods such as beans, lentils, and iron-fortified or iron-enriched foods (ODS, 2007a). A three-ounce serving of lean beef provides 14% of the RDA for iron (U.S. Meat Export Federation, 2005).

Beef is also a good source of riboflavin (vitamin B2), niacin (vitamin B3), and vitamin B6. These B-vitamins are water-soluble, so excess amounts are not stored in the body, but rather, excreted in the urine. Therefore, a continuous supply of these vitamins must be provided by the diet. A three-ounce serving of beef provides 12% of the RDA for riboflavin, 18% of the RDA for niacin, and 16% of the RDA for vitamin B6 (U.S. Meat Export Federation, 2005). The B-vitamins play an important role in carbohydrate metabolism, protein metabolism, growth, red blood cell production, and nervous system and immune function (Medical Encyclopedia, 2007b, 2007c; ODS, 2007b).

Beef also contains naturally occurring *trans*-fats that have exhibited favorable effects on human health in numerous studies focusing on cancer, cardiovascular disease and body fat mass (Belury, 2002a, 2002b).

A hands-on learning approach in the development and implementation of adult education programs has gained attention as a successful means to educate adults. Participants learn knowledge or skills by actively participating in the education process (Smith, 1996). Participants then apply that information toward behavioral or lifestyle changes, or any change that one can make in life. Readiness to change, implementation of change, and maintenance of change over a period of time is the ultimate goal of experiential, or hands-on, learning.

Problem Statement

Beef consumption continues to decline as a result of unfounded and unfavorable health claims and adverse opinions of beef, despite the fact that lean cuts of beef are a nutrient dense food that can improve diet quality and overall health. Lack of cooking skills and decreased time spent in preparation of meals has also negatively impacted the frequency of inclusion of beef, as well as other nutritious foods, in meals prepared at home.

Purpose

The general public has a misconception that beef is not a nutritious food and it takes too much time to prepare. They also lack basic food preparation skills.

The purpose of this study is to determine if nutrition education and hands-on cooking lessons that use beef as the protein food will improve participants' opinion of beef in the diet, improve ability to select lean cuts of beef, increase the use of safe food

handling methods, and increase the self-forecast incorporation of beef into the diet using nutritious and safe preparation methods.

Objectives and Questions

To increase the probability of Oklahoma adults who participate in the Oklahoma Beef Cooking School (OBCS) to make more healthful decisions and increase inclusion of lean beef in the diet after participating in hands-on learning experiences covering the nutritional contributions of beef to the diet, selection of lean cuts of beef, serving sizes, and safe handling and cooking methods of beef. Specific objectives in this study include providing nutrition education to participants regarding the nutrient content of beef, recognition and selection of lean cuts of beef, knowledge of the appropriate serving size, experience with different cooking methods to develop basic cooking skills, and safely handling beef to prevent foodborne illness.

Hypotheses

Hypothesis 1: Beef Sandwiches, Soups and Salads Lesson

Education regarding the fatty acid profile of lean beef and proper cooling methods to avoid the temperature danger zone will increase the intent of participants to include beef in a healthful diet and improve participants' method of clearing the table and refrigerating/freezing leftovers promptly.

Hypothesis 2: Beef Steak Lesson

Education regarding lean and extra lean cuts of beef will increase the intent of participants selecting lean, healthy cuts of beef. Education concerning the safe and appropriate method to determine doneness of beef will result in the intent of participants to use a thermometer to determine doneness of beef steak instead of relying on interior color and texture of beef.

Hypothesis 3: Grilling In and Out Lesson

As a result of this lesson, participants will gain an understanding of the nutritional quality of lean beef and will indicate intention to select grilled lean beef over other options if offered a choice. Education regarding the safest method to determine when grilled beef reaches a safe internal temperature will increase intention of participants changing to using a thermometer to determine doneness of grilled beef.

Hypothesis 4: Ground Beef Lesson

As a result of this lesson, participants will have increased intention to use a thermometer to assure ground beef reaches the safe internal temperature of 160 degrees Fahrenheit (^{o}F) when preparing meals at home. Participants will have increased intention to select ground beef that is defined as lean according to government guidelines more frequently than prior to the lesson.

Hypothesis 5: Homemade with Help Lesson

Education regarding reading Nutrition Facts labels and selecting healthy heat-and-eat beef products will increase participant's intention of selecting healthy and convenient beef dishes, as well as reading the Nutrition Facts label prior to purchase.

Hypothesis 6: Mixing Cultures Lesson

Education regarding cultural beef dishes will increase participants' intention and ability to incorporate lean beef into healthy recipes, as well as expand their cooking skills to new cultural dishes that may call for new equipment.

Hands-on cooking classes using beef as the protein source will increase beef acceptance and consumption of participants by improving their opinion of beef in the diet with nutrition education, and by providing education on the selection of lean cuts of beef, introducing quick and convenient methods to preparing meals at home with beef, and safe handling and cooking methods for beef.

Assumptions

1. Participants will be attending the lesson(s) voluntarily. Therefore, participants will honestly answer questionnaires at the end of each class attended.
2. Participants are not aware of all the truths behind the nutritional content of beef, safety issues, and preparation methods prior to participation.

Limitations

1. Information obtained from participants cannot be applied to the general public. For example, women are generally responsible for the purchasing and preparation of food in the household. However, this generality cannot be applied to the population in this study.
2. Data was collected from voluntary participants willing to participate. However, no attempt was made to determine how many lessons in the series each participant attended.
3. County Educators chose the order for presentation of lessons that best fit their county needs. This resulted in variation from county to county in the order in which material was presented across the state of Oklahoma.
4. No control group was used in the study.
5. Due to the low attendance of men during the six cooking lessons, only women were included in the results.

CHAPTER II

REVIEW OF LITERATURE

Changes in Consumption of Beef and its Affects on Human Health

Beef is a controversial red meat that is typically consumed by Americans. Beef sales and consumption were continuously on the rise until 1977, when beef consumption per capita reached its peak at 91.5 pounds (Ollinger, et al., 2000). However, since 1977, beef consumption has declined continuously, and in 2004, per capita beef consumption was 66.1 pounds (Davis & Lin, 2005). Consumption of red meat has declined, in part, as a result of unfounded and unfavorable health claims against beef that have circulated through the general public, resulting in falsified facts. Other issues that have contributed to a steady decline in beef consumption since 1977 include safety issues, cost, time available for preparation of meals, cooking skills, and feelings of aversion toward red meat.

Females tend to eat less red meat than males, and some females have negative sentiments toward red meat and avoid consumption of beef altogether. According to the 1994-96 and 1998 CSFII data, beef consumption varied significantly by gender, with males eating 86 pounds a year compared to 48 pounds for females, a 38-pound difference in annual beef consumption (Davis & Lin, 2005).

Consumption of beef products starts to decline after age 19 in females (Davis & Lin, 2005), and this shift in the female diet could be due to a mix of opinions and beliefs females experience that result in revulsion and ultimately, avoidance of red meat. Reasons for aversion towards red meat in young females have been associated with the actual slaughtering of the animal, undesirable properties related to appearance (e.g. visual blood in packaged raw red meat), texture, smell or taste, negative effects on human health, and perceived negative consequences after the ingestion of red meat (e.g. feelings of fullness or sluggishness). Young women concerned with body image may avoid red meat based on the unfounded belief that consuming red meat results in weight gain (Kubberod, et al., 2006). Red meat is frequently one of the first foods excluded from the diets of women trying to lose or maintain weight. The nutritional benefits of red meat consumption are overlooked and the degraded status of meat as a healthful food dominates. Moral concerns and the belief that the consumption of animals is unethical is one of the main factors responsible for reducing the consumption of meat in western societies in the 1980's and 1990's (Kubberod, et al., 2006).

The general message to the public about red meat consumption is misleading. Beef has been viewed by many as an unhealthy, fatty meat that if consumed regularly could result in weight gain, unfavorable lipid profiles, CVD (e.g. coronary heart disease[CHD]), and possibly cancer. Individuals that change their diet as a result of heart health concerns (e.g. CHD, hypertension) or weight loss goals are frequently under the impression that red meat must be severely restricted or completely eliminated from the diet. Unfortunately, these common beliefs are supported by false assumptions that lack scientific evidence. There is a considerable amount of evidence that shows lean beef, or

lean red meat, does not raise total blood cholesterol and LDL cholesterol levels (Li, et al., 2005; Scott, et al., 1994). Several studies have shown that including lean red meat low in saturated fat is not harmful, but beneficial for those trying to eat healthier diets or lose weight. Consumption of lean red meat low in saturated fat is associated with reductions in LDL cholesterol in healthy and hypercholesterolemic subjects (Li, et al., 2005). Reducing intake of dietary animal fat was the answer to reducing cholesterol levels, not removal of red meat from the diet. One study was conducted on 38 hypercholesterolemic, but otherwise healthy, men ages 20 to 55 years, to compare the effects of lean beef consumption to chicken consumption on plasma lipid levels (Scott, et al., 1994). The study lasted for 13 weeks. Subjects consumed their usual diet for 3 weeks, followed by a 5-week stabilization diet (18% of energy from saturated fatty acids), which was then followed by a 5-week test diet. Subjects were randomly assigned to the chicken group or the beef group for the 5-week test diet. Both test diets provided the same amount of meat, and were the same in the percentage of energy from fat, saturated fat, protein, and carbohydrates. Subjects in both groups experienced a statistically significant decrease in LDL cholesterol and in total cholesterol levels. The study concluded that a diet containing lean beef would have the same effect on plasma lipid levels in hypercholesterolemic men as a diet of chicken that was of comparable fat quantity (low-fat) (Scott, et al., 1994).

Red meat intake has also been associated with hypertension and increased risk of CHD and type-2 diabetes. Hodgson et al. (2006) conducted a study and found partial substitution of carbohydrate intake with animal protein from lean red meat was associated with decreased systolic blood pressure and increased fasting plasma glucose

concentrations in hypertensive adults. Increased fasting plasma glucose concentrations in subjects displayed the opposite of the expected outcome, because the replacement of some carbohydrate with protein would be expected to result in reduced fasting plasma glucose concentrations. However, this unexpected change has been seen in other studies (Hodgson, et al., 2006). Another study conducted by Hodgson et al. (2007) was an 8-week study on 60 subjects to determine if partial replacement of carbohydrates in the diet with approximately 200 g/day of lean red meat would result in elevations in oxidative stress and inflammation. Results suggested a modest increase of lean red meat was unlikely to increase oxidative stress or inflammation. Therefore, higher intake of lean red meat was not associated with increased risk factors of heart disease and type-2 diabetes because lean red meat failed to result in increased oxidative stress and inflammation (Hodgson, et al., 2007).

Weight loss using a low-carbohydrate, high-protein and high-fat diet, such as the Atkins diet, did result in weight loss for individuals on the diet, but adverse changes in blood and renal biomarkers accompanied the weight loss as a result of high intakes of fat and saturated fat (Johnston, et al., 2004). However, high-protein diets low in fat have gained attention as being an effective and healthful way to lose weight. One study comparing a high-protein, low-fat, energy-restricted diet to a high-carbohydrate, low-fat, energy-restricted diet determined both diets were equally effective in reducing body weight and fat mass, as well as lowering total cholesterol. However, subjects assigned the high-protein diet reported greater satiety and less hunger than the high-carbohydrate group (Johnston, et al., 2004). Another study assessed dietary intake accompanied with exercise and their effects on body composition and weight loss in obese women. It found

a high-protein diet (at least 1.4 g/kilogram [kg] body weight) resulted in more total weight lost, more fat mass lost, and less loss of lean muscle tissue when compared to the high-carbohydrate diet (Layman, et al., 2005). In fact, the high-protein diet group and the high-protein diet accompanied with an exercise regime group experienced greater losses of weight and fat mass, and preserved lean mass, when compared to the high-carbohydrate diet group and the high-carbohydrate diet group combined with exercise (Layman et al., 2005). A study by Noakes, et al. (2005) found that use of an energy-restricted, high-protein (34% energy from protein), low-fat diet resulted in nutritional and metabolic benefits equal to and sometimes greater than a high-carbohydrate (17% energy from protein), low-fat diet in obese women. Weight loss in both groups was the same, except subjects with high serum triacylglycerol lost more fat mass and had a greater decrease in triacylglycerol concentrations with the high-protein diet when compared to the high-carbohydrate diet. The high-protein diet required 200 g of lean beef or lamb at least six times a week with an additional 100 g of protein from other foods. The high-carbohydrate group was required to consume 80 g of chicken, pork, or fish more than six times a week and red meat less than one time a week (Noakes, et al., 2005).

One study addressed the conflicting recommendations regarding the appropriateness of red meat versus white meat consumption for individuals aiming to reduce body weight and cardiovascular disease risk (Melanson, et al., 2003). The subjects were overweight women. Weight loss was significant but similar for the group consuming beef and the group consuming chicken. Both diets showed significant reductions in body fat percentage, total cholesterol, and LDL cholesterol, indicating

weight loss and improved lipid profiles could be achieved regardless of the dietary protein source (Melanson, et al., 2003).

Despite the fact that including lean cuts of beef in the diet can improve diet quality and overall health, beef has been labeled as a "danger" food. The widespread opinion is that beef is unhealthy and this has contributed to a decline in beef consumption. Time spent preparing meals at home and lack of basic cooking skills have also contributed to a decline in the consumption of beef and other nutritious foods. Safety issues regarding the purchasing and consumption of red meat have also attracted negative attention.

Cooking Skills and Time Spent on Food Preparation

To further compound the decline in beef intake, lack of food preparation skills and time spent preparing meals in the home have also negatively impacted the inclusion of beef in the diet. Cooking skills and preparation time influence eating habits and dietary intake of adults and their families at home. On average, American men spend less time grocery shopping and preparing food than women. Men spend an estimated 15 minutes per day total on food preparation and clean up, compared to women who spend approximately 48 minutes per day on food preparation and clean up (Hamrick & Shelley, 2005). Lifestyle changes, including an increasing number of women in the workforce and an increased number of single heads of households have contributed to limited time spent on food preparation in the home, as well as an increasing consumer interest in convenience foods (Walderhaug, 1999). Lack of food preparation skills and limited time to prepare meals in the home can prevent including foods that require longer preparation

and cooking time. However, beef can be included in the diet using quick and convenient preparation methods, quick-cooking beef cuts, and convenience products. For example, purchasing pre-cooked beef can provide a nutritious meal in minutes. The beef industry has identified this problem and now provides a wide variety of beef products that require less preparation and cooking time for consumers. The limiting factor with these products is that they tend to be expensive and may have higher levels of sodium, fat, and saturated fat than a similar product the consumer could prepare at home.

Health-conscious consumers should start off with reading the food labels of convenience foods. For consumers trying to watch cholesterol intake, key words to look for are low-fat, low saturated fat, low cholesterol, reduced-fat or reduced cholesterol, no saturated fat, *trans*-fat free, cholesterol free, light, lean, and extra lean. For consumers concerned with their blood pressure, key words to look for are low-sodium, very low sodium, reduced sodium, light in sodium, and no salt added (Stevens, 2008).

Barriers to Controlling Portion Sizing

Larger packages in grocery stores, larger serving sizes in restaurants, and larger dishware at home have contributed to portion distortion among the public. Sizes of packages in supermarkets have increased 10-fold between 1970 and 2000 (Wansink & van Ittersum, 2007). Jumbo-sized portions served in restaurants are consistently 250% larger than the regular portion. Even bowls, glasses, and plates in the home have increased in size by 36% since 1960 (Wansink & van Ittersum, 2007).

Cuts of Meat And Cooking Methods

"Beef" is meat from a full-grown steer about 2 years of age, weighing about 1,000 pounds and providing approximately 450 pounds of edible meat (FSIS, 2003). A widespread concern for consumers of beef is the fat and saturated fat content. Lean and extra lean beef products are available to consumers. Lean beef is defined as 100 g of beef with less than 10 g of fat, 4.5 g or less of saturated fat, and less than 95 mg of cholesterol (FSIS, 2003). Extra lean beef is defined as 100 g of beef with less than 5 g of fat, less than 2 g of saturated fat, and less than 95 mg of cholesterol (FSIS, 2003). Twenty-nine cuts of beef are currently categorized according to government guidelines as lean for a three-ounce serving (Cattlemen's Beef Board, 2008). Three ounces is equivalent to approximately 85 g. A three-ounce serving of any of the 29 lean cuts of beef have a total fat content that falls between three ounces of cooked skinless chicken breast and three ounces of cooked skinless chicken thigh (Cattlemen's Beef Board, 2008).

There are 4 major retail cuts of beef sold in grocery stores: chuck, loin, rib, and round. Frequently, fresh beef sold in supermarkets is labeled with the primal cut and the product to help consumers know what type of heat or cooking method is recommended in order to achieve optimal results (e.g. chuck roast or round steak) (FSIS, 2003). The recommended cooking methods are based on the tenderness of beef. Tenderness varies on what part of the carcass the meat came from. Generally, meat from the upper part of the carcass along the backbone is more tender than meat from the lower part (e.g. meat from the chuck is more tender than meat from the brisket). Meat from the rib and loin are the most tender cuts of meat (Charley & Weaver, 1998). Less tender cuts come from the front and hind sections of the animal (e.g. chuck and round) because these muscles are

heavily exercised in the live animal, and therefore, contain more connective tissue (Epley, 1992). Meat from the lower part of the legs and from the neck and flank is tougher than cuts from any other part of the cow (Charley & Weaver, 1998). A decrease in tenderness of meat is also experienced with increasing age of the animal because collagen and connective tissue becomes more complex and tough with advancing age (Epley, 1992).

Different cooking methods are recommended for different cuts of meats depending of tenderness or toughness of the meat. There are two main methods of cooking meat: dry heat and moist heat. Dry heat methods (e.g. broiling, roasting, and grilling) surround meat with hot dry air. Dry heat methods should be used only on tender cuts of meat (e.g. rib or loin) because no additional tenderization occurs during the cooking process. Moist heat cooking methods (e.g. braising, stewing, and boiling) are recommended for cuts of meat that are from tougher (e.g. chuck or round) cuts or lower quality cuts of beef because they are less tender (Charley & Weaver, 1998; FSIS, 2003). Moist heat is used on tough cuts of beef because the meat cooks slowly in a closed container with added water to loosen or break down the connective tissue (Charley & Weaver, 1998).

Nutritional Contributions of Beef

Beef is a naturally nutrient-rich food that provides high-quality protein, vitamins, minerals, and other nutrients that may be hard to consume in adequate amounts if beef was eliminated from the diet. A food is considered an excellent source of a nutrient when it provides at least 20% of the daily value for that particular nutrient in a serving, and a

good source of a nutrient when it provides 10-19% of the daily value for a particular nutrient in a serving (American Dietetic Association [ADA], 2007). A three-ounce serving of beef is an excellent source (provides at least 20% of RDA) of protein, zinc, vitamin B12, selenium, and phosphorus. It is also a good source (provides at least 10% of RDA) of niacin, vitamin B6, iron, and riboflavin (U.S. Meat Export Federation, 2005). Lean beef is the prominent food source of protein, zinc, and vitamin B12, as well as one of the most important dietary sources of iron (ODS, 2007a). Following 3 ½ ounces of chicken liver providing 12.8 mg of heme iron, and 6 breaded and fried oysters providing 4.5 mg of heme iron, three ounces of lean beef provides 3.2 mg of heme iron (ODS, 2007a). Lean red meat, trimmed of visible fat is not associated with increased total blood cholesterol or LDL cholesterol levels (Li, et al., 2005), or increases in weight or fat mass (Layman, et al., 2005).

Protein

Many foods contain some protein, but the amount and quality of the protein vary greatly. Meat, fish, poultry, eggs, soy, nuts, legumes, and dairy products are considered high-protein foods (U.S. Meat Export Federation, 2005). Protein provides amino acids to build and maintain body tissues, as well as form enzymes to act as regulators and transporters for vitamins and minerals in the body (Gerrior, et al., 2004). Proteins from animal sources, such as beef, are high-quality proteins, or complete proteins (U.S. Meat Export Federation, 2005). Complete proteins contain all the essential amino acids that the human body cannot synthesize on its own. Grains and vegetables contain protein in

smaller amounts than what is found in meat, and they are incomplete proteins because they do not provide all the essential amino acids (U.S. Meat Export Federation, 2005).

Complementary proteins are two or more incomplete protein sources (e.g. corn, rice, beans, and tofu) that together provide sufficient amounts of all essential amino acids (Centers for Disease Control and Prevention [CDC], 2008a). In 2005, the meat, poultry, and fish group contributed 42% of the protein available in the food supply (Hiza, et al., 2008). This is a slight increase from 40% of protein in the food supply being provided by the meat, poultry, and fish group in 2000. Grains contributed 22%, and dairy products contributed 19% of protein in the food supply in 2000 (Gerrior, et al., 2004). A three-ounce serving of beef provides approximately 50% of protein recommended daily (U.S. Meat Export Federation, 2005).

Current usual intake of protein in the United States was assessed using data from the National Health and Nutrition Examination Survey, 2003-2004. Protein intake averaged 56 +/- 14 g per day in young children, 91 +/-22 g per day in adults aged 19-30 years, and 66 +/- 17 g per day in the older adult population. The male and female population who consumed less than the estimated average requirement was very low (7.7% for females adolescents and 7.2-8.6% of older women) (Fulgoni, 2008). The RDA for protein is 46 g of protein per day for females 19 years and older, and 56 g per day for males 19 years and older (CDC, 2008a), or 17-21% of calories consumed (Fulgoni, 2008).

Vitamin B12

Beef is an excellent source of vitamin B12. Vitamin B12, also called cobalamin, helps maintain healthy nerve cells, healthy red blood cells, and is required to make DNA, the genetic material found in all cells (Mayo Clinic, 2008a; ODS, 2006). Vitamin B12 occurs naturally only in animal foods and is found in foods including fish, red meat, and poultry (Gerrior, et al., 2004). Smaller amounts of vitamin B12 are found in yogurt, milk, eggs, and fortified breakfast cereals (ODS, 2006).

The human body can store several years' worth of vitamin B12. Therefore nutritional deficiency is extremely rare (Mayo Clinic, 2008a). The elderly population is most at risk for vitamin B12 deficiency because they do not absorb vitamin B12 as efficiently as their younger counterparts due to atrophic gastritis (ODS, 2006). Strict vegetarians or vegans who are not supplementing vitamin B12 in their diet are also at risk for vitamin B12 deficiency (Mayo Clinic, 2008a). Vitamin B12 deficiency is usually a result of an individual having a stomach or intestinal disorder that compromises the ability to absorb vitamin B12 (ODS, 2006). Inability to absorb vitamin B12 from the intestinal tract can be caused by a condition called pernicious anemia. Pernicious anemia is a blood abnormality that occurs when there is an absence of intrinsic factor in the stomach (Mayo Clinic, 2008a). Once vitamin B12 has reached the stomach, it must combine with the intrinsic factor if it is going to be absorbed into the bloodstream and used by the body. Lack of intrinsic factor results in poor absorption of vitamin B12, and possibly, pernicious anemia (Mayo Clinic, 2008a).

Vitamin B12 deficiency due to poor dietary intake can result in megaloblastic anemia. In megaloblastic anemia, red blood cells are larger than normal and the nucleus

is enlarged (Mayo Clinic, 2008a). If the cause of megaloblastic anemia is vitamin B12 deficiency, treatment with vitamin B12 injections or oral supplementation is the standard approach (Mayo Clinic, 2008a).

Deficiency of vitamin B12 can lead to abnormal neurologic and psychiatric symptoms including ataxia, muscle weakness, incontinence, hypotension, psychoses, and mood disturbances (Mayo Clinic, 2008a). Additional symptoms of vitamin B12 deficiency include difficulty maintaining balance, depression, fatigue, poor memory, dementia, and soreness of mouth or tongue (ODS, 2006). Permanent neurological damage can form in untreated breastfed infants with vitamin B12 deficiency as a result of the mother following a strict vegetarian diet and, therefore, having a very limited reserve of vitamin B12 for the infant (ODS, 2006). Permanent nerve damage can also occur if vitamin B12 deficiency is not treated or is mistreated (e.g. treating with folic acid can correct the anemia caused by vitamin B12 deficiency but cannot correct nerve damage) (ODS, 2006). Vitamin B12 deficiency may also lead to an accumulation of homocysteine. This can result in hyperhomocysteinaemia, a significant risk factor for CVD (Li, et al., 2005).

One study comparing a high-protein diet emphasizing lean red meat to a high-carbohydrate diet noted significant differences in vitamin B12 status (Noakes, et al., 2005). Vitamin B12 rose significantly (9%) with the high-protein diet and decreased (by 13%) with the high-carbohydrate diet. One three-ounce serving of beef provides 2.4 micrograms (μg) of vitamin B12, which is 40% of the RDA (ODS, 2006). The RDA for vitamin B12 is 6.0 μg per day for males and females 14 years of age and older (Mayo Clinic, 2008a; ODS, 2006).

The meat, fish, and poultry group has been the primary contributor of vitamin B12 in the diet over the years, and was responsible for approximately 75% of the total amount of vitamin B12 in the food supply in 2000. Dairy products contributed about 20% and eggs contributed 4-6% of vitamin B12 in the food supply (Gerrior, et al., 2004).

Zinc

A three-ounce serving of lean beef is an excellent source of zinc. Zinc plays a vital role in the metabolism of carbohydrates, lipids, proteins, and nucleic acids. It is also involved in wound healing, blood formation, and general growth and maintenance of all body tissues (Gerrior, et al. 2004). Zinc supports a healthy immune system, is needed for DNA synthesis, and is needed to maintain taste and smell senses (ODS, 2008). Zinc is needed for normal growth and development during pregnancy, childhood, and the young adult years (ODS, 2008).

Severe zinc deficiency is rare in the United States, but mild to moderate deficiency has been found in older adults and individuals susceptible to stress (e.g. following a surgery) (Gerrior, et al., 2004). Inadequate calorie intake, alcoholism, and digestive diseases are risk factors that could result in zinc deficiency. Alcohol decreases zinc absorption and increases loss of zinc in urine. Individuals with digestive disorders (e.g. Crohn's disease) or who have had gastrointestinal surgery (e.g. short bowl syndrome) are at a greater risk of developing zinc deficiency. Signs of zinc deficiency include impaired growth in infants and children, hair loss, diarrhea, delayed sexual maturation, lesions on the eyes and skin, loss of appetite, delayed wound healing, and taste abnormalities (ODS, 2008). Zinc from a diet high in animal protein is absorbed

more efficiently than from a diet rich in plant proteins. Vegetarians may need more zinc than non-vegetarians because of lower absorption of zinc from plant foods. Legumes and whole grains contain phytates, which bind to the zinc in plant foods and inhibit it absorption (ODS, 2008).

Oysters contain more zinc per serving than any other food. However, red meat and poultry provide the majority of zinc in the American diet. A three-ounce serving of lean beef provides 39% of the RDA for zinc (U.S. Meat Export Federation, 2005). Other sources of zinc include beans, nuts, some seafood (e.g. crab and lobster), whole grains, fortified breakfast cereals, and dairy products (ODS, 2008). The RDA for zinc for males 19 years of age and older is 11 mg, and 8 mg for females aged 19 years or older (ODS, 2008).

In 2000, animal products contributed 57% of the total supply of zinc. The meat, fish, and poultry group was the primary source of zinc in the food supply in 2000, contributing 38% (Gerrior, et al., 2004). In 2005, the meat, fish, and poultry group remained the primary source of zinc in the food supply (41%), followed by grains (e.g. fortified ready-to-eat breakfast cereals) contributing 25% of zinc in the food supply (Hiza, et al., 2008).

Selenium

Beef is an excellent source of selenium. Selenium is a trace mineral that is used by the body in addition with protein to make selenoproteins, which are antioxidant enzymes that prevent oxidative or cellular damage from free radicals (Gerrior, et al., 2004; ODS, 2004). Free radicals are natural by-products of oxygen metabolism that have

damaging effects and can contribute to the development of chronic diseases such as heart disease and cancer (ODS, 2004). Selenium works like vitamin E to prevent cell damage (Gerrior et al., 2004). Selenium is found in most foods, but the primary sources include meats, seafood, and grains (Gerrior, et al., 2004). According to the ODS, in conjunction with the National Institutes of Health (NIH), 3 ½-ounces of cooked beef supplies 35 μg of selenium, more than half of the RDA of 55 μg for males and females aged 14 years and older (ODS, 2004). The U.S. Meat Export Federation reported that three ounces of lean beef provides 24% of the RDA for selenium (U.S. Meat Export Federation, 2005). The content of selenium in foods depend on the amount of selenium in the soil where plants are grown or livestock graze, which may account for different values of selenium in beef. Animals that feed on grains or plants grown in selenium-rich soil have higher amounts of selenium in their muscle. Plant sources are the major dietary sources of selenium for most countries (ODS, 2004).

Selenium deficiency is rare in the United States but is seen in other countries (e.g. China) where concentration of selenium in the soil is low (ODS, 2004). In the U.S., most cases of selenium depletion or deficiency occur as a result of impaired selenium absorption from severe gastrointestinal disorders (e.g. Crohn's Disease) or surgical removal of part of the gastrointestinal tract (ODS, 2004). Keshan Disease, which results in a weak and enlarged heart, is still seen in China due to selenium poor soil (ODS, 2004). Other diseases associated with selenium deficiency include Kashin-Beck Disease, resulting in osteoarthropathy, and Myxedematous Endemic Cretinism, resulting in mental retardation (ODS, 2004). Selenium deficiency may contribute to heart disease, hypothyroidism, and a weakened immune system.

Selenium toxicity is also rare in the U.S., but a small number of reported cases have occurred due to industrial accidents and manufacturing error that resulted in an excessively high dose of selenium in a supplement (ODS, 2004). Selenium toxicity can result in a condition called selenosis, and can be accompanied with symptoms of gastrointestinal upset, hair loss, white blotchy nails, garlic breath odor, irritability, fatigue, and mild nerve damage (ODS, 2004).

Meats and breads are common sources of dietary selenium in the United States (ODS, 2004). Grains have always been the primary source of selenium in the U.S. food supply, but its contribution decreased from supplying approximately 60% of selenium in the food supply in 1909 (Gerrior, et al., 2004) to supplying about 40% in 2005 (Hiza, et al., 2008). The meat, poultry, and fish group has taken the lead as the secondary source of selenium in the food supply since the 1960's, contributing 29% in 2005 (Gerrior, et al., 2004; Hiza, et al., 2008).

Phosphorus

Beef is an excellent source of phosphorus. Phosphorus is a mineral that makes up approximately 1% of a person's total body weight. Most phosphorus in the body is found in the bones and teeth, but phosphorus is also present in every cell of the body (Medical Encyclopedia, 2007a). The main function of phosphorus is in the formation of bones and teeth. It is also important for the utilization of carbohydrates and fats, and for the synthesis of protein for growth, maintenance, and repair of cells and tissues. It is also critical for the production of ATP (Medical Encyclopedia, 2007a). Phosphorus is also

needed for muscle contraction, normal kidney function, heartbeat regularity, and nerve conduction (Medical Encyclopedia, 2007a).

Foods from the meat and milk food groups contain the most phosphorus. Whole-grain breads and cereals contain more phosphorus than those made from refined flour. However, this form of phosphorus is a storage form called phytin, and is not absorbed by humans (Medical Encyclopedia, 2007a). Phosphorus deficiency is not a concern because it is so readily available in the food supply. Excessive phosphorus intake can result in phosphorus combining with calcium and forming deposits in soft tissues in the body. However, this is very rare and seen only in individuals with severe kidney disease or severe dysfunction of calcium regulation (Medical Encyclopedia, 2007a).

Dairy products provided about one-third of phosphorus in the food supply in 2005. The meat, fish, and poultry group contributed about 24% of phosphorus in the food supply, followed by grains contributing about 20% (Hiza, et al., 2008). A three-ounce serving of lean beef provides 20% of the RDA for phosphorus (U.S. Meat Export Federation, 2005).

Iron

Iron deficiency anemia is the most common nutritional deficiency in the United States, and infants, adolescents, and women of childbearing age are at the greatest risk for developing anemia because they require higher demands of iron by the body (Gerrior, et al., 2004). Rapid growth or excessive blood loss due to menstruation are reasons for higher iron demands for adolescents and women (Gerrior, et al., 2004). A deficiency in iron limits oxygen delivery to cells. This results in fatigue, poor work performance,

decreased immune function, and glossitis (ODS, 2007a). Iron can be a difficult mineral for individuals to consume enough by dietary intake alone, especially for individuals with low or no beef intake. Women require 18 mg of iron a day from the ages of 19-50 compared to men of the same age requiring only 8 mg a day (ODS, 2007a). To complicate this further, women tend to eat less meat then men.

Iron is a crucial component of hemoglobin in the blood and myoglobin in muscles (Gerrior, et al., 2004), and an essential component of enzymes and proteins involved in oxygen transport (ODS, 2007a). Nearly two-thirds of iron in the body is located in hemoglobin, the protein in red blood cells that carries oxygen to muscles (ODS, 2007a).

Dietary iron is found in two forms: heme and non-heme iron. Heme iron is found in foods of animal origin that originally contained hemoglobin such as red meats, fish, and poultry (ODS, 2007a). Non-heme iron is found in plant foods such as lentils and beans, and it is the form of iron added to iron-fortified or iron-enriched foods. Heme iron is superior to non-heme iron in terms of absorption by the human body (ODS, 2007a).

Vegetarians may need almost twice as much dietary iron than their meat-eating peers to avoid deficiency. Vegetarians may be meeting the recommended level for iron intake, but since the iron is non-heme and not absorbed as efficiently as heme iron, greater amounts are needed in the diet (ODS, 2007a). Fortified cereals and beans are common non-heme sources of dietary iron (ODA, 2007a). One study comparing adolescents consuming a low-fat diet emphasizing lean red meat to adolescents consuming a low-fat diet emphasizing lean poultry and fish showed a significant decline in serum ferritin levels for the poultry and fish group, while serum ferritin levels for the lean red meat group remained unchanged (Snetselaar, et al., 2004). Inclusion of lean beef

that is rich in heme iron can improve iron status in adolescents and adults. Three ounces of lean beef provides 3.2 mg of heme-iron, while three ounces of chicken breast provides 1.1 mg (ODS, 2007a). A three-ounce serving of lean beef provides 14% of the RDA for iron (U.S. Meat Export Federation, 2005).

The primary source of iron in the food supply is grain products due to fortification (Hiza, et al., 2008). Grain products accounted for 52% of the iron in the food supply in 1995 and 2000 (Gerrior, et al., 2004; Hiza, et al., 2008). However, in 2005, the percent of iron in the food supply from grains decreased by approximately 50% (Hiza, et al., 2008). The meat, poultry, and fish group (particularly red meats) ranked second as a source of iron in 2000, providing 16% of iron in the food supply (Gerrior, et al., 2004).

Riboflavin

Riboflavin (vitamin B2) is important for red blood cell production, body growth, and it assists in releasing energy from ingested carbohydrates (Medical Encyclopedia, 2007b). Food sources of riboflavin include lean meats, eggs, legumes, nuts, green leafy vegetables, dairy products, and milk. Other foods are fortified with riboflavin such as breads and cereals (Medical Encyclopedia, 2007b). A three-ounce serving of lean beef provides 12% of the RDA for riboflavin (U.S. Meat Export Federation, 2005).

Exposure to light can destroy riboflavin, so care should be taken as to how riboflavin-containing foods are stored. Deficiency is uncommon in the United States because it is plentiful in the food supply. However if a deficiency from riboflavin were to manifest, symptoms include sore throat, swelling of the mucous membranes, mouth and/or lip sores, anemia, and skin disorders (Medical Encyclopedia, 2007b).

Niacin

Niacin (vitamin B3) helps in the functioning of the digestive system and nervous system, as well as helping to keep skin, hair, and eyes healthy (Mayo Clinic, 2008b; Medical Encyclopedia, 2007c). Like riboflavin, it plays an important role in carbohydrate metabolism (Mayo Clinic, 2008b). If niacin deficiency, or pellagra, develops, symptoms include inflamed skin, digestive complications, and mental impairment (Medical Encyclopedia, 2007c). Large doses of niacin are dangerous and can result in liver damage, peptic ulcers, and skin rashes (Medical Encyclopedia, 2007c). Even normal doses of niacin can result in side effects, with skin-flushing being the most common.

Niacin food sources include dairy products, poultry, fish, lean meats, eggs, and nuts (Mayo Clinic, 2008b; Medical Encyclopedia, 2007c). Breads and cereals are also enriched with niacin. The RDA for niacin for males and females aged 14 years and older is 14 mg a day (Medical Encyclopedia, 2007c). One three-ounce serving of lean beef provides 18% of the RDA for niacin (U.S. Meat Export Federation, 2005).

Niacin has been prescribed as a treatment for elevated total cholesterol levels (Mayo Clinic, 2008b). Niacin has also been credited with having a significant impact on high-density lipoprotein (HDL) cholesterol levels by increasing HDL cholesterol levels in a dose-dependent manner (van der Hoorn, et al., 2008).

Vitamin B6

Vitamin B6 is needed by the body to synthesize over 100 different enzymes involved in protein metabolism. It is essential for red blood cell metabolism, and

required for the nervous system and immune system to function efficiently (ODS, 2007b). Vitamin B6's role in the immune system is to help maintain the health of lymphoid organs (thymus, spleen, and lymph nodes) that make white blood cells. Vitamin B6 is needed to produce and increase the oxygen-carrying capacity of hemoglobin (ODS, 2007b). It also helps maintain normal blood glucose levels by helping convert stored carbohydrate (glycogen) or other nutrients to glucose when blood glucose levels are low (ODS, 2007b). Vitamin B6 is also needed to convert tryptophan (an amino acid) to niacin (ODS, 2007b).

Vitamin B6 deficiency can result in a form of anemia similar to iron deficiency anemia. Clinical signs of vitamin B6 deficiency are rarely seen in the United States. However, older Americans and alcoholics are at risk for developing vitamin B6 deficiency because poor diet quality and alcohol consumption promotes the destruction and loss of vitamin B6 from the body (ODS, 2007b). Symptoms of vitamin B6 deficiency do not surface until it has been present for an extended period of time, but include dermatitis, glossitis, depression, confusion, and convulsions (ODS, 2007b). Excessive intake of vitamin B6, usually from vitamin B6 supplements, can result in nerve damage to the arms and legs that is reversible when supplementation is stopped (ODS, 2007b).

Vitamin B6 is found in many different foods including fortified cereals, beans, meat, poultry, fish, some fruits (e.g. bananas), vegetables (e.g. carrots, spinach, peas, and potatoes), milk, and eggs (Mayo Clinic, 2008c; ODS, 2007b). The leading source of vitamin B6 in the food supply is the meat, poultry, and fish group, which provided more than one-third of the total available vitamin B6 in 2005 (Hiza, et al., 2008). The RDA for

vitamin B6 for adults are 1.3 mg for men and women ages 19-50, 1.7 mg for men 51 years and older, and 1.5 mg for women over age 51 (Mayo Clinic, 2008c; ODS, 2007b). A three-ounce serving of lean beef provides approximately 16% of the RDA for adults aged 19-50 (U.S. Meat Export Federation, 2005).

Beef is a good source of riboflavin, niacin, and vitamin B6. These B vitamins are water-soluble, which means they are not stored in the body and excess amounts are excreted in the urine. Since these vitamins are not stored in the body, a continuous supply of these vitamins must be provided in the diet (Medical Encyclopedia, 2007b, 2007c; ODS, 2007b).

Fatty Acids

Conjugated Linoleic Acids

Beef, whole milk, and dairy products are the only sources for the conjugated linoleic acid (CLA) family (Eynard & Lopez, 2003). CLA is a naturally occurring *trans*-fat found in foods from ruminant animal sources (Belury, 2002a). Structural differences between man-made (derived from vegetable fats) and naturally occurring *trans*-fat result in very different health effects (Cattlemen's Beef Board, 2003).

Trans-fat is associated with increased risk of developing CVD. Man-made *trans*-fats are created by adding hydrogen molecules to monounsaturated and polyunsaturated fatty acids, a process known as hydrogenation (Cattlemen's Beef Board, 2003). Hydrogenation converts liquid oils to a solid form, which lengthens shelf life and improves flavor (Mayo Clinic, 2006a). Partially-hydrogenated vegetable oil is the prime source of *trans*-fatty acids in the human diet (Sundram, et al., 2007).

Trans-fats are commonly found in commercial baked goods (e.g. crackers, cookies, and cakes), fried foods (e.g. doughnuts and French fries), shortenings and some margarines (Mayo Clinic, 2006a). These man-made *trans*-fats have unfavorable effects on human health. *Trans*-fats increase the risk of developing heart disease by raising LDL cholesterol and lowering HDL cholesterol levels (Mayo Clinic, 2006a). This is the reason why the U.S. Food and Drug Administration (FDA) has required *trans*-fat be included on Nutrition Facts labels as of January 1, 2006 (FDA, 2006). The FDA's chemical definition for a *trans*-fatty acid is all unsaturated fatty acids that contain one or more isolated (non-conjugated) double bonds in a *trans* configuration (FDA, 2006). Under this definition, CLAs are not considered a *trans*-fat are do not need to be included on nutrition labels on foods (FDA, 2006).

The American Heart Association (AHA) recommends no more than 1% of total daily calories come from *trans*-fat (e.g. no more than 2 g of *trans*-fat for a 2,000 calorie/day consumption) (Mayo Clinic, 2006a). However, CLAs are not a man-made *trans*-fat and are not associated with atherosclerotic lesions or increased risk for CVD (Belury, 2002a).

CLAs are located in the interstitial, non-visible fat that is evenly distributed along muscle fibers and in subcutaneous stores of beef (Eynard & Lopez, 2003). CLAs exhibit various health benefits and have been the focus of numerous studies that investigated the effects of CLA on cancer, CVD, body composition (e.g. body fat mass), and other conditions involving insulin resistance, immune function, and bone health (Belury, 2002b).

CLA has been credited with reducing the accumulation of adipose tissue in experimental animal studies (Belury, 2002b). Studies on human subjects regarding the effect of CLA on adipose tissue have shown it reduces adipose tissue, while other studies exhibited CLA had no affect on human adipose tissue (Belury, 2002b).

Several other studies conducted on experimental animals have exhibited promising results in several areas including diabetes insulin sensitivity (e.g. decreased fasting blood glucose), carcinogenesis (e.g. inhibition of tumor promotion), decreased atherosclerotic plaque formation, bone formation, and immune function (Belury, 2002b). A small amount of CLA in the diet (0.5% of diet) has been shown to impact conditions such as carcinogenesis, obesity, diabetes, and atherosclerosis in experimental animals (Belury, 2002b).

One study investigated the anti-proliferative properties of CLA mixtures that occur naturally in beef on breast, lung, melanoma, colon, and ovarian human cancer cell lines (de la Torre, et al., 2006). Four fatty acid extracts prepared from beef lipids of varying CLA composition were tested on cancer cell lines, as was four CLA-enhanced mixtures prepared from beef samples, and three synthetically made CLA mixtures (samples were isomerically different). Following fatty acid treatment, the number of cancer cells was reduced from 25-67% when compared to cells not treated with fatty acids. The cell-growth inhibitory activity of CLA mixtures varied according to their origin (purified beef CLA mixtures compared to synthetic mixtures). All mixtures exhibited a reduction in cell growth, but the 4 fatty acid mixtures extracted from beef significantly decreased human cancer cell growth despite their lower content of CLAs when compared to the CLA-enhanced mixtures. Beef total fatty acid mixtures exhibited

greater inhibitory activity on cancer cells than the CLA-enriched fractions. This indicates that fatty acids present in beef other than CLAs may possess anti-proliferative properties against cancer cells (de la Torre, et al., 2006).

CLAs are the only natural fatty acids accepted by the National Academy of Sciences as exhibiting consistent anti-tumor properties at levels as low as 0.25-1.0 % of total fats (Eynard & Lopez, 2003). Naturally occurring *trans*-fats are not associated with increased risk of CHD (Eynard & Lopez, 2003).

Vaccenic Acid

Vaccenic acid (VA), like CLA, is a naturally occurring *trans*-fat found in ruminant animal sources, particularly dairy and red meat (Lock, et al., 2005; Turpeinen, et al., 2002). It is converted to an isomer of CLA in the body (Turpeinen, et al., 2002). A study conducted by Turpeinen et al. (2002) focused on observing the conversion of VA to the CLA isomer after consumption of diets with increasing amounts of VA. Thirty subjects were provided a diet containing.1.5, 3.0, or 4.5 g of VA per day for 9 days. The proportion of VA in serum total fatty acids increased 94%, 307%, and 620% when compared to baseline. Results indicated that dietary intake of VA did affect plasma levels of CLA in body (Turpeinen, et al., 2002).

VA has been shown to be an effective anti-carcinogen in animal studies. One study examined the effect of VA and CLA-enriched butter on plasma lipoproteins and tissue fatty acid profiles in hamsters fed diets containing 0.2% cholesterol and 20% added fats after 4 weeks (Lock, et al., 2005). The control group was fed 20% standard butter (SB), the second group was fed 5% standard butter and 15% of VA/CLA-enriched butter

(EB), and the third group was fed 15% standard butter and 5% partially-hydrogenated vegetable oil (VO). Tissue concentrations of VA and CLA were increased in hamsters fed the EB diet when compared to the other two groups, and the group fed the VO diet experienced increased concentrations when compared the SB group. Total and LDL cholesterol concentrations were significantly reduced in hamsters fed the EB and VO diet when compared to the SB group. Hamsters fed the EB diet experienced the greatest reduction of very low-density lipoprotein (VLDL) cholesterol concentrations. The ratio of possible atherogenic lipoproteins (VLDL, LDL, and intermediates) to anti-atherogenic lipoproteins (HDL) was significantly lower in the hamsters fed the EB diet. Increasing VA and CLA concentrations in the butter resulted in plasma lipoprotein cholesterol levels that are associated with a reduced risk of atherosclerosis (Lock, et al., 2005).

Stearic Acid

Stearic acid (SA) is a saturated fatty acid that is mainly found in animal products (AHA, 2007). Although SA is a saturated fat, studies have indicated that it has little effect on blood cholesterol levels because a high proportion is converted to oleic acid (AHA, 2007). Oleic acid is the main monounsaturated fatty acid in olive oil (Menendez, et al., 2005) and it is a potent antioxidant that protects against lipid peroxidation, which contributes to atherosclerosis (Roche, 2001).

Beef products are the most common source of dietary SA in the United States. Beef fat is 19% SA and because of this, the cholesterol-raising potential of beef is not as great as predicted earlier based on its total saturated fatty acid content (Denke, 1994). Studies have indicated that lean beef is not any more hypercholesterolemic than chicken

or fish, and therefore, does not need to be eliminated from cholesterol-lowering diets because it does not raise LDL cholesterol (Baer, et al., 2003; Denke, 1994).

Beef and Cancer

Beef has received negative attention because red meat has been labeled as a food that increases the risk of developing certain types of cancer. Fatty meat derivatives, such as cold cuts, prepared mainly from fatty beef (up to 37% fat) are associated with a higher risk of developing colorectal cancer, but high consumption of lean beef (<15% fat) displays protective dietary qualities (Eynard & Lopez, 2003). Fatty meat also contains substantial amounts of saturated fat and cholesterol.

Many studies that focus on a link between red meat and cancer do not differentiate between the fat content and type of meat being consumed in the diet. Frequently in studies, intake of red meat is coupled with processed meats (American Cancer Society, 2005), which are high in fat. The American Cancer Society links red meat to colon cancer, and states, "people who eat a lot of red meat or processed meats may be raising their risk for colon cancer" (American Cancer Society, 2005). No differentiation between beef, other red meat, and processed meats are done prior to analysis. Epidemiological research has found no conclusive evidence of a causal relationship between red meat and cancer (e.g. breast cancer, prostate cancer, kidney cancer, pancreatic cancer, stomach cancer, and colorectal cancer) (National Cattlemen's Beef Association, 2007). Lean red meat has been shown in studies to exhibit anti-cancerous, anti-proliferative effects on cancer cells as a result of the CLAs naturally present in red meat (de la Torre, et al., 2006). The National Academy of Sciences

acknowledged CLA as exhibiting consistent anti-tumor properties when consumed in the diet (Eynard & Lopez, 2003).

Cooking Beef and the Formation of Carcinogens

Cooking meats at high temperatures creates chemicals that are associated with increased cancer risk. Heterocyclic amines (HCAs) are carcinogenic chemicals formed from high temperature cooking of meats such as beef, pork, poultry, and fish (National Cancer Institute, 2004). HCAs form when amino acids and creatine are broken down and react with high cooking temperatures (National Cancer Institute, 2004; Steck, et al., 2007).

Polycyclic aromatic hydrocarbons (PAHs) are a major component of air pollution and a potential human carcinogen. PAHs and HCAs are carcinogens formed in or on the surface of well-done meat cooked at high temperatures (Steck, et al., 2007). PAHs appear on or near the surface of foods from the smoke created by incomplete combustion of carbon and hydrogen in fat that has fallen onto hot coals, such as during grilling or barbequing (Steck, et al., 2007). They are also formed on food when it comes into direct contact with flames (Foods Standards Agency, 2008). Dietary intake of HCAs and PAHs has been linked to colorectal cancer, and in fewer studies, linked to breast cancer, although association between these compounds and breast cancer was not indicated in all studies (Steck, et al., 2007).

PAHs are a group of harmful chemicals formed during the incomplete burning of coal, oil, gas, wood, garbage, and other organic substances such as charbroiled meat (Agency for Toxic Substances & Disease Registry [ATSDR], 1995). There are over 100

different PAHs. PAHs enter the environment generally from volcanoes, forest fires, residential wood burning, and exhaust from automobiles. They can also enter water through discharges from waste treatment plants and industrial plants. PAHs are present throughout the environment and exposure can occur at home, outside, or at the workplace (ATSDR, 1995).

PAHs can enter all the tissues in the body that contain fat. They tend to be stored mostly in the kidneys, liver, and fat. Smaller amounts of PAHs can be stored in the spleen, adrenal glands, and ovaries. PAHs leave the body a few days after entering via feces and urine (ATSDR, 1995). Studies of people exposed the PAHs by breathing or skin contact for long periods have shown an increased risk of developing cancer. The primary sources of exposure to PAHs for most of the U.S. population are by inhalation of compounds in tobacco smoke, wood smoke, and consumption of PAHs in foods (ATSDR, 1995).

Four factors influence HCA formation on foods during cooking: type of food, cooking method, temperature, and time (National Cancer Institute, 2004), with greater doneness associated with higher concentrations of HCAs (Steck, et al., 2007). Temperature is the most crucial factor in the formation of HCAs, so cooking methods that cook meats at high temperatures such as frying, broiling, and barbequing increase HCA formation (National Cancer Institute, 2004). Oven roasting and baking are done at lower temperatures resulting in greatly reduced levels of HCA formation. However, gravies from meat drippings contain high amounts of HCAs. Stewing, boiling, and poaching are done at or below 212 ^{o}F, creating negligible amounts of HCAs. Time also plays an important role in HCA formation. Foods cooked for longer times, such as “well-

done" instead of "medium", will contribute to formation of slightly more chemicals (National Cancer Institute, 2004). Research has linked HCAs to the formation of stomach, colorectal, pancreatic, and breast cancer. High HCA intake is associated with high intakes of well-done, fried, or barbequed meats (National Cancer Institute, 2004).

In a study conducted by Steck at al. (2007) breast cancer risk in relation to intake of grilled or barbequed, and smoked meats was examined in women in the Long Island, New York area from 1996-1997. An interview-administered questionnaire of intake and self-administered Food Frequency Questionnaire was used to determine lifetime and recent dietary intake of grilled or barbequed and smoked meat. A modest increased risk of developing breast cancer was observed among postmenopausal, but not pre-menopausal, women consuming the highest reported intake of grilled or barbequed and smoked meats throughout their lifetime. Postmenopausal women with reported high lifetime intake of grilled or barbequed and smoked meats accompanied with low fruit and vegetable intake had the highest risk of developing breast cancer. No associations were observed with the questionnaires-derived intake measures of PAHs and HCAs, except with the possible exception of one PAH, benzo(*a*)pyrene (BaP), from meat among postmenopausal women whose tumors were positive for both estrogen receptors and progesterone receptors (Steck, et al., 2007). Animal studies have shown that dietary intake of BaP causes increased levels of tumors at various sites, especially the upper gastrointestinal tract (Kazerouni, et al., 2001).

Kazerouni, et al. (2001) created a BaP database of selected foods to estimate BaP intake in human subjects. Two-hundred twenty-eight subjects in the Washington, DC metropolitan area completed Food Frequency Questionnaires and results were used to

estimate daily BaP intake. Meat samples were cooked using different techniques by restaurants and fast-food chains. Non-meat products were purchased from national supermarket chains. Meat samples and non-meat foods were measured for BaP content (Kazerouni, et al., 2001).

The highest levels of BaP were found in grilled or barbequed, very well-done steaks, hamburgers, and chicken with skin. BaP concentrations were lower in grilled or barbequed meat cooked to medium done, as well as lower in all broiled and pan-fried meat samples regardless of the level of doneness. The BaP levels in non-meat products were low, except for certain cereals and greens (e.g. kale, collard greens). In the study population, the bread, cereal, and grain group contributed 29% to the mean daily intake of BaP, and grilled or barbequed meat contributed 21% (Kazerouni, et al., 2001).

According to the American Institute for Cancer Research (AICR), what you grill is the most important issue. During cookout season, consumption of hot dogs and hamburgers increases. The AICR report that diets high in red meat (e.g. beef, pork, and lamb) and especially processed meats (e.g. hot dogs) are now a convincing cause of colorectal cancer (AICR, 2008). The AICR recommends limiting consumption of red meat to no more than 18 ounces (cooked) per week. However, the biggest concern is the evidence on diets high in processed meats. According to the AICR, every 3.5 ounces of processed meat eaten per day increases risk for colorectal cancer by 42%. Avoiding consumption of hot dogs, sausage, bacon, ham, cold cuts, and other processed meats is now strongly advised (AICR, 2008).

An effective method for reducing HCA formation in meats are to partially cook meats in the microwave oven before cooking by other methods, especially before frying,

broiling, or barbequing. Meats that are microwaved for 2 minutes prior to cooking have a 90% decrease in HCA content (National Cancer Institute, 2004). Cooking meats below 392 ^{o}F, turning meat more frequently during cooking, draining off any liquid before conventional cooking, and applying marinades before grilling have also been shown to reduce HCA formation (U.S. Department of Health and Human Services, 2005). Avoid making gravy from meat drippings, which contain relatively high amounts of HCAs. (National Cancer Institute, 2004). Prevent charring meat on the grill by removing visible fat and cook food in the center of the grill, moving coals to the side to prevent fat and juices from dripping on them. Do not eat charred portions of the meat (FSIS, 2007).

Food Safety Issues Associated with Beef

Consumer safety concerns affect beef sales and consumption. The Hazard Analysis and Critical Control Point (HACCP) uses a preventative approach to assure food safety by identifying potential hazards associated with a food from its raw state to the consumption of the food by the consumer. Food processing and slaughter plants that are required to follow HACCP are required to evaluate potential hazards and execute controls to prevent or reduce hazards (Stefan, 1997). Plants must keep records to assure proper execution of the HACCP plan. The U.S. Department of Agriculture (USDA) meat inspectors review these records, visit plant sites, and conduct needed testing on products or livestock (Stefan, 1997). In 1998, the USDA established HACCP guidelines for the meat industry. FSIS is responsible for enforcing a combination of HACCP-based procedures including microbial testing, pathogen reduction performance standards, and

sanitation standard operating procedures to reduce contamination of meat and poultry, thereby reducing the risk of foodborne illness (FSIS, 2006).

The most serious food safety concern in the United States is foodborne illness caused by pathogens. The CDC reported that 79% of outbreaks that occurred between 1987 and 1992 were bacterial (Walderhaug, 1999). Between 1973 and 1988, *Escherichia coli* O157:H7 (*E. coli* O157:H7) and *Salmonella enteritidis* surfaced in the food industry as dangerous causes of food-borne illness (FDA, 2001).

E. coli O157:H7

From November 15, 1992 through February 28, 1993, an outbreak of *E. coli* O157:H7 hit the West Coast resulting in more than 500 laboratory-confirmed infections and four deaths (Stefan, 1997; Walderhaug, 2001). This lethal strain of bacteria was traced back to hamburger meat from one restaurant chain (FDA, 2001).

E. coli O157:H7 produces a toxin that damages the lining of the small intestine, resulting in painful abdominal cramps and severe, bloody diarrhea (Mayo Clinic, 2006b). The disease produced by *E. coli* O157:H7, hemorrhagic colitis, is characterized by this bloody diarrhea, and is sometimes followed by kidney failure and even death (FSIS, 2003; Mayo Clinic, 2006b). Undercooked or raw ground beef has been implicated in numerous documented outbreaks of the *E. coli* O157:H7 strain. However, in the past decade, outbreaks of human illness associated with consumption of raw vegetables and fruits have increased in the United States (Walderhaug, 2001). *E. coli* O157:H7 outbreaks have been linked to spinach, alfalfa sprouts, tomatoes, unpasteurized fruit

juices, dry-cured salami, lettuce, green onions, game meat, and cheese curds (Mayo Clinic, 2006b; Walderhaug, 2001).

E. coli colonizes in the intestines of animals and can contaminate muscle meat at slaughter (FSIS, 2003). *E. coli* O157:H7 is unaffected by refrigeration and freezer temperatures and can multiply in a food at temperatures as low as 44^{o}F (FSIS, 2002). However, *E. coli* O157:H7 is easily destroyed by thorough cooking (FSIS, 2003). Recent outbreaks of *E. coli* O157:H7 have also led to questions and concerns about the safety of the food supply. Percent positive samples of *E. coli* bacteria present in ground beef was 73.9% in 2002, 66.2% in 2003, 70.4% in 2004, and 67.5% in 2005 (FDA, 2002-2005).

Salmonella

Salmonella is found in the intestinal tract of livestock and poultry. Illness from *Salmonella* is a result of ingestion of the bacteria. Cross-contamination (e.g. juices from raw meat comes in contact with already cooked foods that will receive no further cooking or foods that will be eaten raw) is a frequent cause of ingesting *Salmonella* bacteria (FSIS, 2003). Freezing does not destroy *Salmonella*, but thorough cooking does destroy it (FSIS, 2003). The percent positive samples for *Salmonella* bacteria in ground beef was 1.4% in 2002, 1.1% in 2003, 1.2% in 2004, and 0.7% in 2005 (FDA, 2002-2005).

Campylobacter

Campylobacter bacteria are the second most frequently reported cause of foodborne illness following *Salmonella*, with the strain *Campylobacter jejuni* having the highest association with reported human infections. *Campylobacter jejuni* is one of the

most common bacterial causes of diarrhea in the United States (FSIS, 2006). *Campylobacter* organisms are usually found in the intestinal tract of poultry, cattle, swine, wild birds, some humans, and other animals not consumed in the United States (FSIS, 2006). The bacteria passes through the digestive tract of these animals, is found in the feces, and can cycle through the environment via untreated water (FSIS, 2006). The most common causes of campylobacteriosis, the infection caused by *Campylobacter*, is consumption of unpasteurized milk, raw or undercooked meat or poultry, and other contaminated foods or water that has come into contact with feces from infected animals. Common symptoms included fever, abdominal cramps, and bloody diarrhea, all of which manifest 2 to 10 days after ingestion of the bacteria (FSIS, 2006). Campylobacteriosis is usually followed by complete recovery within 2 to 5 days after contraction. However, serious complications including meningitis, urinary tract infections, short-term reactive arthritis, and on rare occasions, Guillain-Barre syndrome, a form of paralysis, can occur (FSIS, 2006). *Campylobacter* infections can be fatal, resulting in approximately 124 deaths each year (FSIS, 2006).

One study was conducted in Australia on 475 slaughter-age cattle and sheep from 19 herds or flocks, to determine prevalence of *Campylobacter* species *(C. jejuni and C. coli).* There was a higher prevalence of *Campylobacter* found in cattle than in sheep. The median prevalences and ranges were 6% (0-24%) for dairy cattle, 58% (12-92%) for feedlot beef cattle, 2% (0-52%) for pasture beef cattle, 0% (0-4%) for mutton sheep, and 8% for lambs (Bailey et al., 2003). *Campylobacter* species found in the beef supply in the United States has not been a concern as of yet. According to the FDA, no positive samples for *Campylobacter* were found in ground beef samples in 2002, 2004, or 2005.

In 2003, one ground beef sample (0.1%) tested positive for *Campylobacter* bacteria. Chicken breast retail meat tested the highest for percent positive samples of *Campylobacter* (FDA, 2002-2005).

Bovine Spongiform Encephalopathy and Variant Creutzfeldt-Jacob Disease

The first probable infections of bovine spongiform encephalopathy (BSE) in cows happened during the 1970's in the United Kingdom with 2 cases of BSE being identified in 1986 (CDC, 2008b). BSE, or "mad cow" disease, is believed to have originated from feeding cattle meat-and-bone meal that was made from BSE-infected products from a spontaneously-occurring case of BSE or from sheep products infected with scrapie, a prion disease of sheep (CDC, 2008b).

BSE is a progressive and fatal neurological disorder that was first found in cattle in the mid-1980's (Davis & Lin, 2005). BSE is caused by an unusual transmissible agent called a prion (CDC, 2008b). A prion is a modified form of a normal protein that ultimately changes into a pathogenic form that damages the central nervous system of cattle (CDC, 2008b). It became a human health issue in 1996 when its human form, variant Creutzfeldt-Jacob Disease (vCJD), also a fatal disease, was discovered (Davis & Lin, 2005). VCJD most likely results from humans eating tissue from cattle infected with BSE (CDC, 2008b).

Strong evidence suggests the first outbreak of BSE in the United Kingdom was spread by feeding young calves prion-infected bovine meat-and-bone meal (CDC, 2008b). The BSE epidemic in the United Kingdom peaked in January of 1993 at almost 1,000 new cases per week. More than 184,500 cases of BSE have been confirmed in the

United Kingdom alone, in more than 35,000 herds at the end of 2007 (CDC, 2008b). In 2009, a regulation issued by the FDA will go into effect regarding an improved BSE-related feed ban in the United States. Use of BSE-infectious tissues known as "specified risk materials" will be prohibited from all animal feeds, pet foods, and fertilizers. The FDA continues to enforce the feed ban from 1997 that prohibits use of these risk materials in cattle feed only until the new feed ban is enforced (CDC, 2008b).

There is strong evidence that a causal association exists between vCJD in humans and BSE in cattle. It was first reported in the United Kingdom in 1996 (CDC, 2008b). The most likely time period for extended exposure to potentially BSE-contaminated food to the public was 1984-1986. The onset of initial vCJD cases in the United Kingdom (1994-1996) was consistent with the expected incubation period for the human form of this prion disease (CDC, 2008b).

The U.S. Beef Industry faced a challenge in 2003 and 2005, when the discovery of two cases of BSE surfaced in the United States (Davis & Lin, 2005). The USDA announced the diagnosis of the first known case of BSE in the United States on December 23, 2003. The source was an adult cow from Washington State. On June 24, 2005, the USDA announced results confirming a cow from Texas had BSE (CDC, 2008b).

Eighteen cases of BSE have been identified in North America as of August, 2008. Three cases of BSE occurred in the United States and the other 15 cases occurred in Canada. The third case of BSE in the United States was in 2006 in Alabama (CDC, 2008b). The first cow diagnosed with BSE in the United States was imported from

Canada, the second cow was native to the United States, and the third cow's herd of origin could not be identified (CDC, 2008b).

Environmental Concerns Associated with Beef

Concentrated Animal Feeding Operations

Some individuals may avoid consumption of beef, as well as other livestock, because of concern for the environment. Animal production has become increasingly specialized in the last 30 years. Many farm's primary function is to house and feed cattle and poultry. In 2003, the United State's 238,000 feeding operations produced 500 million tons on manure (CDC, 2004). A very small amount of these facilities, called concentrated animal feeding operations (CAFOs), were responsible for more than half of the manure (CDC, 2004).

CAFOs are facilities that house and feed a large number of animals in a confined area for 45 days or more during any 12-month period (CDC, 2004). The EPA began regulating CAFOs in the 1970s, and in 2003, a revised EPA rule took effect that required CAFOs to comply with waste-storage and waste-disposal guidelines and report waste-disposal practices to the federal government annually (CDC, 2004). The main concern is the disposal of large amounts of animal waste could pollute surface and ground water and contaminate soil near CAFOs. In fact, the amount and type of animals in the operation house, and the extent to which waste from the operation house can pollute surface water and groundwater, determines whether the EPA considers the feeding operation to be a CAFO (CDC, 2004). Pollutants possibly associated with manure-related discharges at CAFOs include antibiotics that may contribute to the development of antibiotic-resistant

pathogens, disease-causing pathogens, pollutants associated with waste (e.g. ammonia, nitrogen, and phosphorus), trace elements (e.g. arsenic, copper), and exposure to pesticides and hormones (CDC, 2004). Further research is required to determine how all of these substances from CAFOs affect human health.

Methane Emissions from Cattle

Ruminant animals, such as cattle, sheep, buffalo, and goats, have special digestive systems that can convert unusable plant materials to food and fiber. However, methane, a potent greenhouse gas that contributes to global climate change, is produced. Cattle emit methane through a digestive process called enteric fermentation. Livestock can emit other greenhouse gases such as nitrous oxide and carbon dioxide (EPA, 2008).

According to the EPA, ruminant livestock are one of the largest sources of methane globally. They produce about 80 million metric tons of methane annually, accounting for close to 30% of global methane emissions from human-related activities. In the U.S., cattle emit about 5.5 million metric tons of methane per year, accounting for 20% of U. S. methane emissions. The effects of climate change on agriculture are uncertain, but the frequency of severe weather such as floods, droughts, and storms may increase. Scientists have been looking for ways to reduce methane production from U.S. livestock. The U.S. dairy industry has increased milk production and decreased methane emissions over the past several decades by making nutritional changes and genetic improvements. Emissions from beef cows are high because they are large animals, diets are generally of poorer quality than in the dairy or feedlot sectors, management is typically poor, and the beef cow population is very large. Better grazing management

and dietary supplementation have been identified as the most effective ways to reduce emissions from cattle, as well as improve animal nutrition and reproductive efficiency (EPA, 2008).

Livestock Influences on Stream and Riparian Ecosystems

Livestock grazing has damaged approximately 80% of stream and riparian ecosystems in arid regions of the western United States (Belsky, et al., 1999). Riparian areas are found around rivers and streams, as well as riparian vegetation around ponds, gravel pits, and ditches (Pacific Northwest National Laboratory, 2008). Riparian zones link water to dry land, and it is a different habitat that supports the growth of various types of plants and animals (Pacific Northwest National Laboratory, 2008). Although riparian and stream ecosystems represent such a small amount of overall landscape in the western United States (0.5-1.0%), about 80% of all desert, shrub, and grassland plants and animals depend on them (Belsky, et al., 1999). Riparian areas provide a wildlife habitat, natural flood control, shoreline erosion control, and pollution reduction by providing a natural barrier that prevents agricultural pollution from contaminating the larger ecosystem (Pacific Northwest National Laboratory, 2008).

Rooted plants retard streambank erosion, filter sediments out of water, stabilize streambanks and streambeds, and provide shade, food, and nutrients for aquatic and riparian species (Belsky, et al., 1999). Livestock seek out water, food, and shade in riparian zones, leading to trampling and overgrazing of streambank areas, resulting in soil erosion, streambank instability, and declining water quality (Belsky, et al., 1999). Grazing is just as damaging in wetter environments because moist soil is more vulnerable

to compaction and disturbance than dry soil. However, livestock may be less attracted to streamsides where grasses are green and lush for more months of the year (Belsky, et al., 1999).

Streams, rivers, and riparian habitats are complex and offer an environment for high species diversity (Belsky, et al., 1999). Plants on undisturbed uplands and streamsides slow the downhill flow of rainwater and it is absorbed into soil. Eventually, this water will seep into stream channels throughout the year. However, when vegetation is removed or destroyed by the trampling of livestock, less rainwater enters the soil and more flows overland into streams as runoff (Belsky, et al., 1999). In dry regions, riparian zones provide the main source of moisture for plant, animal, and human communities (Belsky, et al., 1999).

Changes in riparian zones have a ripple effect that also reduces habitat quality for certain plant species, fish, birds, and other wildlife, which can result in a decline in number, or local extinction. Livestock grazing is a major cause of species endangerment (Belsky, et al., 1999). Bacterial contamination of drinking and surface water by livestock is a source of water pollution. Fecal contamination by livestock may include pathogenic bacteria, which can enter the human water supply (Belsky, et al., 1999).

The concern regarding livestock and degradation to streams and rivers rests on how to solve the issue, with total rest from grazing offering the most promising changes in terms of reversing the damage and preventing further degradation (Belsky, et al., 1999). Damage needs to be reduced by improving grazing methods, herding or fencing cattle away from streams, reducing livestock numbers, or increasing periods of rest from

grazing (Belsky, et al., 1999). Less than 20% of potential riparian habitat still exists in the western United States (Belsky, et al., 1999).

Sanitation and Safety Measures

Good sanitation practices are beneficial in preventing the spread of pathogenic bacteria. Most foodborne illness outbreaks are a result of improper storage, holding or cooking temperatures, and unsanitary food handling practices (FSIS, 2003; Walderhaug, 1999). Improving safe food handling practices in kitchens can reduce the risk of foodborne illnesses. *E. coli* O157:H7 and *Salmonella* are both easily destroyed by thorough cooking (FSIS, 2003). Therefore, education regarding proper handling and preparation of food to prevent food-borne illness is important.

Basic precautions can minimize the risk of foodborne illness by the consumer. Washing hands with warm soapy water for 20 seconds before and after handling food, using the bathroom, changing diapers, handling pets, or touching other items or surfaces can prevent cross-contamination (FDA, 2007). Washing utensils, dishes, cutting boards and countertops with hot soapy water after preparing each food item also can prevent bacteria from causing illness (FSIS, 2006). Kitchen sanitizers can also be used periodically for additional protection against bacteria (FDA, 2007). To avoid cross-contamination, raw meats should not be refrigerated near or above other foods that will receive no additional, or any, cooking (FSIS, 2006). Raw meat should be packaged so juices do not leak out and possibly contaminate other foods (FDA, 2007; FSIS, 2003). Utensils and surfaces that come in contact with raw meat should not be used on other foods, or should be washed thoroughly before re-using (FSIS, 2006). If possible, cutting

boards used for raw meat should not be used for fresh fruits and vegetables (FDA, 2007). Cooked food should never be placed on a plate that previously held raw meat, poultry, or seafood (FSIS, 2006). Bacteria can be present on equipment, hands, and in the air (FSIS, 2002).

Cooking beef and other meats to a safe internal temperature is recommended in order to avoid ingestion of harmful bacteria. Color is not an acceptable indicator of whether food is safe to eat, especially when one out of every four hamburgers turn brown before it has reached the recommended safe internal temperature (FDA, 2007). This is especially true for ground beef. Not only are bacteria present on the surface, but they are also present inside the ground beef patty. The FDA and USDA recommend cooking whole muscle meats such as steaks and roasts to a minimum internal temperature of 145 ^{o}F, ground beef to 160 ^{o}F, and to reheat leftovers to a minimum temperature of 165 ^{o}F (FDA, 2007; FSIS, 2006). Table 1 shows recommended endpoint temperatures for common meats.

Table 1. Recommended Endpoint Temperatures for Common Meats.

TEMPERATURE RULES!	
Food	**°F**
Ground Meat & Meat Mixtures	
Beef, Pork, Veal, Lamb	160
Turkey, Chicken	165
Fresh Beef, Veal, Lamb	
Medium Rare	145
Medium	160
Well Done	170
Poultry	
Chicken & Turkey, whole	165
Poultry breasts, roast	165
Poultry thighs, wings	165
Duck & Goose	165
Stuffing (cooked alone or in bird)	165
Fresh Pork	160
Ham	
Fresh (raw)	160
Pre-cooked (to reheat)	140
Eggs & Egg Dishes	
Eggs	Cook until yolk & white are firm
Egg dishes	160
Leftovers & Casseroles	165

Thermy™ is the messenger of a national consumer education campaign of the USDA/FSIS designed to promote the use of food thermometers.
www.fsis.usda.gov/thermy

Consumers remain the last link in the food safety chain and have the ability to greatly reduce their risk of exposure to dangerous bacteria in foods prepared at home

through avoidance of cross-contamination, elimination of temperature abuse, using stored meat within appropriate deadlines, and cooking beef to the recommended safe internal temperature (FDA, 2007; FSIS, 2003, 2006).

It is important to refrigerate food promptly and properly following a meal. Prepared foods or leftovers should be refrigerated or frozen within 2 hours of preparation (one hour if room temperature is 90 ^{o}F or higher). Frozen foods should never be thawed at room temperature. At room temperature, pathogenic bacteria in food can double in number every 30 to 40 minutes. Frozen food can be safely thawed in the refrigerator or in the microwave oven (FDA, 2007). Thawing food in the refrigerator is a slow, yet safe method for defrosting meat. Once raw meat defrosts, it will be safe in the refrigerator for 3 to 5 days before cooking (FSIS, 2003). Defrosting beef using cold water can be done if defrosting in the refrigerator will take too long. Beef should be in an airtight and leak proof package or bag. It should be submerged in cold water that is changed every 30 minutes and cooked immediately after it has thawed (FSIS, 2003). Beef can also safely be defrosted in the microwave oven, but it should be cooked immediately after thawing (FSIS, 2003). Beef thawed in the microwave oven may actually have already started to cook but not enough to destroy any bacteria that are present (FSIS, 2003). Refrigerated food should be kept at 40 ^{o}F or below and frozen foods at 0 ^{o}F (FDA, 2007; FSIS, 2002).

Experiential Learning Theory

Beef consumption continues to decline as a result of unfounded and unfavorable claims against beef and adverse opinions, despite the fact that lean cuts of beef are a nutrient dense food that can improve diet quality and overall health. Lack of food preparation skills and time spent preparing meals has also negatively impacted the frequency of inclusion of beef in meals prepared at home. Addressing these issues through experiential learning may affect how individuals, especially women, view including beef in their diets. Generally, women are responsible for the purchasing and preparing of meals for their families.

Experimental learning can be used in two different types of environments. The first is learning as a student given a chance to acquire or apply knowledge or skills via a direct encounter with the topic or subject being studied (Smith, 1996). This type of learning is usually conducted in an institution such as a university. The second type of experiential learning is acquiring education through direct participation in life events (Smith, 1996). This type of learning is not sponsored by a formal educational institution, but by people teaching other people through reflection of everyday experiences (Smith, 1996).

David A. Kolb started a growing interest around experiential learning. Kolb, and his associate Roger Fry, created a model out of four elements: concrete experience, observation and reflection, formation of abstract concepts, and testing in new situations (Smith, 1996). These were represented in the experiential learning circle. Generally, the learning process begins with carrying out a particular action and then seeing the effect or

result of the action. Understanding the effect and general principle of the action may result in repeating the learnt action (Smith, 1996).

Kolb and Fry argue that effective learning requires the possession of four different abilities: concrete experience abilities, reflective observation abilities, abstract conceptualization abilities, and active experimentation abilities (Smith, 1996). Kolb and Fry also identified 4 basic learning styles: converger, diverger, assimilator, and accommodator. The converger learning characteristics are abstract conceptualization and active experimentation. The diverger learning characteristics are concrete experience and reflective observation. The assimilator learning characteristics are abstract conceptualization and reflective observation. The accommodator learning characteristics are concrete experience and active experimentation (Smith, 1996).

Kolb's experimental learning theory included learning styles, basic concepts of learning, and individual development (Rollins & Yoder, 1993). Kolb presented two basic elements to the learning process: accumulating experience by taking in information in concrete or abstract ways, and transforming the experience or information to fit one's way of thinking (Rollins & Yoder, 1993).

Experiments have used the Transtheoretical Model (Stages of Change), which has five different stages: precontemplation, contemplation, preparation for action, action, and maintenance. The Stages of Change are steps people progress through in stages depending on motivational readiness to change a problem behavior (Center for Health Communications Research, 2008). The Stages of Change model has become an important feature within health promotion and most literature associated with the Stages of Change describes it as being an effective approach in promoting change. However,

many problems exist in using this method on a population, and literature is now beginning to show that the model has been ineffective in achieving health promotion aims (Whitelaw, et al., 2000). This, however, is dependent on several factors that are specific to each study.

The Stages of Change may be an ineffective approach on children. Domel, et al. (1996) used an adapted 32-question survey to measure stages of change in fourth- and fifth-grade school children and their fruit and vegetable consumption. This was done to measure validity and reliability of the Stages of Change model on a young population. The approach was problematic beyond the first Stage of Change: precontemplation. The study concluded that the approach used in the study was not entirely appropriate and could not be applied to children because they lack the ability to comprehend questions measuring the concept (Domel, et al., 1996). However, a participatory approach in the development and implementation of adult education programs has gained attention as being a successful route to educate adults.

The ultimate goal of the Stages of Change for participants is readiness to change, implementation of change, and maintenance of change over a period of time. Hands-on, or experiential, learning has a similar goal: participants learn knowledge or skills by actively participating in the education process, and then apply that information as necessary. Participants take the information with them when the lesson is over and use the information to make lifestyle changes and behavioral changes, or any change that one can learn and apply to life. Hands-on learning goes beyond books and lectures by providing a learning style that actively engages participants in acquiring knowledge and

skills. Hands-on learning is a teaching method that ensures participants have gained an understanding of new concepts (Apple Learning Interchange, 2003).

CHAPTER III

METHODOLOGY

The purpose of the OBCS was to offer hands-on cooking experiences using beef while providing basic nutrition education, as well as safe food preparation and cooking techniques and tips. The project was funded through a grant provided by the Oklahoma Beef Council (OBC).

Curriculum

The OBCS curriculum was developed in a train-the-trainer format and was composed of six hands-on cooking lessons developed in 2004 for middle-class adults in Oklahoma (see Table 2). A middle-class audience was targeted because the OBC viewed that group as probable purchasers of value-added beef products.

Table 2. OBCS Curriculum Lesson Titles

Beef Sandwiches, Soups and Salads Lesson
Beef Steak Lesson
Grilling In and Out Lesson
Ground Beef Lesson
Homemade with Help Lesson
Mixing Cultures Lesson

The curriculum focused on nutrition benefits from eating beef, safe food handling practices, nutritious selections of beef, preparation and cooking techniques, and quick and convenient methods to prepare beef at home.

Experimental Study

Each lesson presented to participants included a PowerPoint presentation, a minimum of ten tested recipes, handout materials, and an evaluation. Evaluations were conducted after each lesson to determine if participants anticipated making changes in the amount and frequency of beef consumed, preparation methods, food safety practices, and/or their opinion of beef as a food included regularly in the diet.

Forty-eight Oklahoma Cooperative Extension County Educators were trained on the curriculum to ensure a consistent message and presentation format. County Educators were then given the opportunity to submit proposals for small grants to cover OBCS costs in their home counties. Funds for the small county grants were included as part of the funding from the OBC for the OBCS. Thirty-four Oklahoma counties were awarded 32 grants, resulting in 32 cooking school series statewide (Appendix A). Each grant provided $200-$400 to be used for approved equipment, cooking materials and supplies, and for duplicating materials for participants.

Participant Recruitment

County Educators recruited participants by advertising lessons through club meetings, newsletters, and weekly radio and television programs. They were provided a radio script announcement, and a news release they could provide to newspapers. County

Educators conducted the series of hands-on sessions, in the order of their choosing. At the beginning of each lesson, County Educators read a script explaining informed consent to participate in research to the audience (Appendix B). Following each lesson, the evaluation for that lesson was administered (Appendix C). While the curriculum was designed as a series, County Educators advertised each session as a "stand alone" event that was part of the OBCS. Participants were welcome to attend one or all of the lessons. With this limitation in mind, separate evaluations were developed for each lesson.

Statistical Analysis

Frequencies obtained from Statistical Analysis System (SAS) software were used to determine changes in participants' knowledge and intended behavior following each lesson. Frequencies were chosen because only post-evaluations were administered to participants. Participants were welcome to attend all six lessons. However, individual attendance was not recorded and each lesson was treated as a separate entity.

The final question of each evaluation asked whether or not participants would be interested in attending additional lessons. Because the purpose of that question was to determine future programming interests and needs rather than to evaluate the OBCS, the results were not included in this thesis.

Institutional Review Board (IRB) approval was not required for this thesis project because data used was previously collected and contained no identifiable information.

CHAPTER IV

RESULTS AND DISCUSSION

Results

A larger majority of program participants were female. Males accounted for 13.76% of the total participants that took part in the OBCS lessons (8.46% in the Beef Sandwiches, Soups, and Salads Lesson, 20.61% in the Beef Steak Lesson, 22.56% in Grilling In and Out Lesson, 7.86% in the Ground Beef Lesson, 13.00% in the Homemade with Help Lesson, and 10.03% in the Mixing Cultures Lesson). Since the number of males who participated was so small, the results and discussion presented in this paper represent the female population only.

Some participants failed to complete the entire evaluation at the end of the lesson, resulting in missing frequencies and data. Results reported are based on questions that were answered on evaluations. If a participant skipped a question, the remainder of the evaluation was still recorded in results. Missing frequencies were omitted from final results because they offer no assistance in determining if the OBCS was effective in participants' anticipation of changing practices at home as a result of the lesson.

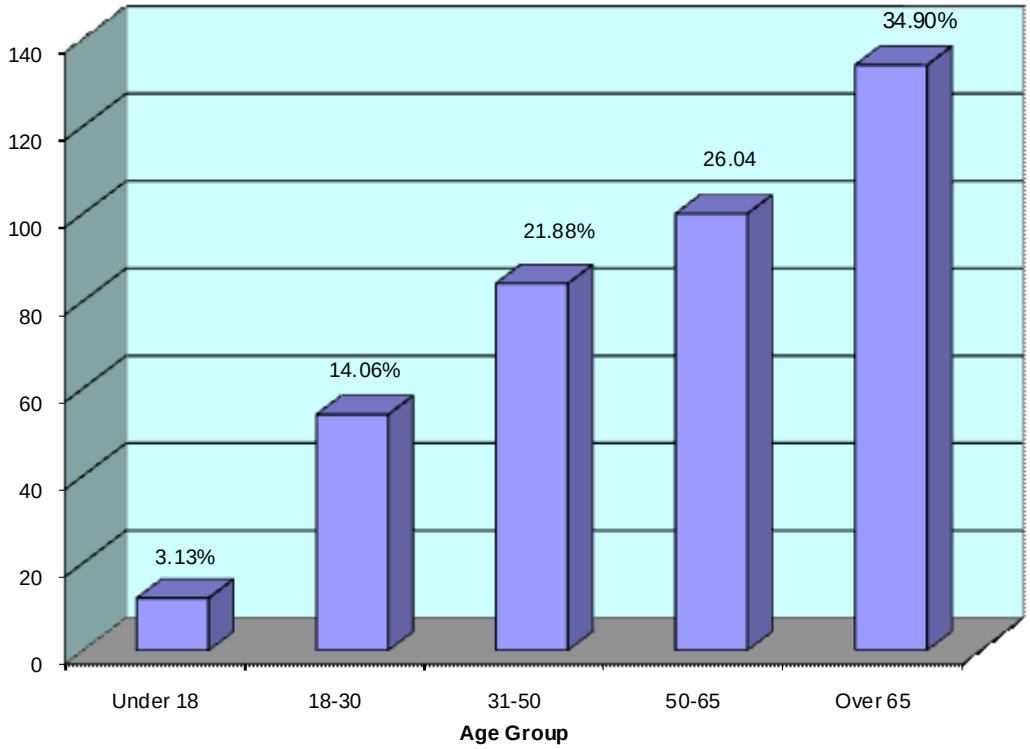
When 25% or more of participants reported a definite intent to change, the lesson was considered successful, and the hypothesis was accepted. Twenty-five percent was

the value assigned to signify a respectable level of acceptability and anticipated intent to change among participants.

Beef Sandwiches, Soups, and Salads Lesson

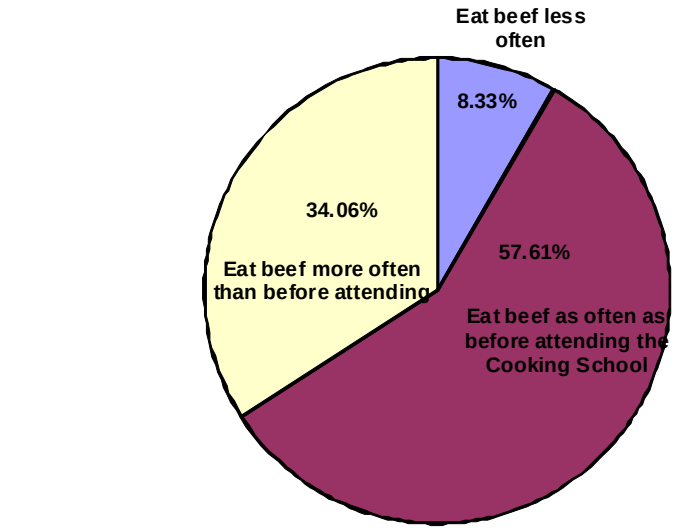
Four-hundred forty-three adults participated in the *Beef Sandwiches, Soups, and Salads Lesson.* Of those, 389 were female (36 males, 18 gender unknown). The greatest number of participants (134, 34.90%) was over the age of 65. The 50-65 years age group was the second largest with 100 participants (26.04%), followed by the 31-50 years age group (84 participants, 21.88%). Fifty-four participants reported being in the 18-30 age group (14.06%) and 12 participants (3.13%) reported being younger than 18 (Figure 1).

Figure 1. Age Distribution of Female Participants (Beef Sandwiches, Soups, and Salads Lesson)



Participants were asked if they already knew saturated fatty acids that could potentially raise blood cholesterol levels are comparable in lean beef, fish, and chicken. One-hundred twenty-one (41.44%) participants reported they already knew, while 58.56% (171) reported that they learned about it during the lesson. Participants that reported they learned about saturated fatty acids, cholesterol, and lean beef compared to chicken and fish, were asked about their anticipated changes in beef consumption based on what they learned during the lesson. Ninety-four (34.06%) participants reported they planned to eat beef more often than they did before attending the lesson, 57.61% (159) reported they would continue to eat beef as often as they did before attending the lesson, and 8.33% (23) reported they would eat beef less often than before the lesson (Figure 2).

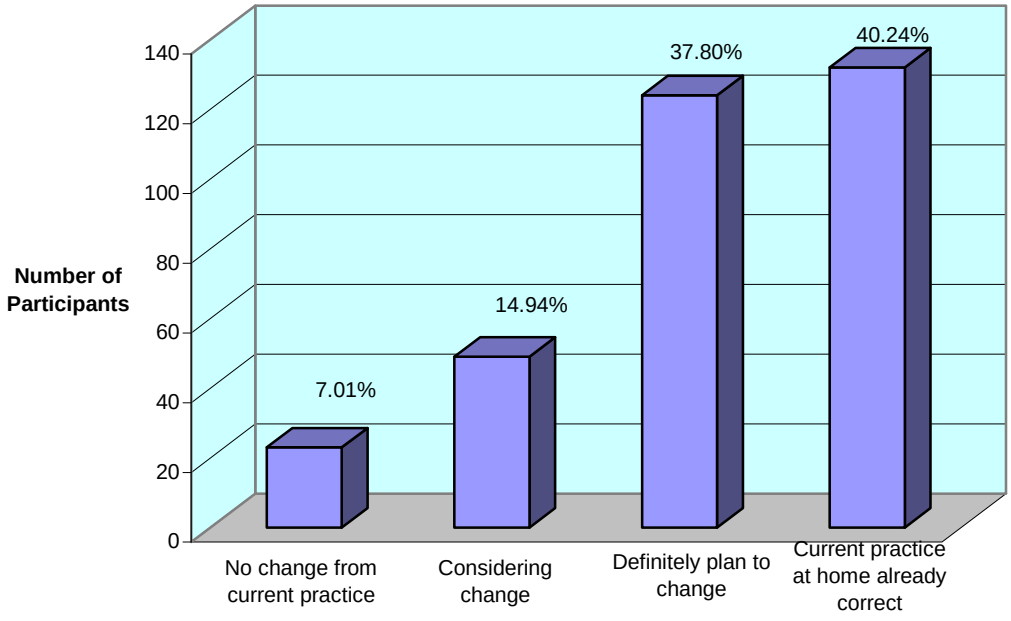
Figure 2. Anticipated changes in beef consumption based on knowledge gained during the lesson (Beef Sandwiches, Soups, and Salads)



Participants who reported consuming beef less may have realized they were consuming beef too frequently or in larger portions than the recommended three ounce serving.

Participants were asked if they intended to change their practice of clearing the table and quickly and properly storing food after a meal following information on danger zone temperatures (between 40°F and 140°F) and pathogenic bacteria presented during the lesson. One-hundred thirty-two (40.24%) participants reported they already clear the table and refrigerate/freeze leftovers promptly, and 37.80% (124) reported they anticipated changing to clearing the table and storing foods quickly and properly at home. Forty-nine (14.94%) participants reported they would consider making a change at home, and 7.01% (23) reported they intended to make no change in their practices following a meal, even if it food would sit at room temperature longer than two hours (Figure 3).

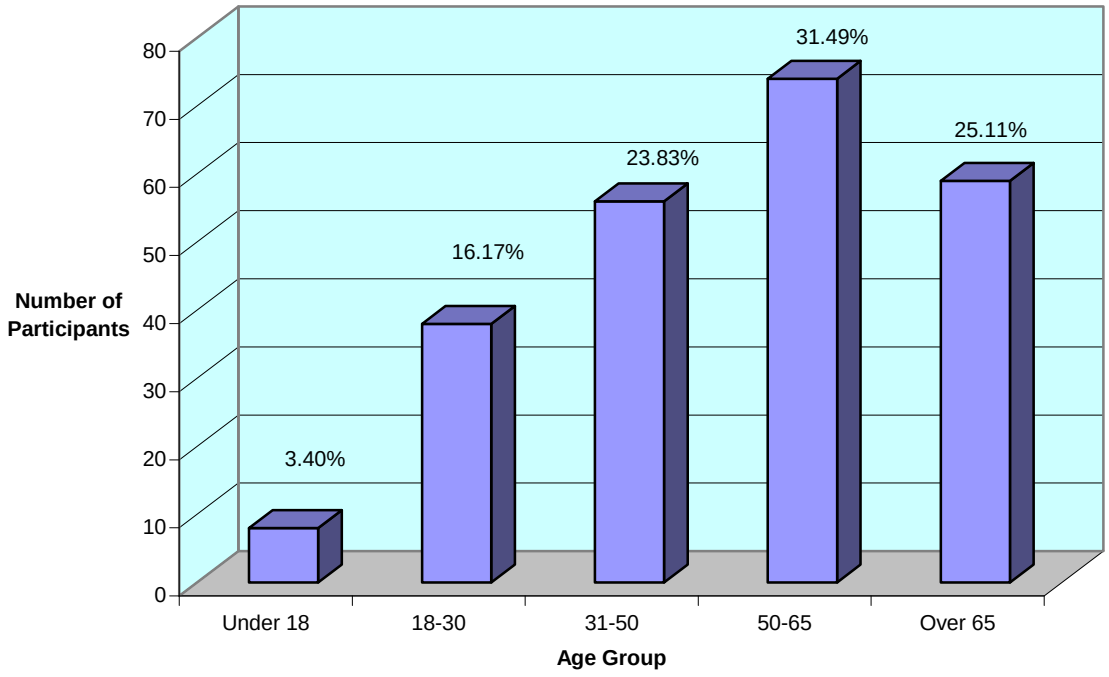
Figure 3. Participants plan to change current practice of clearing table and refrigerating/freezing foods quickly after a meal



Beef Steak Lesson

Three-hundred-five adults participated in the *Beef Steak Lesson*. Of those, 235 were female (61 males, 9 gender unknown). The greatest number of participants (74, 31.49%) was in the 50-65 years age group. This was followed by the over 65 years age group (59, 25.11%), and the 31-50 years age group (56, 23.83%). Thirty-eight (16.17%) participants reported being in the 18-30 age group and 8 (3.40%) participants reported being younger than 18 years of age (Figure 4).

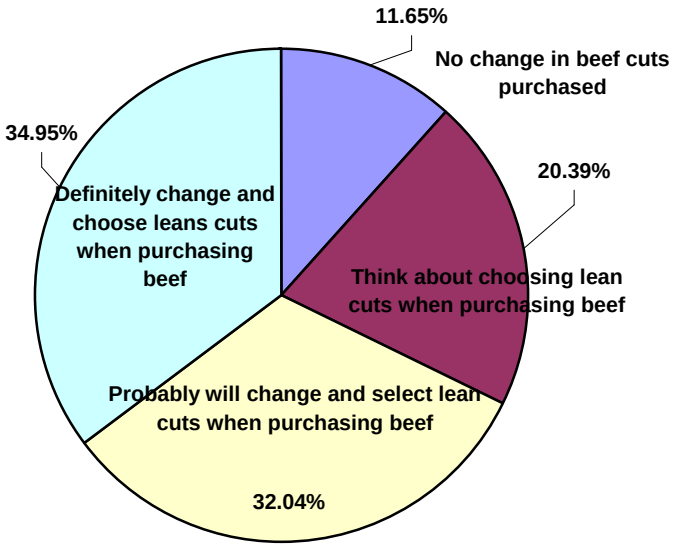
Figure 4. Age Distribution of Female Participants (Beef Steak Lesson)



Participants learned that there are at least 19 cuts of beef (29 cuts of beef currently) that meet the government labeling guidelines for lean or extra lean during the lesson. They were asked if they planned to continue to select from lean cuts when choosing beef implying no change would be necessary, or if they would consider making

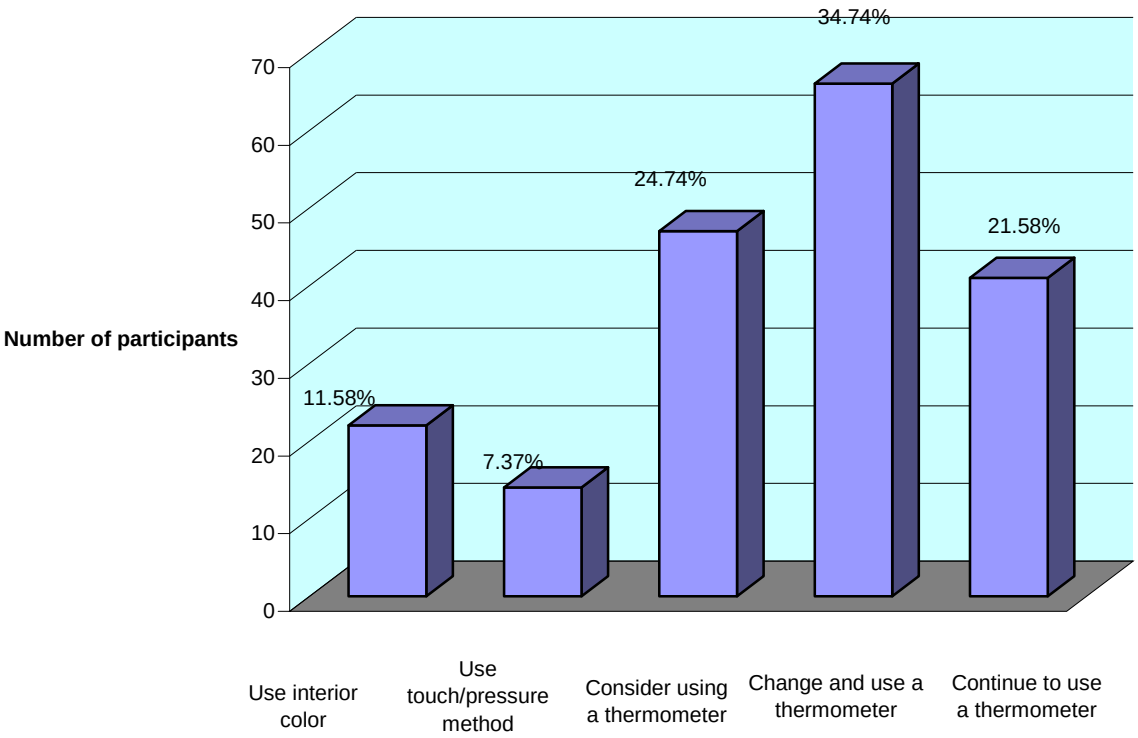
a change by selecting lean cuts when choosing beef. One-hundred forty-eight (67.27%) participants reported they would continue selecting lean cuts of beef as they did prior to the lesson, and 32.73% (72) reported anticipated change while selecting beef. Participants who reported a possible change were asked what types of change they planned to make. Thirty-six (34.95%) participants reported they would definitely choose from the 19 cuts of lean beef when purchasing beef, and 32.04% (33) reported they would probably make this change. Twenty-one (20.39%) participants reported they would think about making a change and selecting lean cuts of beef, while 11.65% (12) reported no anticipated change in the cuts of beef purchased (Figure 5).

Figure 5. Self-anticipated changes for participants during future beef purchases based on knowledge gained during the lesson (Beef Steak)



The evaluation asked participants if they intended to use a thermometer, the most effective and safe method, to determine doneness of beef steaks. Forty-one (21.58%) participants reported they currently use a thermometer to determine doneness of beef steak and plan to continue to do so, while 34.74% (66) reported they planned to change and use a food thermometer to determine doneness. Forty-seven (24.74%) participants reported they would consider using a thermometer, 7.37% (14) reported they would use the touch/pressure method, and 11.58% (22) reported they planned to use interior color to determine doneness of beef steaks (Figure 6).

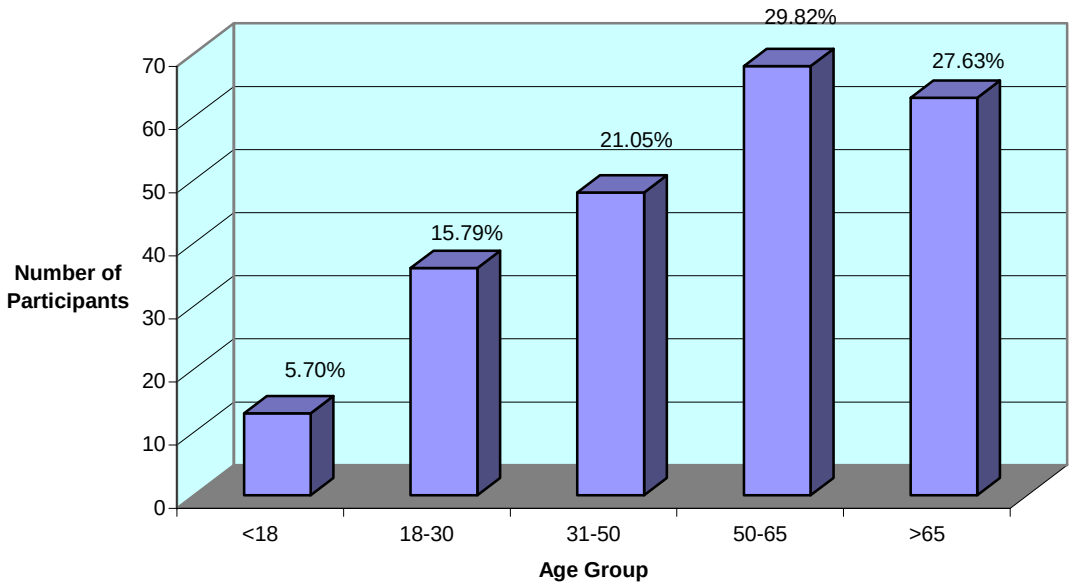
Figure 6. Participants planned the following actions to determine doneness of beef steak:



Grilling In and Out Lesson

Three-hundred-two adults participated in the *Grilling In and Out Lesson*. Of those, 230 were female (67 males, 5 gender unknown). The greatest number of participants (68, 29.82%) were in the 50-65 years age group, followed closely behind by the over 65 years age group (63, 27.63%), and the 31-50 years age group (48, 21.05%). Thirty-six (15.79%) participants reported being in the 18-30 years age group, and 13 (5.70%) reported being younger than 18 years of age (Figure 7).

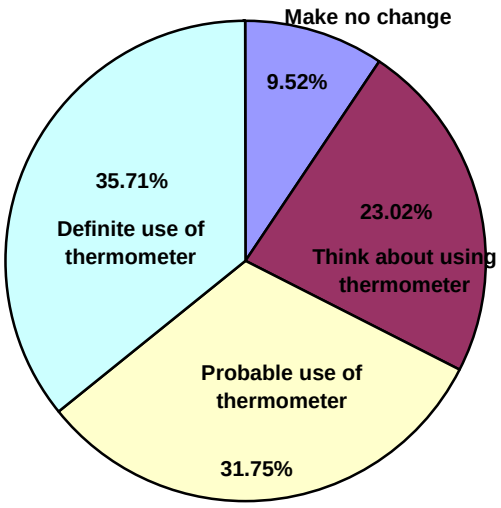
Figure 7. Age Distribution of Female Participants (Grilling In and Out Lesson)



The evaluation for this lesson asked participants if they learned during the lesson that they should make a change in the way they determine when grilled beef is cooked to a safe internal temperature, or if they currently use a thermometer correctly when grilling beef to ensure it reaches a safe internal temperature. Eighty-one (41.33%) participants reported they already correctly use a thermometer when grilling beef to ensure it reaches

a safe internal temperature, while 58.16% (114) reported a change should be made in the way they decide when grilled beef is done cooking. Participants that reported a change should be made in their method of determining doneness of grilled beef were asked what they planned to differently. Forty-five (35.71%) participants reported they definitely planned to use a thermometer when grilling beef, 31.75% (40) reported probable use, 23.02% (29) reported they would think about using a thermometer, and 9.52% (12) reported no intended change to determine doneness when grilling beef (Figure 8).

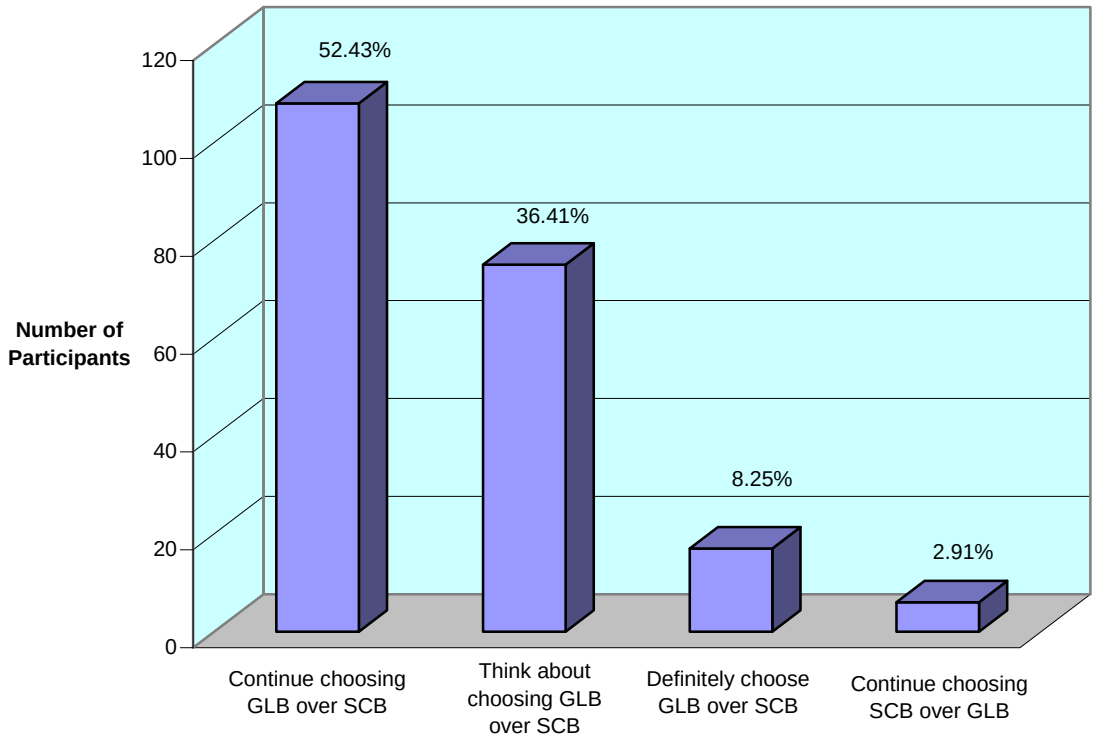
Figure 8. Anticipanted changes in how to determine doneness of grilled lean beef based on knowledge gained during the lesson (Grilling In and Out)



Participants learned during the grilling lesson that lean beef provides more vitamin B12, zinc, and iron than skinless chicken breast and is low in fat and saturated fat. Participants were asked what they would select if offered a choice between grilled

lean beef or skinless chicken breast. One-hundred-eight (52.43%) participants reported they would continue to choose grilled lean beef, 36.41% (75) reported they would consider choosing grilled lean beef instead of skinless chicken breast, 8.25% (17) reported they would definitely change to choosing grilled lean beef instead of skinless chicken breast, and 2.91% (6) reported they would continue to choose grilled skinless chicken breast instead of lean beef (Figure 9).

Figure 9. When offered the choice between grilled lean beef (GLB) and skinless chicken breast (SCB), participants plan to:

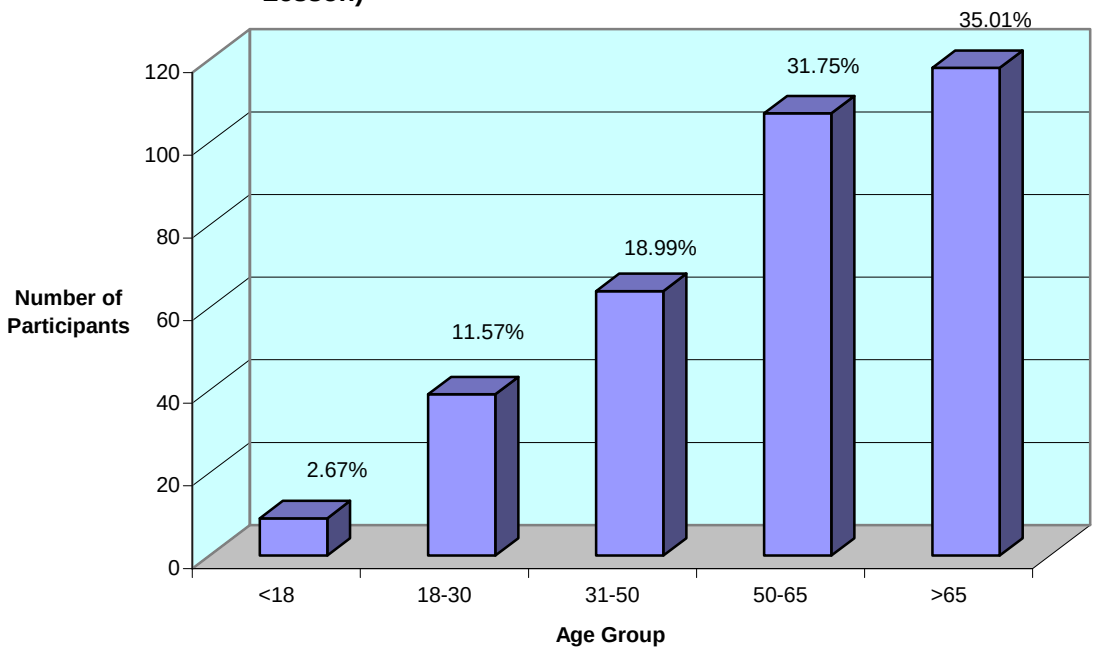


Ground Beef Lesson

Three-hundred seventy adults participated in the *Ground Beef Lesson*. Of those, 340 were female (29 males, 1 gender unknown). The greatest number of participants

(118, 35.01%) was over the age of 65. The second largest group was the 50-65 years age group with 107 (31.75%) participants, followed by the 31-50 years age group (64, 18.99%). Thirty-nine (11.57%) participants reported being in the 18-30 age group, and 9 (2.67%) participants reported being younger than 18 years of age (Figure 10).

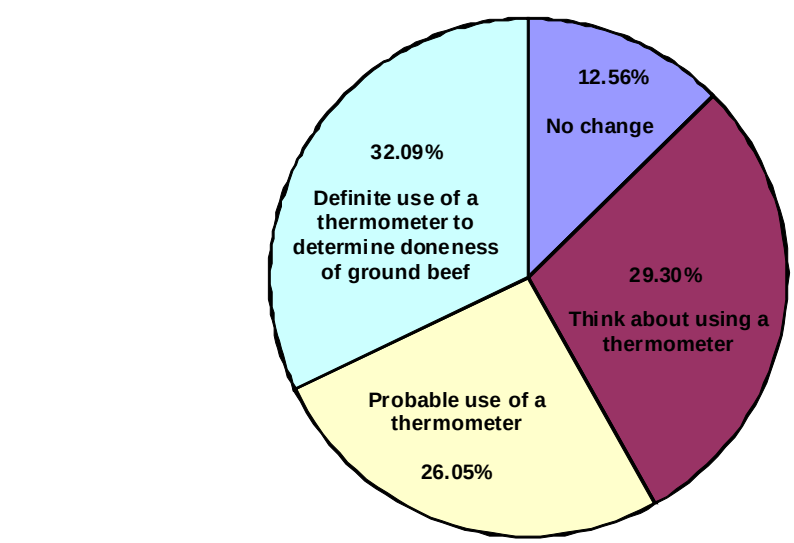
Figure 10. Age Distribution of Female Participants (Ground Beef Lesson)



Participants were asked if they learned during the lesson that they should make a change in the way they determine when ground beef is cooked to a safe internal temperature of 160 ^{o}F. Over 35% (35.21%) of participants reported they already correctly use a thermometer when cooking ground beef to ensure it reaches a safe internal temperature of 160 ^{o}F, and 64.79% (173) reported a change should be made in the way they decide when ground beef is done cooking. Participants that reported a change needed to be made to determine when ground beef is done cooking were asked what they

planned to differently. Sixty-nine (32.09%) participants reported they would definitely use a thermometer in the future, 26.05% (56) reported probable use of a thermometer, and 29.30% (63) reported they would think about using a food thermometer to determine when ground beef is done. Twenty-seven (12.56%) participants reported no intended change in their method for determining when ground beef is done (Figure 11).

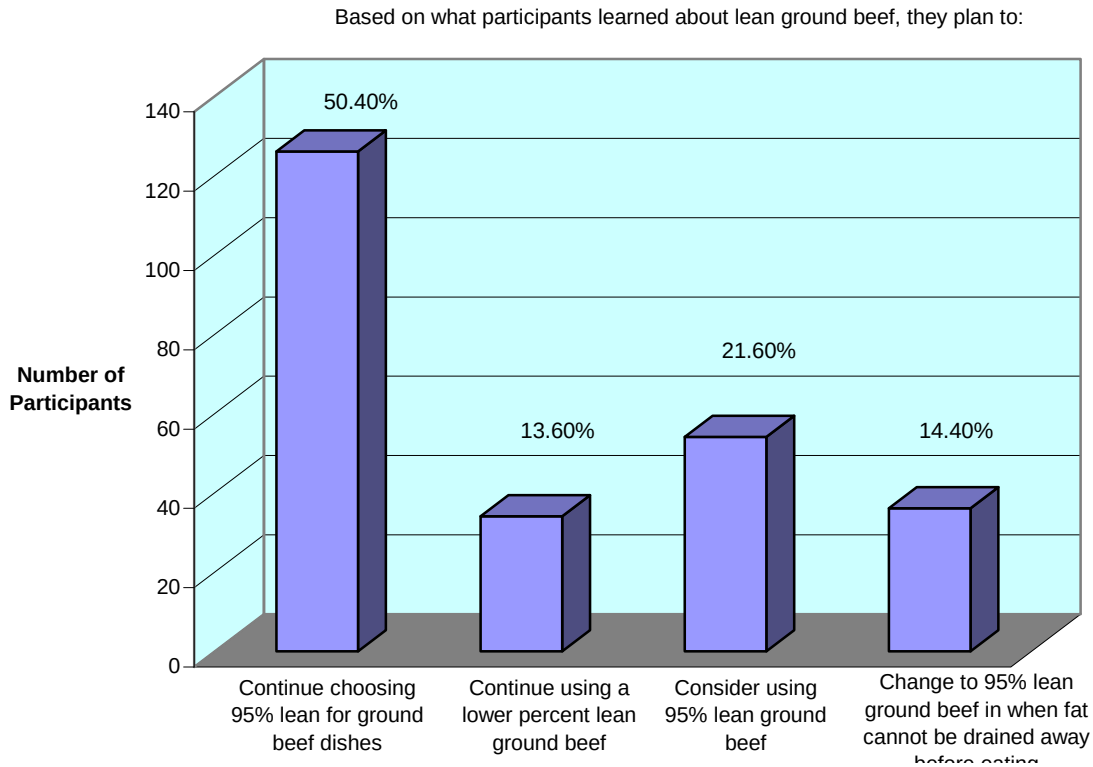
Figure 11. Participants anticipated changes in how to determine when ground beef is done cooking based on knowledge gained during the lesson (Ground Beef)



Participants that attended the Ground Beef lesson learned that 95% lean ground beef meets the government definition of lean. The evaluation asked what they planned to do following the lesson when selecting beef. One-hundred twenty-six (50.40%) participants reported they would continue to choose 95% lean beef (5% fat) when cooking ground beef recipes, 13.60% (34) reported they would continue using a lower

percent lean (higher percent fat) ground beef for all ground beef recipes, 21.60% (54) reported they would consider using 95% lean ground beef in recipes where fat cannot be drained away before eating, and 14.40% (36) reported they would change to 95% lean ground beef in recipes where the fat cannot be drained away before eating (Figure 12).

Figure 12. Participants anticipated plan when selecting ground beef

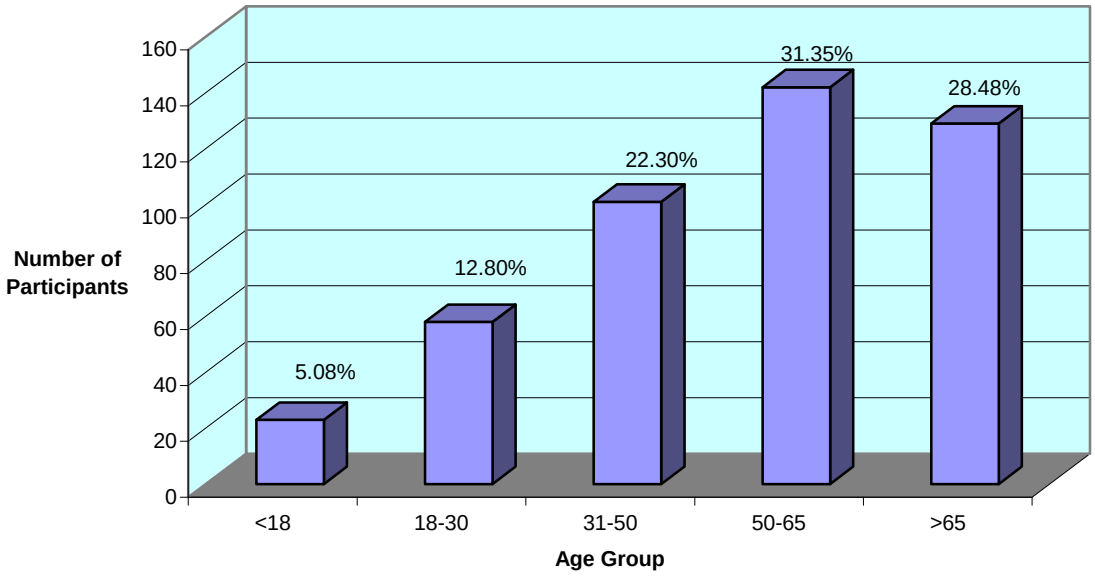


Homemade with Help Lesson

Five-hundred twenty-seven adults participated in the *Homemade with Help Lesson*. Of those, 455 were female (68 males, 4 gender unknown). The greatest number of participants (142, 31.35%) was in the 50-65 years age group, with the over 65 years age group following a close second (129, 28.48%). One-hundred-one (22.30%) of the

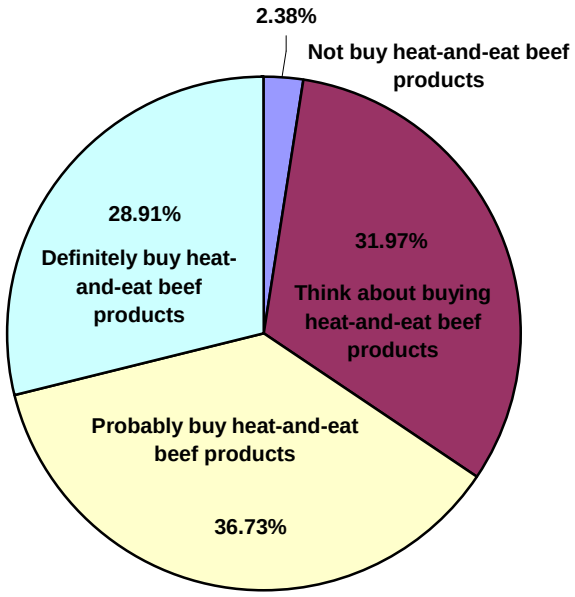
participants were in the 31-50 years age group, 12.80% (58) were in the 18-30 years age group, and 5.08% (23) reported being younger than 18 years of age (Figure 13).

Figure 13. Age Distribution of Female Participants (Homemade with Help Lesson)



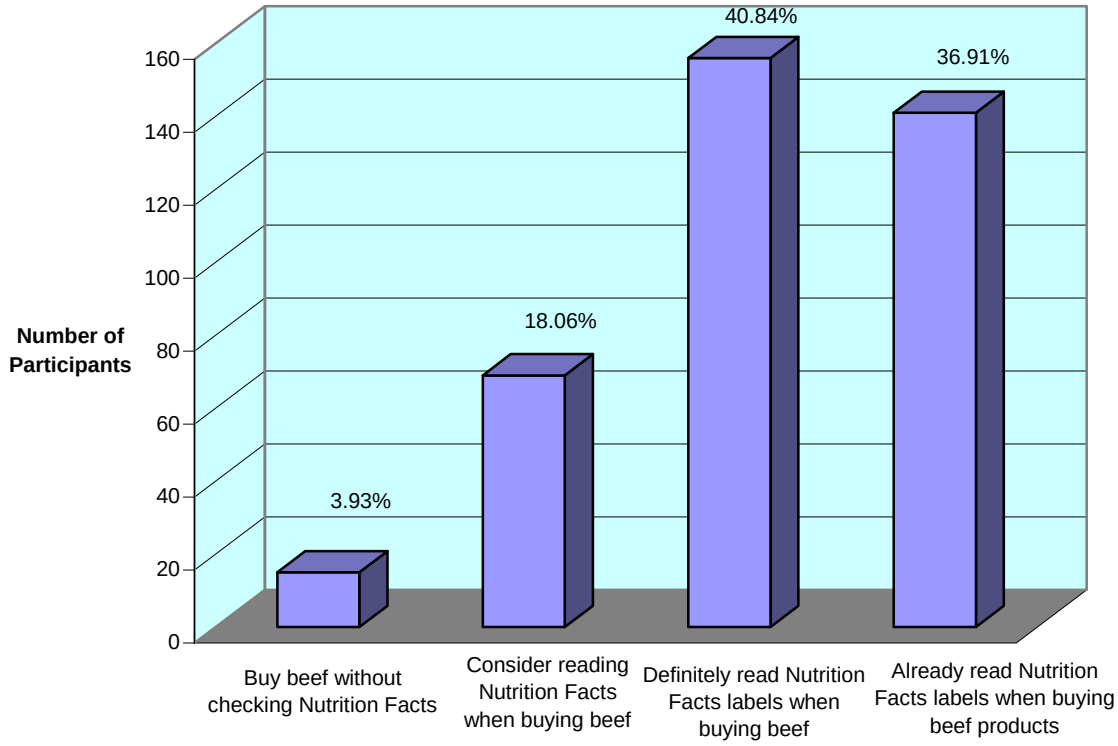
Participants were asked if they already knew refrigerated heat-and-eat beef products are nutritious time savers prior to the lesson, or if they learned this information during the lesson. One-hundred thirty-five (38.14%) participants reported they were already aware, while 61.86% (219) reported they learned heat-and-eat refrigerated beef dishes are nutritious time savers during the lesson. Participants that reported they learned heat-and-eat beef dishes were nutritious from the lesson were asked what changes, if any, they would make as a result of what they learned. Eighty-five (28.91%) participants reported they would definitely buy heat-and-eat refrigerated beef products, 36.73% (108) reported a probable purchase of these beef products, 31.97% (94) reported they would think about changing and purchasing these beef products, and 2.38% (7) reported they would not buy heat-and-eat refrigerated beef dishes (Figure 14).

Figure 14. Probability that participants would purchase heat-and-eat beef products based knowledge gained during the lesson (Homemade with Help)



Participants learned during the lesson that lean beef was high in protein, zinc, iron, and B-vitamins whether the lean beef is fresh, frozen, or in heat-and-eat products. Participants were asked if they planned to make a change in whether or not they would read Nutrition Facts to help select nutritious beef products. One-hundred fifty-six (40.84%) participants reported they would definitely read the Nutrition Facts label to help select nutritious beef products, 36.91% (141) reported they already read the Nutrition Facts label when purchasing beef products, 18.06% (69) reported they would think about reading the Nutrition Facts label, and 3.93% (15) reported they would buy beef without checking the Nutrition Facts label (Figure 15).

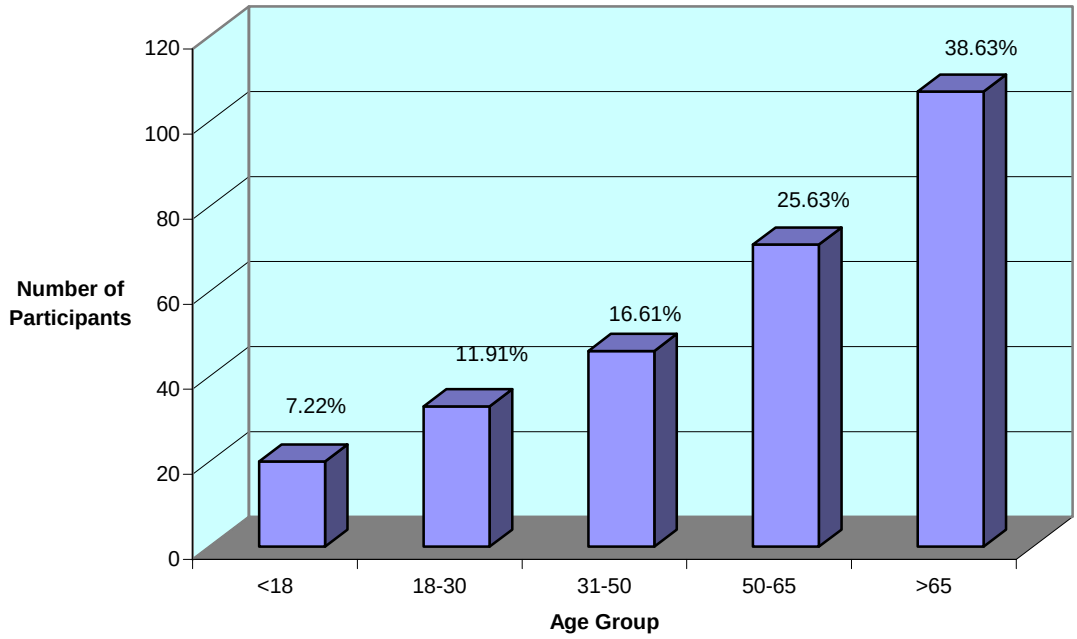
Figure 15. Participant responses to if they plan to read Nutrition Facts labels when buying nutritious beef products



Mixing Cultures Lesson

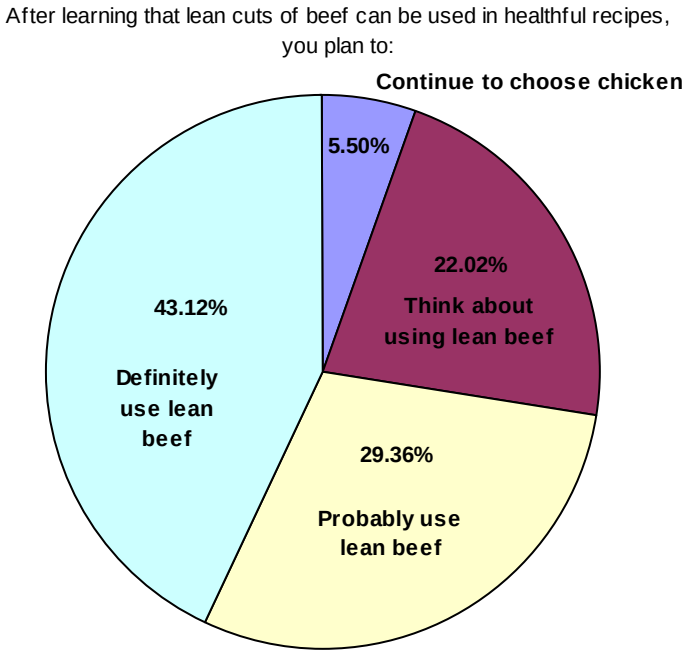
Three-hundred-twenty adults participated in the *Mixing Cultures Lessons*. Of those, 278 were female (31 males, 11 gender unknown). The greatest number of participants (107, 38.63%) was over the age of 65. The 50-65 years age group was the second largest, with 71 participants (25.63%), followed by the 31-50 years age group (46, 16.61%). Thirty-three (11.91%) participants reported being in the 18-30 years age group, and 20 (7.22%) participants reported being younger than 18 years of age (Figure 16).

Figure 16. Age Distribution of Female Participants (Mixing Cultures Lesson)



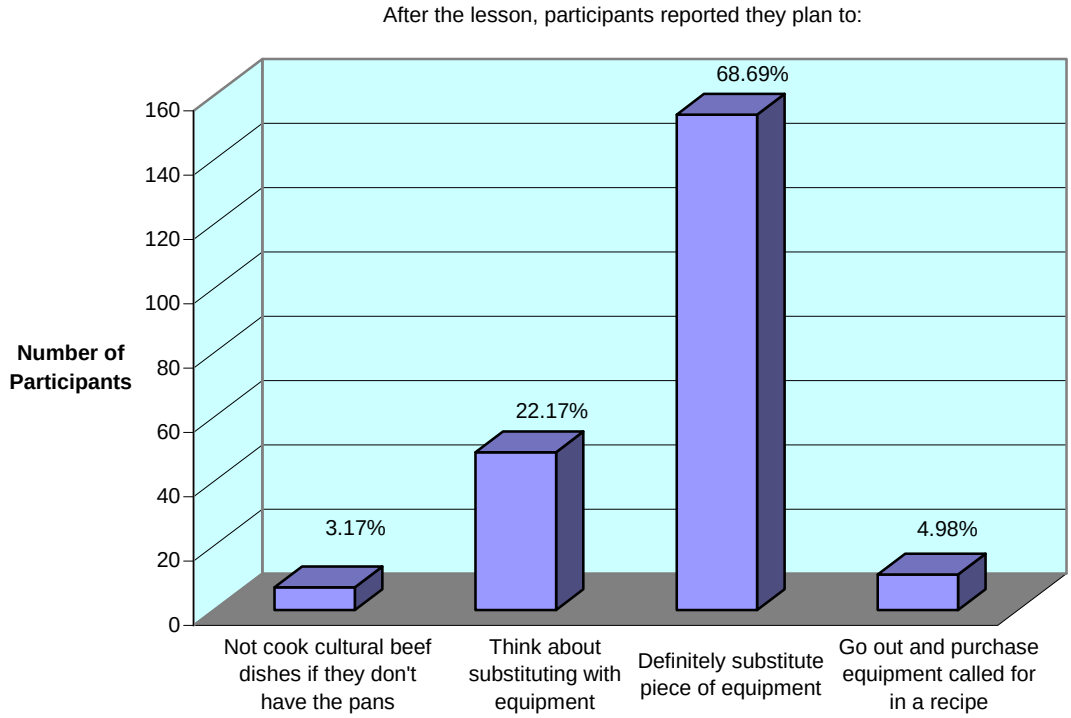
The evaluation asked participants if they learned during the lesson that lean cuts of beef can be used in healthful recipes, or if they already knew this information. One-hundred forty-one (63.51%) participants reported they already knew, while 36.49% (81) reported they learned that lean beef could be used in healthful recipes from the lesson. Participants that reported this information was learned during the lesson were asked what they planned to do differently. Forty-seven (43.12%) participants reported they definitely planed to use lean beef when preparing meals, 29.36% (32) reported a probable change to using lean beef, 22.02% (24) reported they would think about changing to lean beef when preparing meals, and 5.50% (6) reported no change was intended and they would continue to use chicken when preparing healthful meals (Figure 17).

Figure 17. Participants selection when given a choice between cooking with chicken or cooking with lean beef when preparing healthy meals based on knowledge gained during the lesson (Mixing Cultures)



Participants were asked how they planned to prepare foods from recipes introduced during the lesson at home if they did not own the needed cooking ware (e.g. pots and pans). One-hundred fifty-four (69.68%) participants reported a definite intention to substitute cookware they currently have at home when they do not have the equipment called for in cultural recipes, 22.17% (49) reported they would think about substituting equipment to make a cultural dish at home, 4.98% (11) reported they intended to go out and purchase equipment when it is called for in a cultural recipe, and 3.17% (7) reported they would not cook cultural beef dishes if they did not have the equipment the recipe called for (Figure 18).

Figure 18. Preparation of cultural beef dishes and possibility of substituting cookware when necessary



Discussion

This study was conducted to provide basic beef nutrition education and hands-on learning experiences in an effort to improve participants' opinion of beef and increase intention to consume lean beef as part of a healthful diet, as well as improve basic cooking skills and the safe handling, preparation, and storage of beef. The purpose of evaluating participants after each lesson was to assess if hands-on learning experiences resulted in intention to change in Oklahoma adults that participated in the OBCS. Lessons offered information and hands-on cooking experiences using beef to improve basic cooking skills and food safety practices, and provided nutrition education regarding how lean beef can be incorporated into the diet nutritiously, deliciously, and safely.

The Oklahoma Cooperative Extension Service has contributed to other hands-on curriculums that focused on foods including pork, and fruits and vegetables. The Oklahoma Cooperative Extension Service's purpose for this program was to improve basic cooking skills and nutritional health of participants. The OBC was interested in funding the project if lean beef was used as the protein source in the lessons. As a result, subject matter presented during the lessons concentrated on important issues regarding safely preparing, cooking, storing, and re-heating beef or beef dishes and how this can diminish risk of foodborne illness, and general nutrition information regarding the benefits of including lean beef in the diet. The basic cooking skills developed by participants at the lessons can be transferred to other foods they prepare in their homes. The evaluations were administered to examine knowledge gained and what changes, if any, participants intended to make as a result of the lesson.

Female participants were the only population included in the results. Male participants were not included because their attendance at each lesson was low compared to females that attended. Males represented an average of 13.76% of the total population of participants that attended all six lessons (8.47% in the Beef Sandwiches, Soups, and Salads Lesson, 20.61% in the Beef Steak Lesson, 22.56%, in the Grilling In and Out Lesson, 7.86% in the Ground Beef Lesson, 13.00% in the Homemade with Help Lesson, and 10.03% in the Mixing Cultures Lesson). Female participants were also the focus in the study because women tend to experience lower consumption of beef when compared to men for a variety of reasons that may be ethically, environmentally, or nutritionally-based. Iron deficiency is the most common nutritional deficiency in the United States (Gerrior et al. 2004). Women of childbearing age are at greatest risk for developing

anemia. This is partly because women between the ages of 19-50 require 18 mg of iron a day while men only require 8 mg a day (ODS, 2007a). To complicate this further, women that choose to consume no or a low amount of lean beef in the diet are also avoiding a food that provides a good source of heme iron. The number of female participants that attended each lesson ranged from 230-455.

Age Distribution of Female Participants

Age of participants was categorized into five different groups on the evaluations. Representation of each age group was consistent throughout the lessons. Participants under the age of 18 represented the smallest percentage of participants in all six lessons (2.67%-7.22%), an average of 4.65% of the total population. A secondary program, the OBCS for Youth, was developed to better reach that audience. Participants in the 18-30 years age group represented the second smallest percentage of participants in all six lessons (11.57%-16.17%), an average of 13.60%. The 31-50 years age group was consistently represented as the third largest age group, with an average percent population of 20.78% (16.61%-23.83%). It is possible that these two groups (18-30 years age group and 31-50 years age group) would have benefited the most from attending the OBCS due to common factors that decrease the time available this group has for food preparation, such as employment outside the home and children living at home. These two factors may also be the reason why the percentage of participants in these two age groups was not higher. The 50-65 years age group and the over 65-age group exhibited the highest percentage of participants in each lesson. The 50-65 years age group represented the largest percentage of participants in four lessons (25.63%-31.75%), an

average of 29.35% of the total population. Participants over the age of 65 represented the largest percentage of participants in two lessons (25.11%-38.63%), and average of 31.63%.

OBCS Participants Intent to Change

Participants were asked on evaluations if they learned the main objective of the class from the lesson, or if they already knew the information or already correctly used a piece of equipment prior to the lesson. Based on this question, participants who responded they learned the information during the lesson were asked to report changes they intended to make. Percentage of participants who reported they learned the information from the lesson was 52.10% averaged from the six lessons (58.56% in the Beef Sandwiches, Soups, and Salads Lesson, 32.73% in the Beef Steak Lesson, 58.16% in the Grilling In and Out Lesson, 64.79% in the Ground Beef Lesson, 61.86% in the Homemade with Help Lesson, and 36.49% in the Mixing Cultures Lesson).

Participants who reported they learned new information from the lessons expressed a high incidence of planning to possibly make a change, whether it be on the level of thinking of making the change, probably making the change, or definitely making the change. Participants that reported they intended to make no changes to their techniques or dietary habits, even if their methods were incorrect or contradicted the message of the lesson, was low at an average of 8.32% for all lessons. The rest of the participants indicated, at a minimum, consideration towards changing. The average percentage of participants that reported a definite intent to change as a result of the lesson was 34.81%.

The use of a thermometer was addressed in three separate evaluations: Beef Steak, Grilling In and Out, and Ground Beef. In the *Grilling In and Out Lesson* and the *Ground Beef Lesson*, participants were asked if they intended to use a thermometer to determine when grilled beef and ground beef were cooked to a safe internal temperature. The two evaluations combined showed 33.90% of participants definitely intended to use a thermometer following the lesson, 28.90% planned to probably use a thermometer, 26.16% reported they would consider using a thermometer, and 11.04% reported no intended change in the way they determined when beef was done. When participants were asked in the *Beef Steak Lesson* evaluation how they planned to determine doneness of steak, 21.58% reported they currently used a thermometer and planned to continue to use one to determine doneness of beef steaks, 34.74% reported they planned to change and use a thermometer, 24.74% reported they would consider using a food thermometer, 7.37% reported they would use touch or pressure to determine doneness, and 11.58% reported they would use interior color to determine when beef steaks are done cooking. Over 81% of participants reported they currently used a thermometer or were considering making the recommended changes to switching to a thermometer to determine doneness of beef.

Effectiveness of OBCS

The OBCS appeared to successfully impact participants' knowledge and opinion about beef. Participants learned lean beef was a nutritious food, and they learned the appropriate serving size for beef, basic cooking skills, and the safe handling of beef to prevent foodborne illness. Positive responses (e.g. intent to change) showed the OBCS

met the objective of increasing the intent of Oklahoma adults to make more healthful decisions and include lean cuts of beef in the diet, incorporate new cooking skills, and practice the safe handling of food to decrease the risk of foodborne illness. Because there was no pretest/posttest conducted, no comparison can be made as to how participants changed from before the lesson to after the lesson, or if participants followed through with their reported intentions to change. Since lessons were voluntary, participants were not required to attend all of them, so it was not possible to determine how many lessons participants attended. It was also not possible to determine if intention to change was influenced by age group because participants' responses on the evaluations was the sole means to categorizing the data.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of Findings

The OBCS was developed to offer hands-on experiences of preparing food with beef while providing nutrition education and information for the purpose of improving participants' opinion of consuming beef, improve ability to select lean cuts of beef, increase the use of safe food handling, and increase the self-forecasted incorporation of beef into the diet using nutritious methods. The curriculum focused on the nutritional benefits of beef, safe food handling practices, improvement of preparation and cooking skills, and convenient methods to prepare meals that include beef.

Participants learned information about beef, including the cuts of beef that meet government guidelines for being lean or extra lean; nutrients provided by beef such as protein, iron, zinc and the B-vitamins; the importance to using proper equipment to determine when beef is thoroughly cooked; preventing cross-contamination and the onset of foodborne illness from improper handling, improper storage, and low cooking temperatures; and how to include lean beef in a healthy diet.

The objective was to increase the probability that Oklahoma adults who participated in the OBCS would make healthful decisions through hands-on learning

experiences and education on the nutritional contribution of beef to the diet, beef selection, appropriate serving size, cooking techniques, and safe handling and preparation of beef. Specific objectives included increasing participants' knowledge, and therefore, improving methods used to prepare meals with beef including use of a food thermometer to determine doneness, recognition of beef as a healthful meat, and acknowledgment that lean beef can be used to prepare healthful meals.

Hypotheses

Hypothesis 1

The *Beef Sandwiches, Soups, and Salads Lesson* stated education regarding the fatty acid profile of lean beef and proper cooling methods to avoid the temperature danger zone would increase the intent to include beef in a healthy diet and improve participants' methods for clearing the table and refrigerating or freezing foods promptly following a meal.

As seen in Figure 2 and Figure 3, participant's intention to change beef consumption and change methods for clearing the table and store leftovers curved in the predicted direction. The hypothesis was accepted because over one-third of participants reported they planned to increase frequency of beef consumption, and nearly 38% reported they anticipated definitely clearing the table, and refrigerating and freezing foods quickly.

Hypothesis 2

The *Beef Steak Lesson* stated education regarding lean and extra lean cuts of beef would increase the intent of participants to select lean cuts of beef, and education on the use of a thermometer to effectively determine doneness of beef would increase the intent of participants to use a thermometer instead of using unsafe methods (e.g. interior color, touch/pressure method).

As seen in Figure 5 and Figure 6, participants reported anticipated changes were in agreement with the hypothesis. The hypothesis was accepted because approximately 35% of participants reported they anticipated definitely choosing from the lean cuts of beef, as well as changing to a thermometer to determine doneness of meat.

Hypothesis 3

The *Grilling In and Out Lesson* stated participants would gain an understanding of the nutritional quality of lean beef and would select grilled lean beef over other options when offered a choice. Education regarding the safest method to determine when grilled beef reaches a safe internal temperature of would increase the probability of participants changing to use of a thermometer.

As seen in Figure 8, participants' anticipated changes were in agreement with the expected outcome stated in the hypothesis. Nearly 36% reported they planned to definitely change and use a thermometer. In Figure 9, however, only slightly more than 8% reported they definitely planned to change and select grilled lean beef if offered the choice. However, over half of the subjects reported they would continue choosing grilled lean beef, meaning they already chose grilled lean beef over chicken. Not enough

participants reported intent to change (25% of participants would have needed to report a definite intent to change) to lean beef following the lesson. Therefore, this hypothesis was rejected.

Hypothesis 4

The *Ground Beef Lesson* stated more participants would use a food thermometer to assure ground beef reaches a safe internal temperature of 160 ^{o}F, and more participants would choose 95% lean ground beef as a result of the lesson.

As seen in Figure 11, participant responses reflected the hypothesis. Over 32 % of participants reported they intended to definitely use a thermometer to determine when ground beef is done. However, less than 15% reported an intention to make the change to 95% lean beef (Figure12). Although this is considered a change in the right direction, it was small and the lesson failed to change the intention of a larger percentage of participants. Therefore, this part of the hypothesis was rejected.

Hypothesis 5

The *Homemade with Help Lesson* stated education on reading Nutrition Facts labels to select heat-and-eat beef products that are nutritious and convenient would increase the intent of participants to purchase heat-and-eat beef products and read Nutrition Facts labels prior to purchase.

As seen in Figure 14 and 15, participant responses were in agreement with the hypothesis. The hypothesis was accepted because about 29% reported they definitely

planned to buy heat-and-eat beef products and nearly 41% reported they would check Nutrition Facts labels before buying heat-and-eat beef products.

Hypothesis 6

The *Mixing Cultures Lesson* stated education regarding cultural beef dishes would increase participants' ability and intent to incorporate lean beef into healthy recipes and expand their cooking skills to new cultural dishes that may call for new equipment.

As seen in Figure 17 and Figure 18, over 43% of participants reported they would definitely change to using lean beef in healthy recipes, and nearly three-quarters of the participants were willing to substitute equipment or purchase equipment needed to prepare cultural beef dishes. Therefore, the hypothesis was accepted.

Conclusions

The findings from this study suggest the OBCS was effective in improving participants' knowledge about beef and cooking skills. Overall, participants exhibited a willingness to change to suggested methods or techniques that were presented in the lesson. There was, however, no way of determining if knowledge and skills, such as using a thermometer when cooking beef, fostered any long-term behavioral changes in participants. Therefore, it can be proposed for further studies evaluating hands-on learning in adult populations to include a pretest/posttest to compare participant responses from the conclusion of the study with prior to the start of the study. Also, a follow-up can evaluate if implemented changes participants intended to make were actually applied. The Oklahoma Cooperative Extension Service dedicates much of their

time and effort to improving the nutritional health of Oklahoma residents through education programs that focus on increasing food and nutrition knowledge, food purchasing, and basic cooking skills. This study demonstrated hands-on experiences targeted at improving basic cooking skills and increasing food and nutrition knowledge was effective in changing, or altering, participants' previous opinions and behaviors.

Limitations

As mentioned in Chapter 1, limitations existed in this study. First of all, there was no control group, or pretest/posttest conducted, to compare data at the end of the program. Following-up on participants would have helped determine how participants implemented their intended changes compared to what was reported on evaluations to assess if the lessons had any long-term effects. Information obtained from participants by evaluations could not be applied to the general public. Although the majority of participants were female (86.25%), it was not assumed these female participants were generally responsible for the purchasing and preparation of food for their household because this data was not collected.

There was no way to determine how many lessons participants attended because the lessons were voluntary. County Educators taught the lessons in the order of their choosing, rather than a set order determined by the program creators. Because of that, and because each lesson was a stand-alone event, there was no method to determine if information gained was reinforced from lesson to lesson. Men were also not included in the results because of low attendance (13.76%).

Recommendations

Based on the limitations of this study, the following recommendations are suggested for further studies:

1. Use a control group to compare experimental group data. The control group would not attend any lessons.
2. Develop a pretest/posttest to determine what participants learned from the lessons.
3. Include a follow-up survey to evaluate any long-term effects.
4. Develop lessons as a series with a pre-determined order and enroll participants to attend the entire series.
5. Market the study to attract a larger number of male participants.

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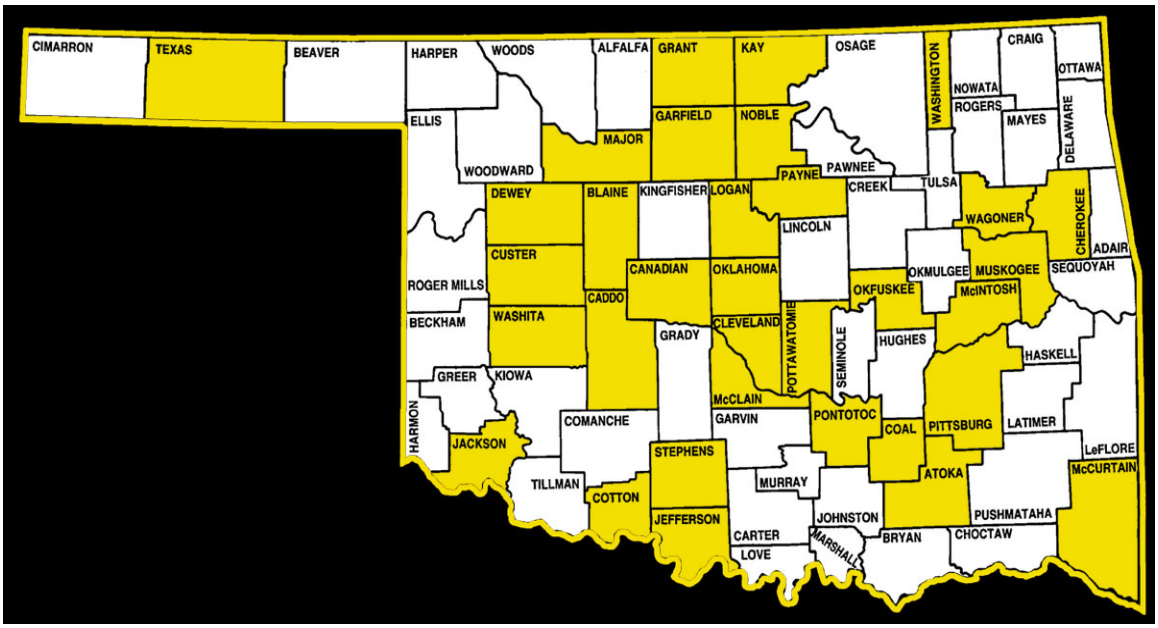
APPENDICES

APPENDIX A

County Map of Oklahoma



Counties that participated in the OBCS are in yellow.

Oklahoma Beef Cooking School
Adult Curriculum

Informed Consent Script

To: County Educators
From: Barbara Brown, Food Specialist
RE: Script to be read to participants before they are given the opportunity to complete an evaluation form.

PLEASE READ TO PARTICIPANTS BEFORE EACH LESSON IS EVALUATED:

In order for the Oklahoma Cooperative Extension Service to be able to determine if the Oklahoma Beef Cooking School has been effective we would like you to participate in the evaluation process. Completing the evaluation forms is voluntary and confidential. There is nothing on the form that would allow us to know who completed the form, when it was completed or where a particular cooking school was held. It will help us determine if the school has met our goal of helping participants increase their understanding of how beef fits into a healthful diet, how to prepare beef quickly and economically and how to make sure the risk of foodborne illness is kept low.

If you have questions about subjects' rights you may contact Dr. Carol Olson, Institutional Review Board Chair at 415 Whitehurst, Stillwater, OK 74078. You may also reach Dr. Olson at (405) 744-1676 or on-line at colson@okstate.edu.

Thank you for your help in improving the quality of our programming.

Barbara Brown, Food Specialist
Oklahoma Cooperative Extension Service

APPENDIX C

Beef Sandwiches, Soups & Salads Lesson

Evaluation

Directions: Check the answer to each question that is the best answer for you.

Section 1

Gender: _____Male _____Female

Age: _____Under 18 _____18—30 _____31—50

_____50—65 _____Over 65

Section 2

Today I learned

_____1. I knew the amount of the saturated fatty acids that can potentially raise blood cholesterol levels is comparable in lean beef, fish and chicken.

_____2. The amount of saturated fatty acids that can potentially raise blood cholesterol levels is comparable in lean beef, fish and chicken.

If you checked number one above skip to the next page.

Based on what you know about the saturated fatty acid content of beef do you plan to:

_____1. Eat beef less often.

_____2. Eat beef as often as before attending the Cooking School.

_____3. Eat beef more often than before attending the Cooking School.

Please answer the questions on the next page.

Evaluation (continued)

Section 3

In today's lesson you heard hot and cold foods should be in the danger zone (between 40°F and 140°F) no longer than two hours. Failing to clear the table and refrigerate or freeze foods quickly can allow time for microorganisms to grow or produce a toxin that can make people sick. Do you plan to:

_____1. Continue my current practice of clearing the table and refrigerating or freezing foods whenever I am ready even if it means the food is at room temperature longer than 2 hours.

_____2. Think about clearing the table and refrigerating or freezing foods more quickly.

_____3. Definitely clear the table and refrigerate or freeze foods more quickly.

_____4. I already clear the table and refrigerate or freeze foods quickly.

Section 4

Please share your comments about today's lesson.

Would you be interested in attending other Oklahoma Beef Cooking School lessons?

_____1. Yes

_____2. No

_____3. Maybe

Thank you for helping evaluate the effectiveness of our program.

Beef Steak Lesson

Evaluation

Directions: Check the answer to each question that is the best answer for you.

Section 1

Gender: _____Male _____Female

Age: _____Under 18 _____18—30 _____31—50
_____50—65 _____Over 65

Section 2

Today I learned there are at least 19 cuts of beef that meet the government labeling guidelines for lean or extra lean.

_____1. I will continue to select from those lean cuts when choosing beef.

_____2. I could make a change in the cuts of beef I choose to reduce the amount of fat.

If you checked number one above skip to section 3 on the next page.

If you checked number 2 above after today's workshop do you plan to:

_____1. Make no change in the beef cuts I buy.

_____2. Think about choosing from the 19 cuts of lean beef when buying beef.

_____3. Probably choose from the 19 cuts of lean beef when buying beef.

_____4. Definitely choose from the 19 cuts of lean beef when buying beef.

Please answer the questions on the next page.

Beef Steak Lesson

Evaluation (continued)

Section 3

In today's lesson you heard that a thermometer is the most effective method to determine the doneness of beef steak. Do you plan to:

_____1. Use interior color to determine doneness

_____2. Use the touch/pressure method to determine doneness of beef steak.

_____3. Consider using a thermometer to determine doneness of beef steak.

_____4. Change to a thermometer to determine doneness of beef steak.

_____5. Continue to use a thermometer to determine doneness of beef steak.

Section 4

Please share your comments about today's lesson.

Would you be interested in attending other Oklahoma Beef Cooking School lessons?

_____1. Yes

_____2. No

_____3. Maybe

Thank you for helping evaluate the effectiveness of our program.

Grilling In and Out Lesson

Evaluation

Directions: Check the answer to each question that is the best answer for you.

Section 1

Gender: _____Male _____Female

Age: _____Under 18 _____18—30 _____31—50
_____50—65 _____Over 65

Section 2

Today I learned

_____1. I correctly use a thermometer when grilling beef for quality and to be sure it reaches a safe internal temperature.

_____2. I should make a change in the way I decide when grilled beef is done for quality and to be sure it reaches a safe internal temperature.

If you checked number one above skip to section 3 on the next page.

If you checked number 2 above after today's workshop do you plan to:

_____1. Make no change in the way you decide grilled beef is done.

_____2. Think about using a thermometer when grilling beef.

_____3. Probably use a thermometer to determine when grilled beef is done.

_____4. Definitely use a thermometer to determine when grilled beef is done.

Please answer the questions on the next page.

Evaluation (continued)

Section 3

In today's lesson you heard that lean beef has more vitamin B_{12}, zinc, and iron than skinless chicken breast and is low in fat and saturated fat. When offered the choice of grilled lean beef or chicken breast will you:

_____1. Continue choosing grilled lean beef.

_____2. Think about choosing grilled lean beef instead of skinless chicken breast.

_____3. Definitely change to grilled lean beef instead of skinless chicken breast.

_____4. Continue choosing grilled skinless chicken breast instead of lean beef.

Section 4

Please share your comments about today's lesson.

Would you be interested in attending other Oklahoma Beef Cooking School lessons?

_____1. Yes

_____2. No

_____3. Maybe

Thank you for helping evaluate the effectiveness of our program.

Ground Beef Lesson

Evaluation

Directions: Check the answer to each question that is the best answer for you.

Section 1

Gender: _____Male _____Female

Age: _____Under 18 _____18—30 _____31—50
_____50—65 _____Over 65

Section 2

Today I learned

_____1. I correctly use a thermometer when cooking ground beef to be sure it reaches a safe internal temperature of 160^{o}F.

_____2. I should make a change in the way I decide when ground beef is done.

If you checked number one above skip to section 3 on the next page.

If you checked number 2 above after today's workshop do you plan to:

_____1. Make no change in the way you decide ground beef is done.

_____2. Think about using a thermometer when cooking ground beef.

_____3. Probably use a thermometer to determine when ground beef is done.

_____4. Definitely use a thermometer to determine when ground beef is done.

Please answer the questions on the next page.

Ground Beef Lesson

Evaluation (continued)

Section 3

In today's lesson you heard that 95% lean ground beef meets the government definition of lean. Do you plan to:

_____1. Continue choosing 95% lean when cooking ground beef dishes.

_____2. Continue using a lower percent lean ground beef for all ground beef recipes.

_____3. Consider using 95% lean ground beef in recipes where fat cannot be drained away before eating.

_____4. Change to 95% lean ground beef in recipes where the fat cannot be drained away before eating.

Section 4

Please share your comments about today's lesson.

Would you be interested in attending other Oklahoma Beef Cooking School lessons?

_____1. Yes

_____2. No

_____3. Maybe

Thank you for helping evaluate the effectiveness of our program.

Beef: Homemade with Help Lesson

Evaluation

Directions: Check the answer to each question that is the best answer for you.

Section 1

Gender: _____Male _____Female

Age: _____Under 18 _____18—30 _____31—50
_____50—65 _____Over 65

Section 2

Today I learned

_____1. I was correct in knowing refrigerated heat-and-eat beef products are nutritious time savers.

_____2. Heat -and-eat refrigerated beef dishes are nutritious time savers.

If you checked number one above skip to section 3 on the next page.

If you checked number 2 above after today's workshop do you plan to:

_____1. Not buy heat-and-eat refrigerated beef products.

_____2. Think about buying heat-and-eat refrigerated beef products.

_____3. Probably buy heat-and-eat refrigerated beef products.

_____4. Definitely buy heat-and-eat refrigerated beef products.

Please answer the questions on the next page.

Evaluation (continued)

Section 3

In today's lesson you heard lean beef can be high in protein, zinc, iron and B-vitamins whether you use it fresh from the meat case, in heat-and-eat products or frozen. This information is on the Nutrition Facts label. Do you plan to:

_____1. Buy beef without checking the Nutrition Facts label.

_____2. Think about reading the Nutrition Facts label to help choose and buy nutritious beef products.

_____3. Definitely read the Nutrition Facts label to choose and buy nutritious beef products.

_____4. I already read the Nutrition Facts label when I choose and buy nutritious beef products.

Section 4

Please share your comments about today's lesson.

Would you be interested in attending other Oklahoma Beef Cooking School lessons?

_____1. Yes

_____2. No

_____3. Maybe

Thank you for helping evaluate the effectiveness of our program.

Mixing Cultures Lesson

Evaluation

Directions: Check the answer to each question that is the best answer for you.

Section 1

Gender: _____Male _____Female

Age: _____Under 18 _____18—30 _____31—50
_____50—65 _____Over 65

Section 2

Today I learned

_____1. I was correct in knowing lean cuts of beef can be used in healthful recipes.

_____2. Lean cuts of beef can be used in healthful recipes.

If you checked number one above skip to section 3 on the next page.

If you checked number 2 above after today's workshop do you plan to:

_____1. Continue to choose chicken when planning healthful meals.

_____2. Think about using lean beef when preparing healthful meals.

_____3. Probably use lean beef when preparing healthful meals.

_____4. Definitely use lean been when preparing healthful meals.

Please answer the questions on the next page.

Evaluation (continued)

Section 3

In today's lesson you saw that some of the recipes were made in pans you may not have in your kitchen. Do you plan to:

_____1. Not cook cultural beef dishes if I don't have the pans called for.

_____2. Think about whether or not I could substitute a piece of equipment I already have to make a cultural dish.

_____3. Definitely substitute a piece of equipment I already have to make a cultural dish when I don't have the equipment called for in the recipe.

_____4. Go out and buy pieces of equipment that I don't have when they are called for in cultural recipes.

Section 4

Please share your comments about today's lesson.

Would you be interested in attending other Oklahoma Beef Cooking School lessons?

_____1. Yes

_____2. No

_____3. Maybe

Thank you for helping evaluate the effectiveness of our program.

VITA

Sarah Lilley Owen

Candidate for the Degree of

Master of Science

Thesis: EVALUATION OF THE OKLAHOMA BEEF COOKING SCHOOL

Major Field: Nutritional Sciences

Biographical:

Personal Data: Born in Cleveland, Ohio. Parents are Charles and Judith Owen. Siblings: Renee Ashcraft, Jeffrey Owen, Alison Colonna, and Lisa Owen

Education: Graduated from Bowling Green State University in May, 2004, with a Bachelor of Science in Dietetics. Completed dietetic internship program through Oklahoma State University in July, 2008.

Professional Memberships: American Dietetic Association, Oklahoma Dietetic Association

Name: Sarah Lilley Owen Date of Degree: May, 2009

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: EVALUATION OF THE OKLAHOMA BEEF COOKING SCHOOL

Pages in Study: 128 Candidate for the Degree of Master of Science

Major Field: Nutritional Sciences

Scope and Method of Study: The purpose of the OBCS was to offer hands-on cooking experiences using beef while providing basic nutrition education, as well as safe food preparation and cooking techniques and tips. The OBCS curriculum was composed of six hands-on cooking classes that were developed in 2004 for middle-class adults in Oklahoma. The curriculum focused on nutrition benefits of eating beef, safe food handling practices, nutritious selections of beef, preparation and cooking techniques, and quick and convenient methods to preparing beef dishes at home. Each lesson included a PowerPoint presentation, a minimum of ten tested recipes, handout materials, and an evaluation. Evaluations were conducted after each lesson to determine if participation in the lesson would result in anticipated changes participants intended to make in the amount and frequency of beef consumed, how it is prepared, cooking methods, and their opinion of beef as a food included regularly in the diet. Forty-eight County Educators were trained to teach lessons in their home counties. The curriculum was designed as a series of six lessons but advertised as “stand alone” events. Participants were welcome to attend one or all of the lessons. With this limitation in mind, separate questionnaires were developed for each lesson. Frequencies using SAS software were used to determine changes in participants’ knowledge and changes participants intended to make as a result of the lesson. Each lesson was treated as a separate entity for evaluation purposes.

Findings and Conclusions: Hands-on cooking classes using beef as the protein source was effective in increasing beef acceptance and intent to include lean beef in the diet. Findings suggested participants’ opinion of beef improved with nutrition education. Education and hands-on experiences regarding the selection of lean cuts of beef, quick and convenient methods to preparing nutritious beef dishes, and safe handling of beef to prevent foodborne illness increased the probability of participants including lean beef in the diet, as well as practicing safe food handling methods while preparing healthful beef dishes.

ADVISER’S APPROVAL: Dr. Barbara J. Brown